

US9577440B2 Inductive power source and charging system

I. Samsung Infringement

This chart refers to versions of the WPC Standard, including exemplary versions 1.1.2 and 1.2.4, as part of its evidence of infringement. However, this should not be interpreted to limit Plaintiff's infringement contentions to products complying with any particular version of the Wireless Power Consortium (WPC) standard (or products complying with the standard at all).

1. A mobile device capable of inductive powering or charging by a universal base unit for charging of different mobile devices and/or batteries of different charging characteristics associated therewith, comprising:

As detailed below by representative products, the 440 Accused Products that can receive wireless power are accused under this claim ("440 Claim 1 Accused Products"). The 440 Claim 1 Accused Products fit the description in this introductory part of the claim. Each is capable of receiving inductive power from a base unit that can wirelessly charge different mobile devices and/or batteries with different charging characteristics as specified by this introductory part of the claim.

Samsung Galaxy smartphones

The S7 and S22 Ultra are presented as representative of the Samsung smartphones that are 440 Claim 1 Accused Products. Each can receive wireless power by a wireless charger that can charge devices of different charging characteristics (e.g., each can be charged by a WPC-certified charger), as specified by claim 1. The S7 and S22 Ultra have been tested and certified to conform to the WPC Standard as shown below.

<https://www.samsung.com/global/galaxy/what-is/wireless-charging/>

Do Galaxy devices have wireless charging?

Get hassle-free charging for when you need to power up fast. Wireless charging saves you from getting all tangled up, giving them the added comfort and speed of simply placing their devices on a charging station. The Wireless Charger Stand (sold separately) gives you the option of using it as a pad or a stand, so you can either give your phone a rest as it charges, or continue watching videos and browsing by propping it up against the stand. And with the Wireless Charger Duo, you're able to charge two devices at once, like your phone and your Galaxy Watch, or your phone and a friend's.

And Fast Wireless Charging 2.0 is a wireless charging standard from Samsung. Delivering a 10W+ charge, it makes your Galaxy S20, S20+, and S20 Ultra wirelessly charge faster, meaning you don't have to be tied down for long. It's available on the Samsung Wireless Charger Stand and Wireless Charger Duo Pad.

Wireless Charging is supported on Galaxy S20, S20+, S20 Ultra, Z Flip, Note10, Note10+, Fold, S10e, S10, S10+, Note9, S9, S9+, Note8, S8, S8+, S7, S7 edge, Note5, S6 edge+, S6 edge, and S6.

Discover more about Galaxy for yourself.

*Wireless charger sold separately.

*Wireless charger requires power connection. Recommend using genuine Samsung branded power cord and/or travel adapter for use.

*Wireless charging under 5W (Normal-mode) is compatible with WPC and PMA.

[Go to Galaxy S20 | S20+ | S20 Ultra PG](#)

[Go to Galaxy Z Flip](#)



<https://www.wirelesspowerconsortium.com/products/1549>

SAMSUNG MOBILE PHONE GALAXY S7 (SM-G930V)



BRAND
Samsung Mobile Phone

PRODUCT NAME
Galaxy S7

MANUFACTURER PART NUMBER
SM-G930V

PRODUCT TYPE
Power Class 0 Receiver

REGISTRATION DATE
February 24, 2016



ADDITIONAL DETAILS

Qi Registration id	1549
Version	1.1.2
Currently licensed	Yes
Power profile	Basic Power Profile
Maximum received power	5 watts

<https://www.wirelesspowerconsortium.com/products/12711>

SAMSUNG ELECTRONICS GALAXY S22 ULTRA (SM-S9080)



BRAND
Samsung Electronics

PRODUCT NAME
Galaxy S22 Ultra

MANUFACTURER PART NUMBER
SM-S9080

PRODUCT TYPE
Power Class 0 Receiver

REGISTRATION DATE
March 16, 2022



ADDITIONAL DETAILS

Qi Registration id	12711
Version	1.2.4
Currently licensed	Yes
Power profile	Basic Power Profile
Maximum received power	4.4 watts

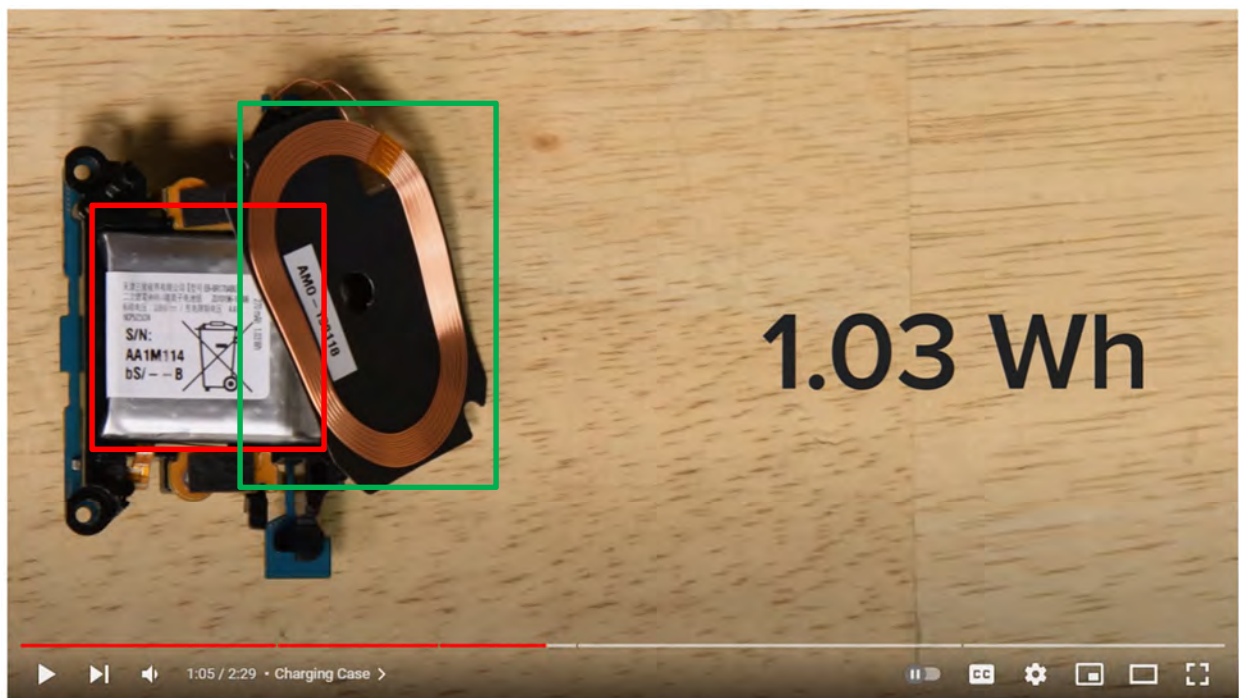
Samsung earbud products

The charging cases for the Buds and Buds2 are presented as representative of the Samsung earbud products that are 440 Claim 1 Accused Products. Each can receive wireless power from a wireless charger that can charge devices of different charging characteristics (e.g., each can be charged by a WPC-certified charger), as specified by claim 1.

For example, Buds and Buds2 cases include a battery (red rectangle) which can be charged wirelessly/inductively via their wireless receiver charging coil (green rectangle) included therein.

Buds

<https://www.youtube.com/watch?v=Mg6OpvMzguY>



Galaxy Buds Teardown: The Most Repairable Wireless Earbuds We've Ever Seen!

<https://www.youtube.com/watch?v=Au9FHHmASjo>

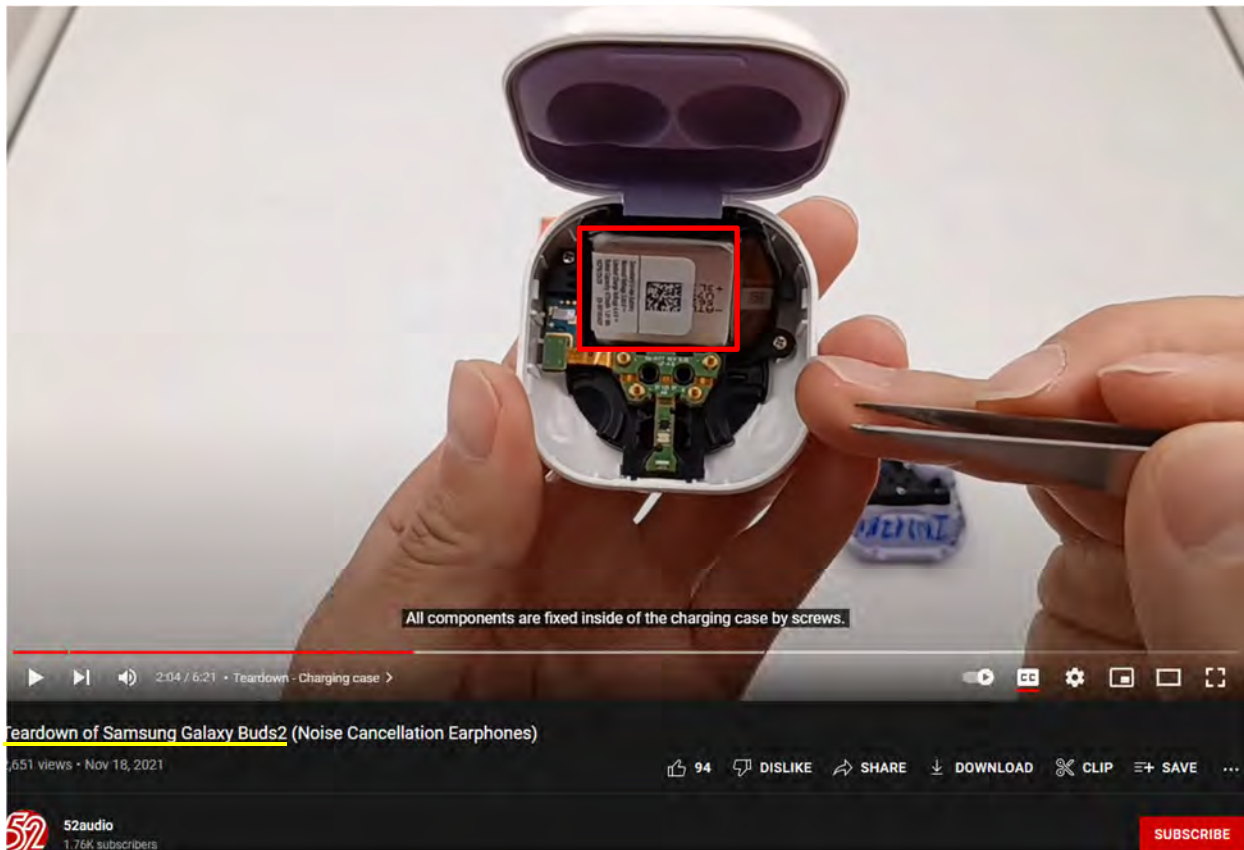


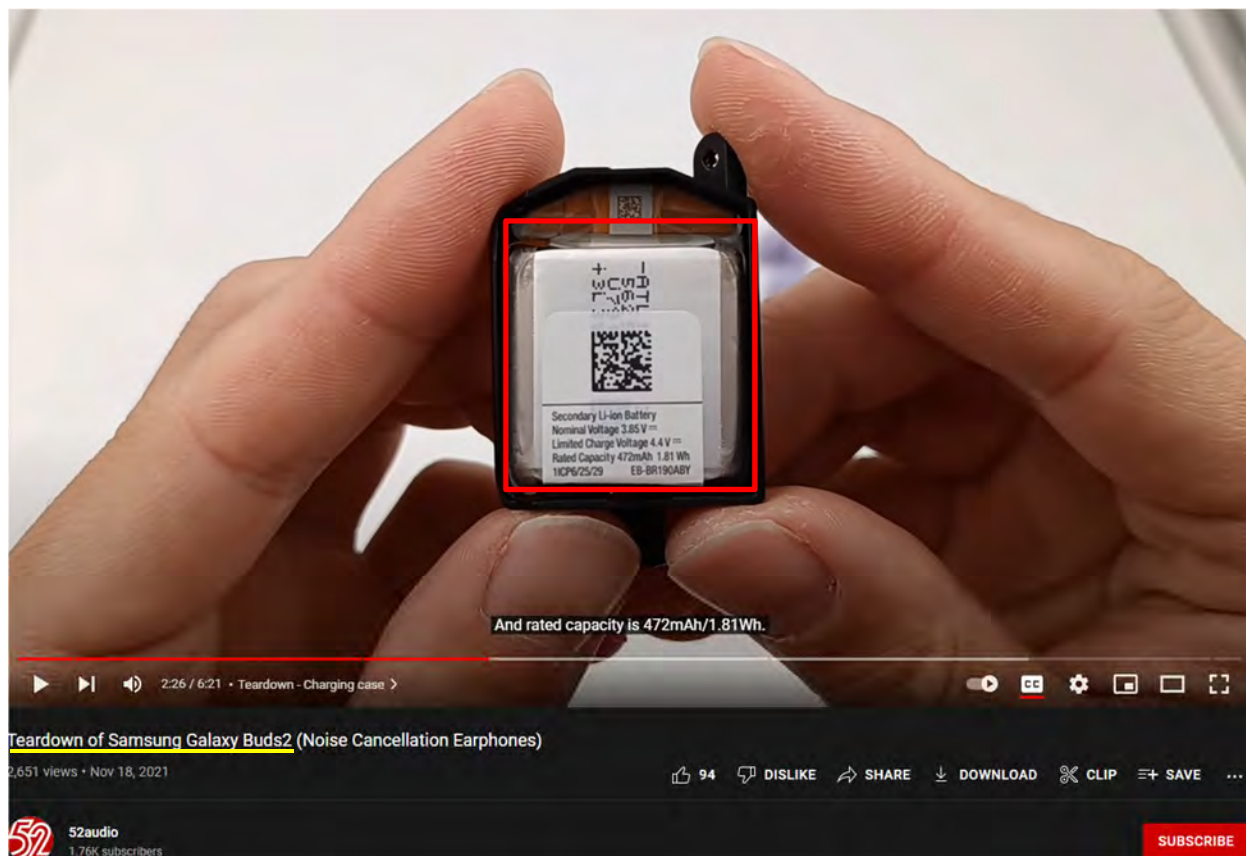
<https://www.youtube.com/watch?v=Au9FHHmASjo>

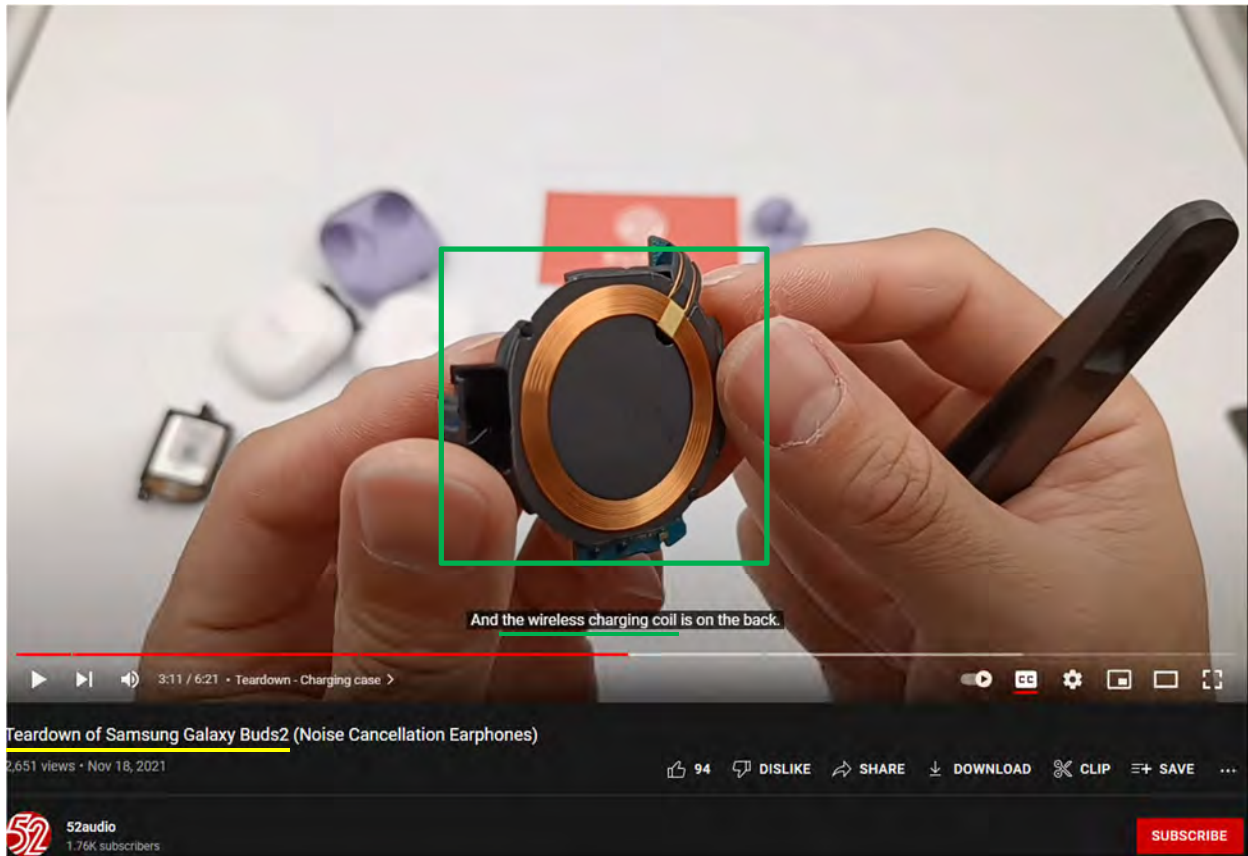


Buds2

https://www.youtube.com/watch?v=IR6FC5qE-vI&ab_channel=52audio







Buds Live

<https://www.youtube.com/watch?v=eHatYtJFECQ>



The Buds and Buds2 cases are interoperable with WPC wireless chargers. The Buds2 case is specifically WPC/Qi-certified showing adherence to its specifications and being able to be charged on a WPC charger

<https://www.wirelesspowerconsortium.com/products/11427>

SAMSUNG ELECTRONICS GALAXY BUDS2 (SM-R177)

**BRAND**

Samsung Electronics

PRODUCT NAME

Galaxy Buds2

MANUFACTURER PART NUMBER

SM-R177

PRODUCT TYPE

Power Class 0 Receiver

REGISTRATION DATE

August 19, 2021

DESCRIPTION

GALAXY BUDS 2

**ADDITIONAL DETAILS**

Qi Registration id	11427
Version	1.2.4
Currently licensed	Yes
Power profile	Basic Power Profile
Maximum received power	2 watts



Samsung wearables

The Watch4 is presented as representative of the Samsung wearables that are 440 Claim 1 Accused Products. Each is able to receive wireless power from a wireless charger that can charge devices of different charging characteristics (e.g., each can be wirelessly charged by the S10 and S22 Ultra smartphones or Samsung wireless chargers such as the 5400 Duo Pad and the 6300 Trio Pad which can each wirelessly charge various WPC-certified receivers), as specified by claim 1.

<https://www.samsung.com/us/support/answer/ANS00082564/>

Compatible Samsung devices

Most Qi-Compatible Samsung devices can be charged with Wireless PowerShare, but check out the full list of compatible devices just in case. The speed and power of the charge will vary by device.

Phones that can use and also be charged with Wireless PowerShare:

- Galaxy S22, S22+, and S22 Ultra
- Galaxy S21, S21+, and S21 Ultra
- Note20 5G and Note20 Ultra 5G
- Galaxy Note10, Note10+, and Note10+ 5G
- Galaxy Fold, Z Fold2, Z Fold3 and Z Fold4
- Galaxy Z Flip, Z Flip 5G, Z Flip3 and Z Flip4
- Galaxy S20 5G, S20+ 5G, S20 Ultra 5G, and S20 FE
- Galaxy S10e, S10, S10+, and S10 5G

Other devices that can be charged by Wireless PowerShare:

- Galaxy Buds, Galaxy Buds2, Galaxy Buds+, Galaxy Buds Live, Galaxy Buds Pro, and Galaxy Buds2 Pro
- Galaxy Watch, Galaxy Watch3, Galaxy Watch4 series, Galaxy Watch5 series, Gear Sport, and Gear S3
- Galaxy S7/S7 Edge, S8/S8+, S9/S9+, Note8, and Note9
- Galaxy Watch Active and Galaxy Watch Active2

a battery, wherein one or both of a mobile device and the battery have particular charging characteristics associated therewith;

The 440 Claim 1 Accused Products meet this part of the 440 claim 1 as they each comprise a battery. Particular charging characteristics such as rate of charge and battery capacity are associated with one or both of a mobile device and the battery.

Samsung Galaxy smartphones

The S7 smartphone includes a battery. Moreover, certain charging characteristics are associated with the S7 and/or the battery included therein.

<https://www.ifixit.com/Teardown/Samsung+Galaxy+S7+Teardown/56686>

Step 8



<https://www.wirelesspowerconsortium.com/products/1549>

SAMSUNG MOBILE PHONE GALAXY S7 (SM-G930V)



BRAND
Samsung Mobile Phone

PRODUCT NAME
Galaxy S7

MANUFACTURER PART NUMBER
SM-G930V

PRODUCT TYPE
Power Class 0 Receiver

REGISTRATION DATE
February 24, 2016

ADDITIONAL DETAILS

Qi Registration id	1549
Version	1.1.2
Currently licensed	Yes
Power profile	Basic Power Profile
Maximum received power	5 watts



The S22 Ultra smartphone also includes a battery. Certain charging characteristics are associated with the S22 Ultra/its battery.

<https://www.ifixit.com/News/57567/galaxy-s22-teardowns-apple-is-making-samsung-sweat>



<https://www.wirelesspowerconsortium.com/products/12711>

SAMSUNG ELECTRONICS GALAXY S22 ULTRA (SM-S9080)

BRAND

Samsung Electronics

PRODUCT NAME

Galaxy S22 Ultra

MANUFACTURER PART NUMBER

SM-S9080

PRODUCT TYPE

Power Class 0 Receiver

REGISTRATION DATE

March 16, 2022

**ADDITIONAL DETAILS**

Qi Registration id	12711
Version	1.2.4
Currently licensed	Yes
Power profile	Basic Power Profile
Maximum received power	4.4 watts

Samsung earbud products

The case of each of the Buds and Buds2 includes a battery having particular charging characteristics. The Samsung PMIC in these cases is designed to receive power inductively and charge the earbud case battery according to its particular charging characteristics.

Buds



Galaxy Buds Teardown: The Most Repairable Wireless Earbuds We've Ever Seen!

<https://www.youtube.com/watch?v=Mg6OpvMzguY>

<https://www.youtube.com/watch?v=Au9FHHmASjo>



#SamsungGalaxy #Earphones #SamsungGalaxybuds

Detailed Tear Down | Samsung Galaxy Buds



Omarr Ghafoor
14.8K subscribers

Subscribe

Like

Comment

Share

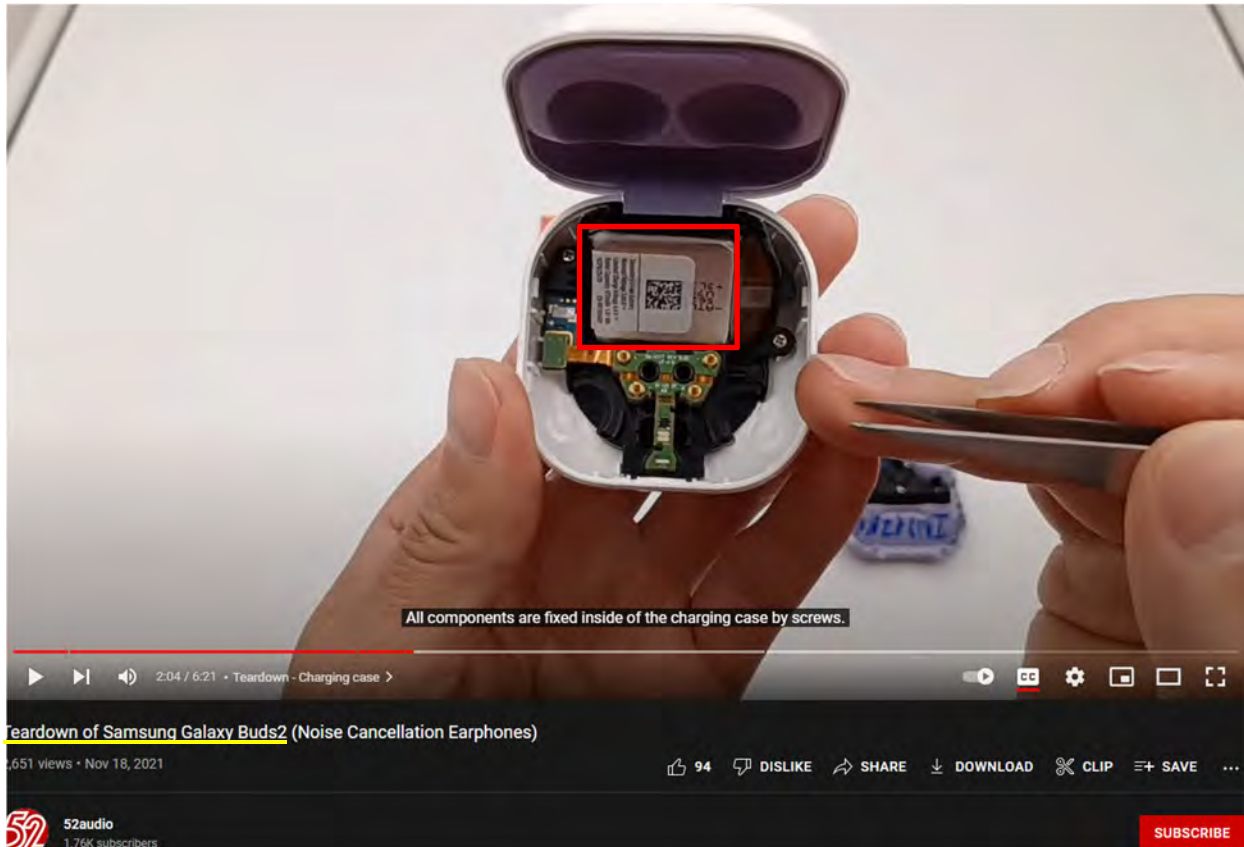
Download

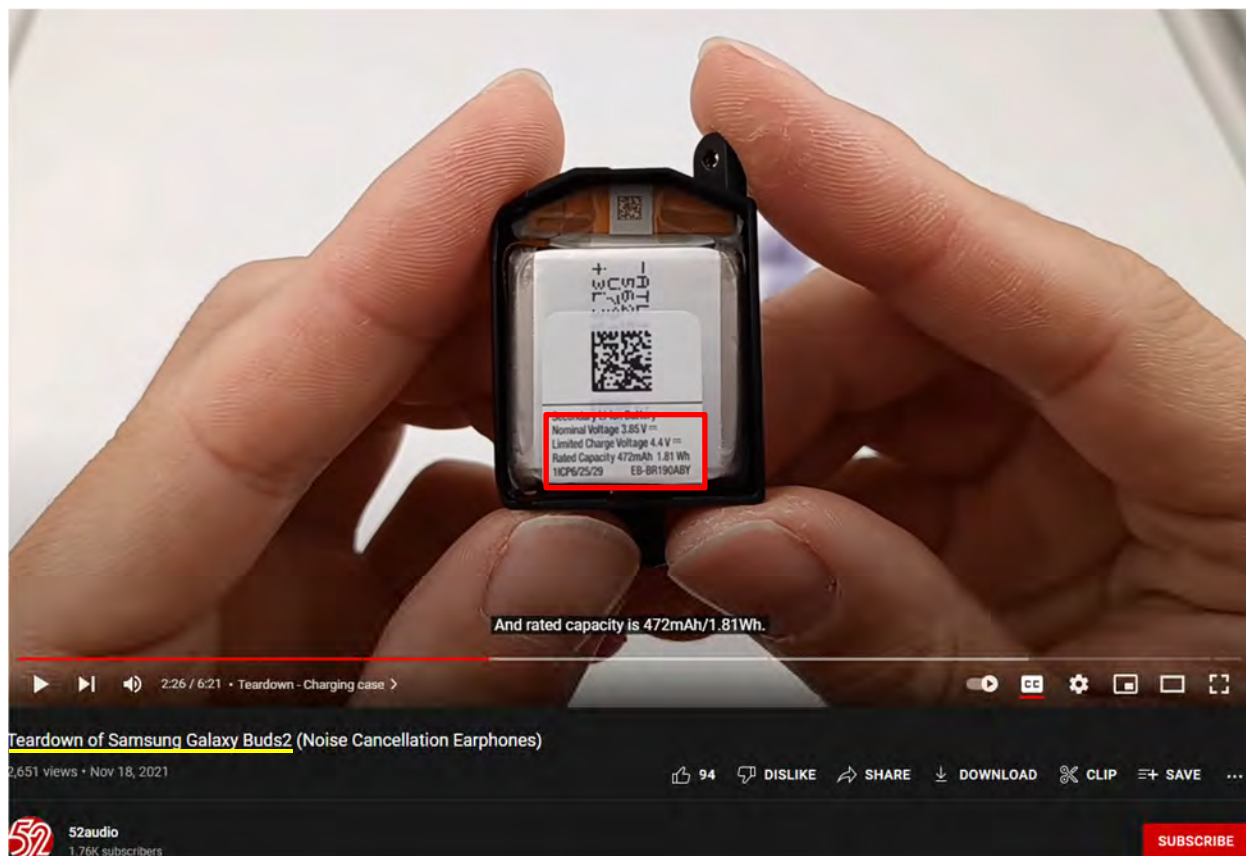
Clip

...

Buds2

https://www.youtube.com/watch?v=IR6FC5qE-vI&ab_channel=52audio





<https://www.wirelesspowerconsortium.com/products/11427>

SAMSUNG ELECTRONICS GALAXY BUDS2 (SM-R177)

**BRAND**

Samsung Electronics

PRODUCT NAME

Galaxy Buds2

MANUFACTURER PART NUMBER

SM-R177

PRODUCT TYPE

Power Class 0 Receiver

REGISTRATION DATE

August 19, 2021

DESCRIPTION

GALAXY BUDS 2

ADDITIONAL DETAILS

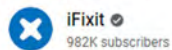
Qi Registration id	11427
Version	1.2.4
Currently licensed	Yes
Power profile	Basic Power Profile
Maximum received power	2 watts

**Buds Live**

<https://www.youtube.com/watch?v=eHatYtJFECQ>



Galaxy Buds Live Teardown: The Most Repairable Earbuds Yet?



Subscribe

17K



Share



Download



Clip



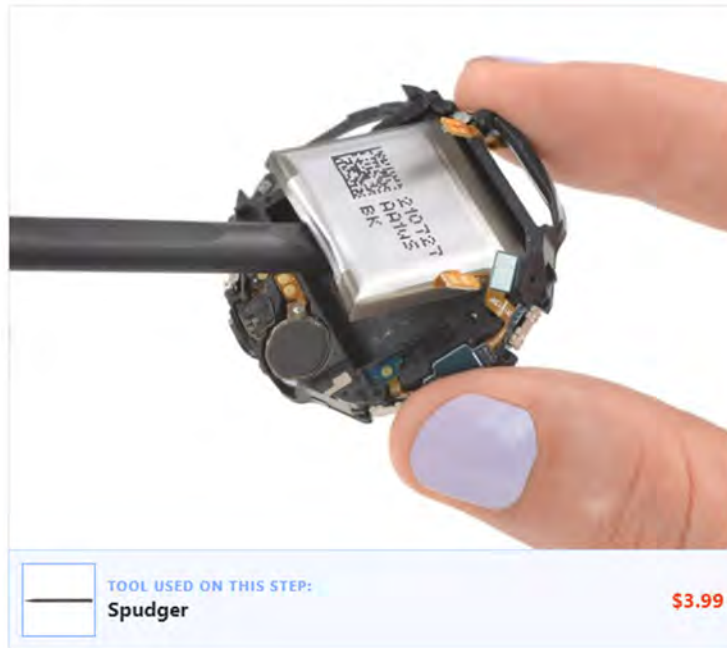
Samsung wearables

The representative Galaxy Watch4 includes a battery having particular charging characteristics.

Watch4

<https://www.ifixit.com/Teardown/Samsung+Galaxy+Watch4+and+Watch4+Classic+Teardown/144595>
(Galaxy Watch4)

Step 7



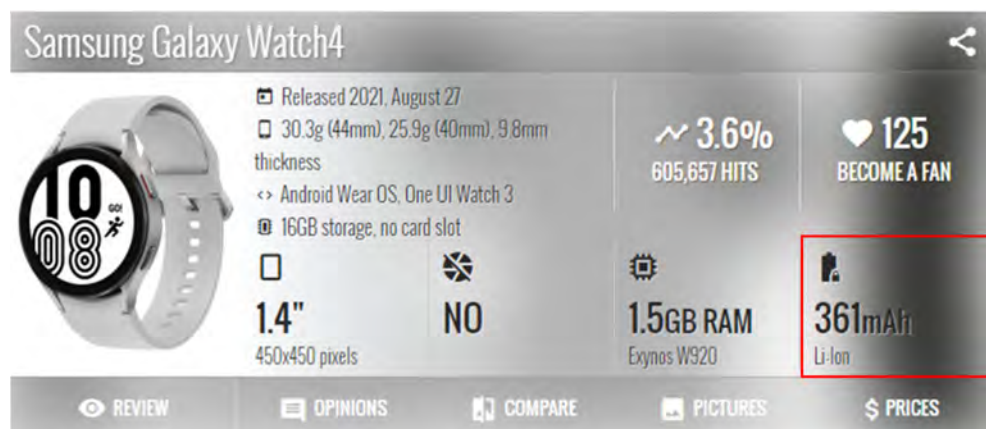
- The watches' fuel tanks are hidden under the motherboards and nestled within plastic midframes.
- ① Thankfully, both can be removed without any heat—so long as you have a sturdy [spudger](#) on hand. (Just don't poke too hard—the usual li-ion battery cautions apply here.)
- The Watch4 Classic 46 mm accommodates a 1.40 Wh (361 mAh @ 3.88 V) battery—while its 40 mm little sister, the Watch4, houses a 0.95 Wh (247 mAh @ 3.88 V) battery.
- ① Compared to the Watch3 with 1.3 Wh (340 mAh @ 3.85 V), this represents a modest upgrade. With 1.62 Wh, the [2021 Mi Watch](#) still packs a bit more power—and the [Apple Watch Series 6 \(44 mm\)](#) twiddles its thumbs at the bottom of the stack with 1.17 Wh.

Step 7



- The watches' fuel tanks are hidden under the motherboards and nestled within plastic midframes.
- ① Thankfully, both can be removed without any heat—so long as you have a sturdy [spudger](#) on hand. (Just don't poke too hard—the usual li-ion battery cautions apply here.)
- The Watch4 Classic 46 mm accommodates a 1.40 Wh (361 mAh @ 3.88 V) battery—while its 40 mm little sister, the Watch4, houses a 0.95 Wh (247 mAh @ 3.88 V) battery.
- ① Compared to the Watch3 with 1.3 Wh (340 mAh @ 3.85 V), this represents a modest upgrade. With 1.62 Wh, the [2021 Mi Watch](#) still packs a bit more power—and the [Apple Watch Series 6 \(44 mm\)](#) twiddles its thumbs at the bottom of the stack with 1.17 Wh.

https://www.gsmarena.com/samsung_galaxy_watch4-11045.php (Galaxy Watch4)



a receiver and receiver coil, for one of inductively powering the device or charging the battery in the mobile device, wherein the receiver is one of attached to or incorporated into the battery or the mobile device, and wherein the receiver coil has a generally planar shape so that a magnetic field received in a direction substantially perpendicular to the plane of the receiver coil is used to inductively generate a current in the receiver coil;

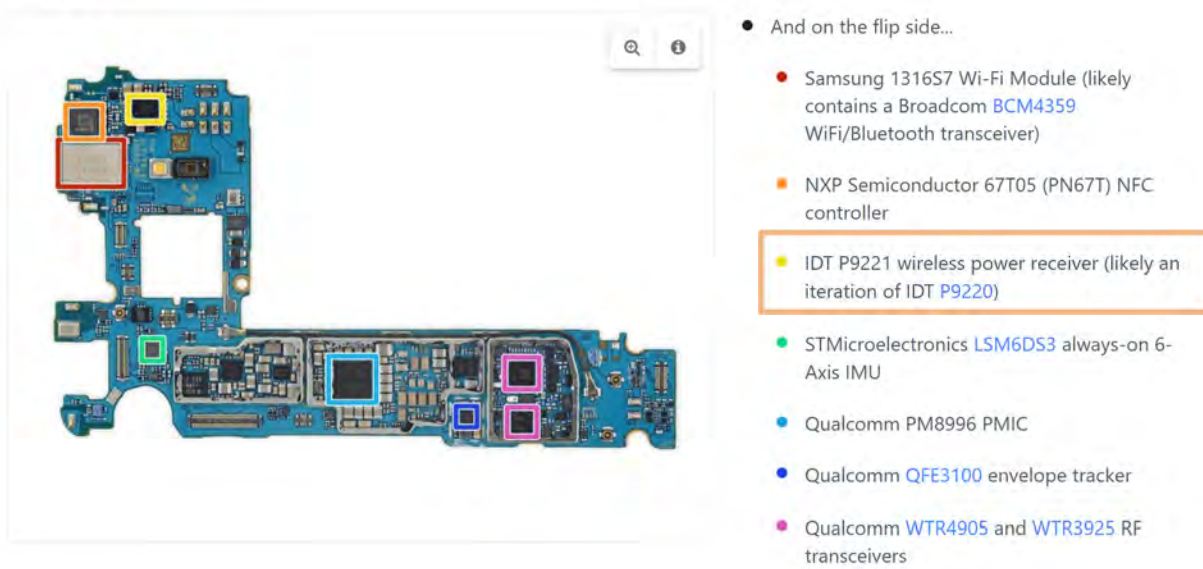
The 440 Claim 1 Accused Products meet this part of the 440 claim 1 as they each comprise a receiver and a receiver coil for inductively powering the device and/or charging its battery. The receiver coil included in the 440 Claim 1 Accused Products is a generally planar receiver coil. A current is induced in the receiver coil by a substantially perpendicular magnetic field.

Samsung Galaxy smartphones

The S7 smartphone includes a wireless power receiver ASIC (e.g., an IDT/Renesas P9221 ASIC), which is an integrated receiver circuit for wireless power transfer.

<https://www.ifixit.com/Teardown/Samsung+Galaxy+S7+Teardown/56686>

Step 13



The S7 smartphone further includes a planar receiver coil shown below.

<https://www.ifixit.com/Teardown/Samsung+Galaxy+S7+Teardown/56686>

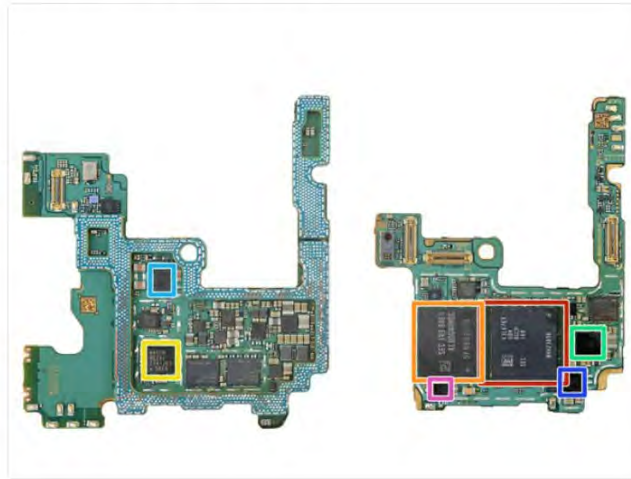
Step 7



The S22 Ultra also includes an integrated transceiver (transmitter / receiver) circuit for wireless power transfer (e.g., the Renesas/IDT P9320S ASIC) along with a planar receiver coil.

<https://www.ifixit.com/Guide/Samsung+Galaxy+S22+Ultra+Chip+ID/148073>

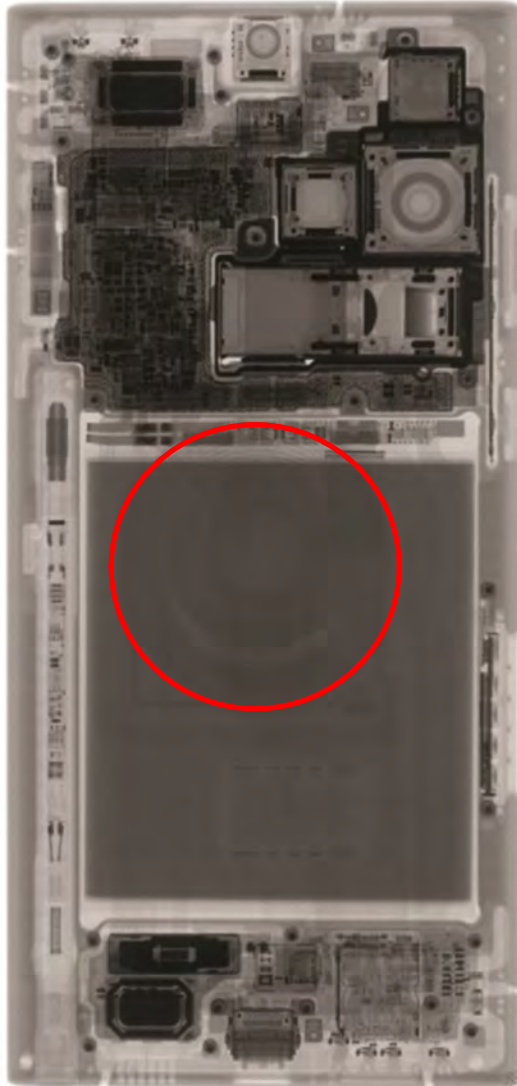
Step 1 Main Board Side 1



• IC Identification Pt. 1:

- Qualcomm **SM8450** Snapdragon 8 Gen 1 Octa-Core Processor layered under a Samsung K3LK7K70BM-BGCP 8 GB Mobile LPDDR5 SDRAM Memory
- Samsung **KLUDG4UHC-B0E1** 128 GB NAND Flash Memory (UFS 3.1)
- Wacom WEZ02 Digitizer Controller
- Maxim MAX77705C Power Management
- **Renesas P9320S Wireless Power Transceiver**
- NXP Semiconductor PCA9468 Battery Charger
- Cirrus Logic CS35L40 Audio Amplifier

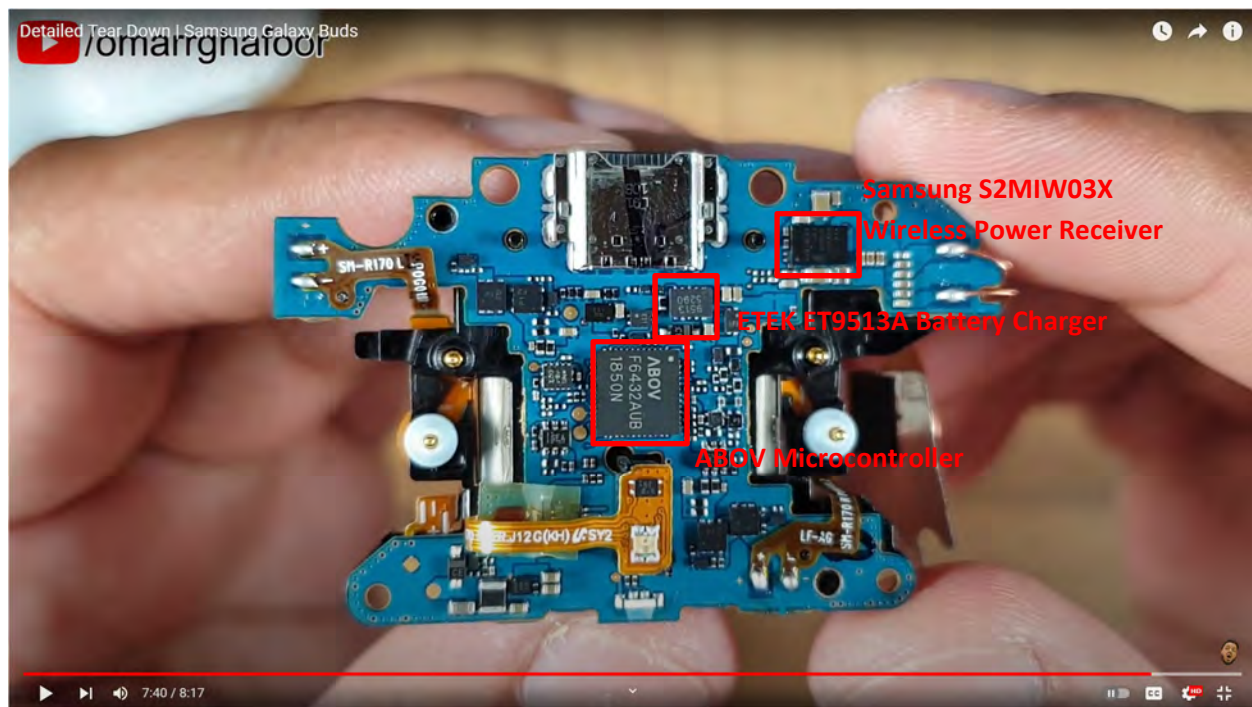
The S22 Ultra also includes a generally planar receiver coil as shown below.



Samsung earbud products

The Buds and Buds2 earbuds satisfy this portion of the claim as the case of each includes a receiver (comprising a microcontroller and associated circuitry or an integrated wireless power ASIC such as the MUA01 ASIC) and a planar receiver coil to receive wireless power, as specified by this part of the claim. The case of each of the Buds and the Buds2 is interoperable with the WPC Standard, with the Buds2 being specifically certified for WPC 1.2.4 as shown below.

<https://www.youtube.com/watch?v=Au9FHHmASjo>



<https://www.wirelesspowerconsortium.com/products/11427>

SAMSUNG ELECTRONICS GALAXY BUDS2 (SM-R177)



BRAND
Samsung Electronics

PRODUCT NAME
Galaxy Buds2

MANUFACTURER PART NUMBER
SM-R177

PRODUCT TYPE
Power Class 0 Receiver

REGISTRATION DATE
August 19, 2021

DESCRIPTION
GALAXY BUDS 2

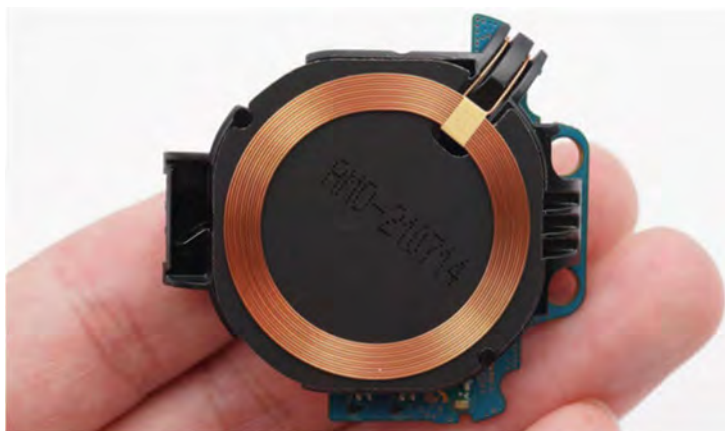


ADDITIONAL DETAILS

Qi Registration id	11427
Version	1.2.4
Currently licensed	Yes
Power profile	Basic Power Profile
Maximum received power	2 watts



<https://www.qucox.com/samsung-galaxy-buds2-teardwon/>



On the back is the wireless charging receiver coil, silk screen number: AM0-210714.

The receiver coil for the Buds case is shown below.

<https://www.youtube.com/watch?v=Mg6OpvMzguY>

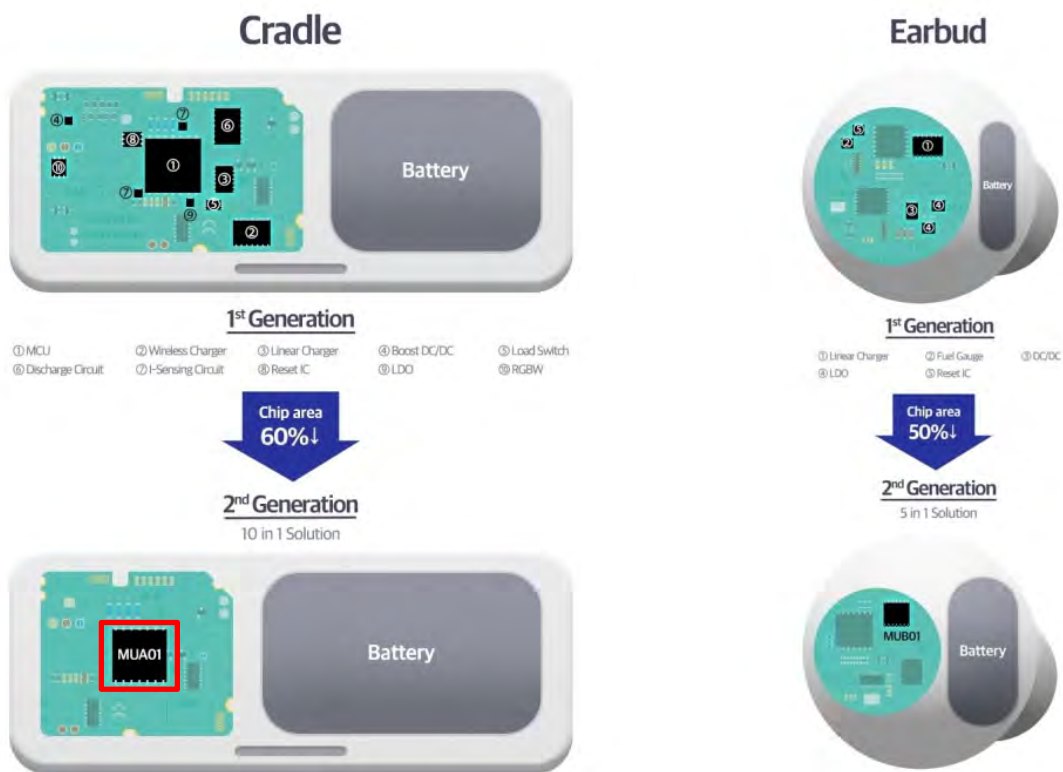


Galaxy Buds Teardown: The Most Repairable Wireless Earbuds We've Ever Seen!

<https://www.youtube.com/watch?v=Au9FHHmASjo>



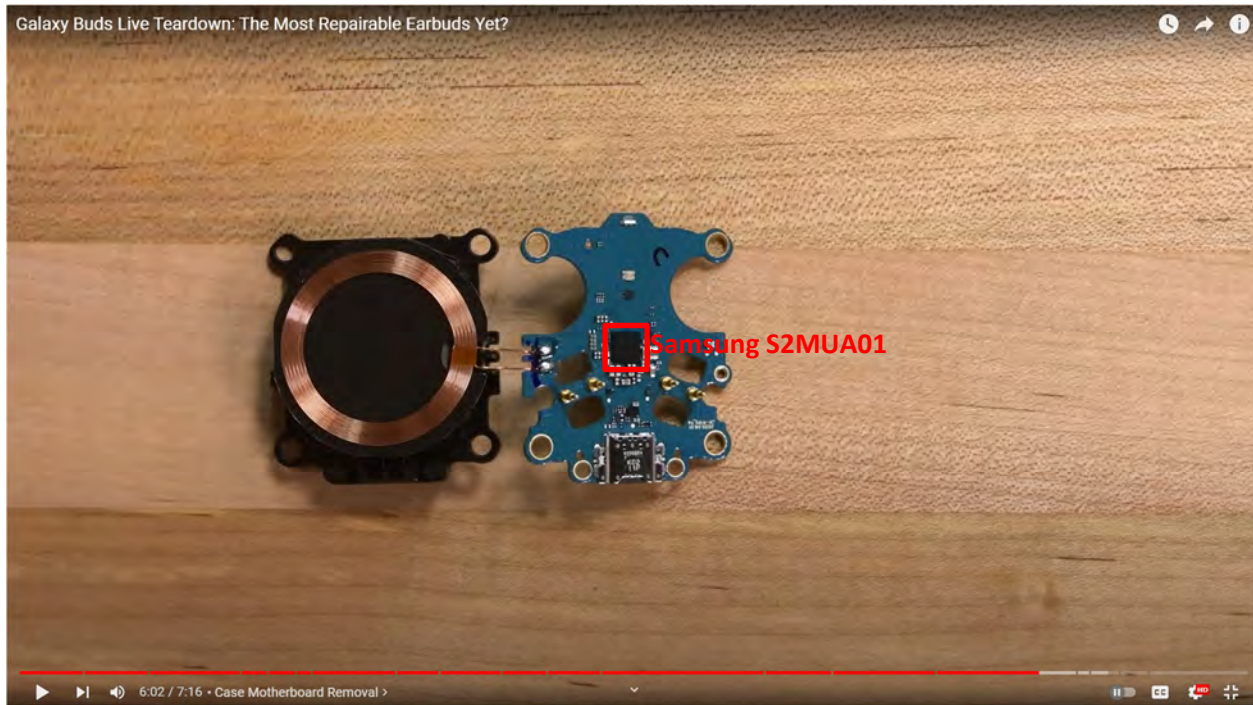
<https://www.sammobile.com/news/samsung-launches-industry-first-power-chipsets-true-wireless-earbuds/>



This snippet directly above on the left shows a portion of the circuit design of the Buds cases 1st and 2nd Generation. The Buds is an example of a 1st generation Buds product. This uses a separate microcontroller (MCU), Wireless Charger and associated circuitry for wireless charging of the case.

The Buds2 is an example of a 2nd Generation Buds product, which uses the MUA01 ASIC as an integrated power management solution in the cradle/charging case, including for wireless charging of the case. The Buds Plus, Buds Live, Buds Pro, and Buds2 Pro are additional examples of 2nd Generation Buds products, which include the MUA01 ASIC. For example, the MUA01 ASIC is expressly seen in the below picture of a Buds Live case, which on information and belief is similar to the other 2nd Generation Buds products..

<https://www.youtube.com/watch?v=eHatYtJFECQ>



Samsung wearables

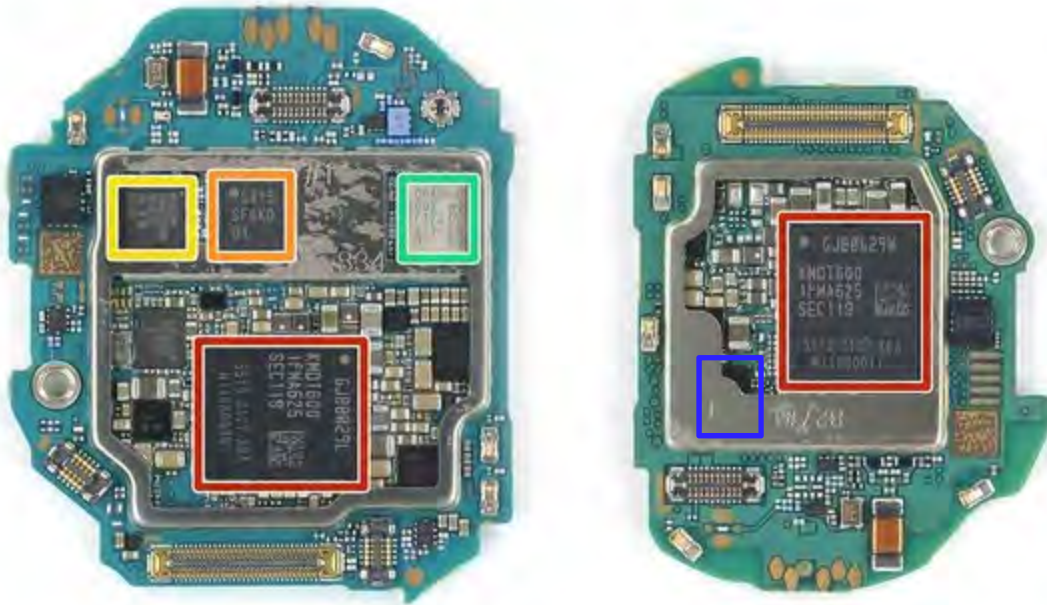
Samsung wearable devices such as the representative Galaxy Watch4 include a receiver (comprising a wireless power receiver ASIC, e.g., the Renesas/IDT P9222S) and generally planar receiver coil (shown below) as specified by this part of the claim. Moreover, the representative Galaxy Watches use WPC communication and messaging to operate with Samsung watch chargers, smartphones operating as chargers in the Wireless PowerShare mode, and Samsung charging pads that support Galaxy watch charging (e.g., the right side of the 5400 Duo Pad).

The Renesas P9222S is identified as the PMIC included in the representative Watch and Watch4 below.

Watch

On information and belief, the Watch4 includes a receiver ASIC (Renesas/IDT P9222S) shown in the blue rectangle in the representative Watch4 below:

<https://www.ifixit.com/Teardown/Samsung+Galaxy+Watch4+and+Watch4+Classic+Teardown/144595>



The Renesas/IDT P9222S is identified as the dark blue square in the Galaxy Watch Active below:

<https://zhuanlan.zhihu.com/p/79998696>

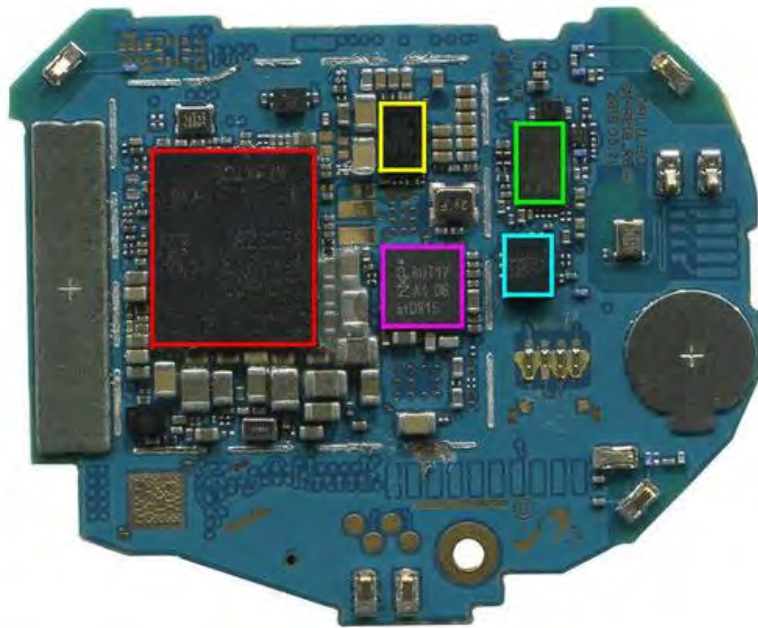


知乎 @半导体模拟联盟

- 青色: Samsung- Exynos 9110-双核处理器+Samsung-KM4J600-0.75GBRAM+4GB ROM
- 红色: BROADCOM-BCM47758-GNSS收发芯片
- 黄色: STMicroelectronics-气压计
- 绿色: BROADCOM-BCM430131-WiFi/BT芯片
- 蓝色: IDT-P9222S-无线充电芯片
- 洋红: NXP-NFC控制芯片

The Renesas/IDT P9222S is identified as the yellow square in the Galaxy Watch below:

<https://kknews.cc/digital/ro3gb6o.html>



黃色：IDT-P9222S-無線功率接收晶片

The Renesas/IDT P9222S is identified as the dark blue square in the Watch3 below:

<https://www.ifixit.com/Teardown/Samsung+Galaxy+Watch3+Teardown/135891>

Step 5



Edit

- Scooping out this vaguely disc-shaped motherboard next, we peek under the shields and find:
 - A Samsung SiP FO-PLP combining the Exynos 9110 dual-core, 1.15 GHz Cortex-A53 processor, their in-house 1 GB DRAM and Power Management IC
 - ① The SiP FO-PLP stands for System-in-Package Fan-Out Panel Level Packaging and is Samsung's take on [getting as much tech in the tiniest package](#)—which was already used in the original Galaxy Watch.
 - Samsung Shannon 915 Intermediate Frequency IC
 - NXP [PN80T](#) NFC controller w/ Secure Element
 - [Broadcom BCM430132](#) WiFi/Bluetooth module and [Broadcom GNSS Location Hub](#) for GPS/GLONASS/etc
 - Qualcomm Atheros QPA5580 Power Amplifier (likely)
 - IDT P9222S wireless power receiver

The Renesas/IDT P9222S is identified as the dark red square in the Galaxy Watch below:

<https://www.ifixit.com/Teardown/Samsung+Galaxy+Watch+Teardown/117519>

Step 10



- ... and even more ID:
 - Renesas (Formerly IDT) P9222S wireless power receiver
 - STMicroelectronics [LSM6DS3](#) 3-axis accelerometer/gyroscope (likely)
 - NXP Semiconductor [BGU8309](#) GPS/GLONASS/Galileo/COMPASS low noise amplifier
 - Goertek MEMS microphone

The Renesas/IDT P9222S is a highly integrated wireless charging receiver ASIC as shown below.

<https://www.renesas.com/us/en/document/dst/p9222-rrn-datasheet>



Wireless Power Receiver for Low Power Applications

P9222-R/RN Datasheet

The P9222-R/RN is an integrated single-chip wireless power receiver IC (Rx) for up to 5W applications implementing in-band, bi-directional data communication with no additional circuitry. The device receives an AC power signal from a wireless power transmitter, such as the P9235A-RB WPC Qi BPP Wireless Transmitter IC, and converts it to a rectified output voltage, which can be used to power devices or supply the battery charger input in a wide range of wireless power applications. The receiver (Rx) integrates a high-efficiency synchronous full bridge rectifier (SFBR) and control circuits that enable bi-directional communication from and to the transmitter (Tx) for optimized power delivery.

The P9222-R/RN is highly efficient at light loads and very well-suited for low-power applications such as earbuds case charging. A unique Ping detect feature gives the user an early indication of the wireless charger connection and improves thermal performance at the end of complete battery charging. Low under-voltage lockout (UVLO) threshold allows the receiver to start up even with a weaker digital ping strength signal from a transmitter over an extended area.

The device includes over-temperature and under/over-voltage protection. The internal over-voltage clamping protects the rectifier output from rising above the overvoltage level when the receiver is quickly moved from a low-coupling position to a high-coupling position. The integrated 32-bit ARM® Cortex®-M0 processor (trademark of ARM, Ltd.) offers a high level of programmability and design parameters that can be easily configured through the I2C interface or an external EEPROM.

The P9222-R default firmware factory programmed in internal OTP is WPC 1.2.4 Qi Baseline Power Profile (BPP) compatible. The P9222-RN default factory firmware programmed in internal OTP is latest WPC 1.3 Qi Baseline Power Profile (BPP) compatible.

The P9222-R/RN is available in a RoHS ultra-small WLCSP-40 package and it is rated for a 0 to 85°C ambient operating temperature range.

Typical Applications

Wireless power solutions for mobile solutions including:

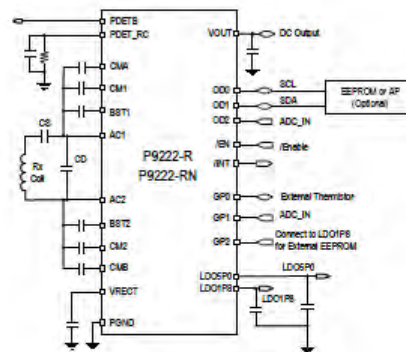
- Wireless earbuds case charging
- Wearables and fitness trackers
- Mobile devices
- Hearing aids case charging

Features

- Ultra-compact, efficient wireless power receiver for up to 5W applications
- P9222-R default firmware is WPC 1.2.4 Qi Baseline Power Profile (BPP) compatible
- P9222-RN default firmware is WPC 1.3 Qi Baseline Power Profile (BPP) compatible
- Ping detection for reduced power consumption at end of charging
- Low under-voltage lockout (UVLO) for low voltage start-up for faster connections over an extended area
- ASK and FSK modulation/demodulation for Bi-directional Communication: Rx-to-Tx and Tx-to-Rx
- Supports bi-directional data communication
- Easy configuration of design parameters through I2C interface on an external EEPROM
- Embedded 32-bit ARM® Cortex®-M0 processor
- Internal over-voltage clamping
- Low standby and operating mode power consumption
- High performance low dropout (LDO) regulator with low RDS(on) and programmable current limiting
- Supports I2C slave/master mode
- 40-WLCSP: 5 × 8 ball array, 2.28 × 3.38 mm, 0.4mm pitch

Block Diagram

Figure 1. Simplified Block Diagram



The following picture shows a Samsung Galaxy Watch Active charging coil in detail, circled in red:

<https://zhuanlan.zhihu.com/p/79998696>



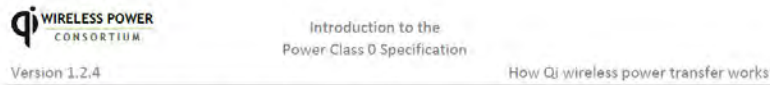
知乎 @半导体投资联盟

The Watch4, representative product, includes a planar receiver coil, (the ring shape in the photo below) as shown in the listing below.

https://www.ebay.com/itm/225173935598?nma=true&si=ziHGdlkwhvLsE97LpXFj7979J8g%253D&orig_cvip=true&nordt=true&rt=nc&trksid=p2047675.12557



WPC Document(s): WPC 1.2.4 Standard, Introduction, pages 8-9.



3 How Qi wireless power transfer works

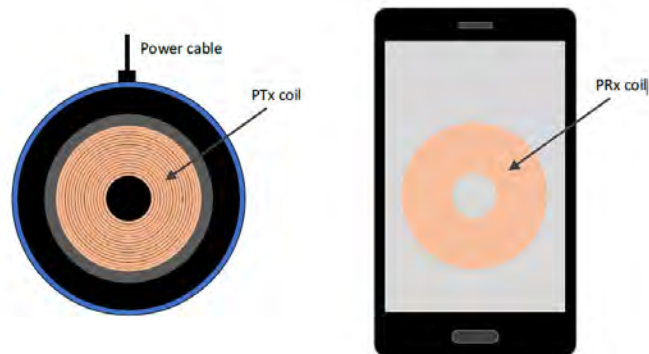
The Qi wireless power transfer system uses magnetic induction to transfer power to a power receiver (PRx) subsystem contained within the mobile device when it is placed on top of a power transmitter (PTx).

Figure 4. A Qi wireless smartphone on a charging pad



Both the PTx and PRx subsystems contain coils, as shown in the conceptual diagram in Figure 5, as well as circuitry that handles the communication and power transfer between them.

Figure 5. Coils in charger and smartphone

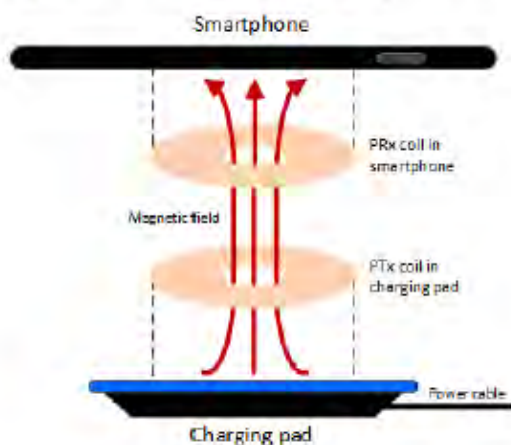


The basic physical principle that governs the functionality defined in the Qi wireless power transfer specification is magnetic induction: the phenomenon that a time-varying magnetic field generates an electromotive force in a suitably positioned inductor. In a Qi wireless power transfer system, this electromotive force produces a voltage across the terminals of a coil-shaped inductor, and is used to drive

When charging begins, the power transmitter runs an alternating electrical current through its coil(s), which generates an alternating magnetic field in accordance with Faraday's law. This magnetic field is in turn picked up by the coil inside the power receiver and transformed by a power converter back into an alternating electrical current that can be used to charge the battery.

A critical feature of the magnetic field is that it can transfer through any non-metallic, non-ferrous materials, such as plastics, glass, water, wood, and air. In other words, wires and connectors are not needed between the power transmitter and power receiver.

Figure 6. Qi wireless power transfer using magnetic induction



an identification component associated with the mobile device or battery, which is configured to provide wireless identification of the receiver to the universal base unit;

The 440 Claim 1 Accused Products meet this part of 440 claim 1 as they include an identification component to provide wireless identification of the receiver to the universal base unit, as claimed. They do so per the WPC Standard protocol. For example, the wireless power receiver ICs identified in the element above include an identification component and unique ID which provides wireless identification of the receiver to the universal base unit.

A high-level description of the information including a unique ID communicated by the receiver in a mobile device or battery in WPC is shown below. *E.g.*, WPC 1.2.4 Standard, Introduction, page 9.



the electronics of an appropriate load to which it is connected. Conventional transformers use the same effect to achieve inductive power transfer between a primary and a secondary coil that are strongly coupled by means of a magnetic core.

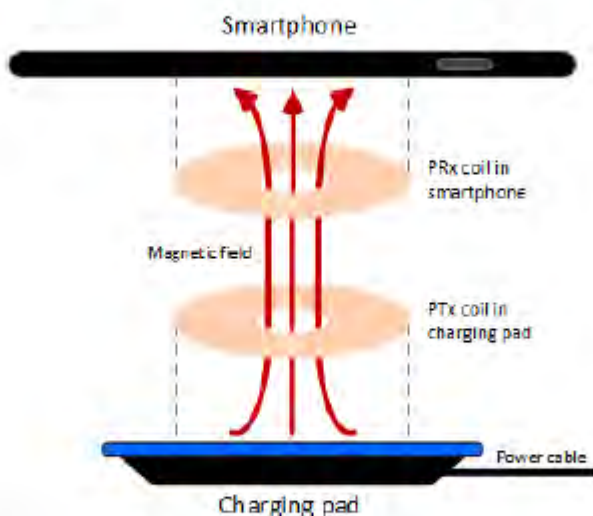
Although a Qi-based system is similar to a conventional transformer in the sense that power is transferred from a first coil to a second coil, it is also very different because of the much lower magnetic coupling between those coils. A conventional transformer has a magnetic coupling coefficient close to one, whereas a Qi-based system typically has a magnetic coupling coefficient in the range of 0.5 or below.

In the Qi-based system illustrated in Figure 4, power is transferred from the PTx contained in the Qi charging pad to a PRx contained in the Qi smartphone. Before charging begins, the PRx and PTx communicate with each other to establish that the mobile device is indeed capable of being charged, whether it needs to be charged, how much power is required, etc. In short, the communication ensures an appropriate power transfer from the power transmitter to the power receiver. The communication channel can also be used to trigger location based services by providing an SSID, a Bluetooth link, or a unique ID.

When charging begins, the power transmitter runs an alternating electrical current through its coil(s), which generates an alternating magnetic field in accordance with Faraday's law. This magnetic field is in turn picked up by the coil inside the power receiver and transformed by a power converter back into an alternating electrical current that can be used to charge the battery.

A critical feature of the magnetic field is that it can transfer through any non-metallic, non-ferrous materials, such as plastics, glass, water, wood, and air. In other words, wires and connectors are not needed between the power transmitter and power receiver.

Figure 6. Qi wireless power transfer using magnetic induction



Samsung Galaxy smartphones

The Galaxy S7 and S22 Ultra smartphones, in accordance with the WPC Standard, transmit an identification packet including a Manufacturer Code and a Device Identifier identifying the device uniquely to the wireless charger base station. *See* WPC 1.1.2 Standard, Part 1, Interface Definition at pages 135-136, 147; *see also*, WPC 1.2.4 Standard, Parts 1 & 2: Interface Definitions at pages 71, 100-101.

5.3 Power Receiver perspective

Section 5.3.1 defines the initial response of the Power Receiver to the application of a Power Signal. As part of this initial response, the Power Receiver wakes up its Communications and Control Unit—if that is not already up and running. Section 5.3.2 defines the response of a Power Receiver to a Digital Ping. This response ensures the Power Transmitter that it is dealing with a Power Receiver (rather than some unknown object). Section 5.3.3 defines the response of a Power Receiver to an extended Digital Ping. This response enables the Power Transmitter to identify the Power Receiver and establish a Power Transfer Contract. Finally, Section 5.3.4 defines the protocol that the Power Receiver shall execute in order to control the power transfer from the Power Transmitter.

5.3.3 Identification & configuration phase

In the *identification & configuration* phase, the Power Receiver shall transmit the following sequence of Packets:

- If the Power Receiver enters the *identification & configuration* phase from the *ping* phase, an Identification Packet.

Version 1.1.2	System Description Wireless Power Transfer	Communications Interface
---------------	---	--------------------------

6.3.8 Identification Packet (0x71)

Table 6-12 defines the format of the message contained in an Identification Packet.

Table 6-12: Identification

	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
B ₀	Major Version				Minor Version			
B ₁	(msb) Manufacturer Code (lsb)							
B ₂								
B ₃	Ext	(msb) Basic Device Identifier (lsb)						
B ₄								
B ₅								

Major Version The combination of this field and the Minor Version field identifies to which revision of the System Description Wireless Power Transfer the Power Receiver complies. The Major Version field shall contain the binary coded digit value 0x1.

Minor Version The combination of this field and the Major Version field identifies to which minor revision of the System Description Wireless Power Transfer the Power Receiver complies. The Minor Version field shall contain the binary coded digit value 0x1.

Manufacturer Code The bit string contained in this field identifies the manufacturer of the Power Receiver, as specified in [PRMC].

Ext If this bit is set to ZERO, the bit string

Manufacturer Code || Basic Device Identifier

identifies the Power Receiver. If this bit is set to ONE, the bit string

Manufacturer Code || Basic Device Identifier || Extended Device Identifier

identifies the Power Receiver (see also Section 6.3.9).

Basic Device Identifier The bit string contained in this field contributes to the identification of the Power Receiver. A Power Receiver manufacturer should ensure that the combination of Basic Device Identifier and Manufacturer ID is sufficiently unique. Embedding a serial number of at least 20 bits in the Basic Device Identifier is sufficient. Alternatively, using a (pseudo) random number generator to dynamically generate part of the Basic Device Identifier is sufficient as well, provided that the generated part complies with the following requirements:

- The generated part shall comprise at least 20 bits.
- All possible values shall occur with equal probability.
- The Power Receiver shall not change the generated part while the Power Signal is applied.
- The Power Receiver shall retain the generated part for at least 2 s if the Power Signal is interrupted or removed.

(Informative) These requirements ensure that the scanning procedure of a type B1 Power Transmitter proceeds correctly; see also Annex C.2.

The wireless power receiver ASIC (such as the IDT/Renesas P9221) included in the S7 comprises, in part, an identification component including a microcontroller and communication circuitry, along with software/firmware that communicates with the base unit in accordance with the WPC Standard as required by this portion of Claim 1. See, for example, Ex. I, which is the publicly available datasheet for the representative P9221-R receiver ASIC at pages 1, 15, 21, 25. The P9221-R ASIC includes an ARM M0 microcontroller (green rectangle), which includes memory for embedded software/firmware, and circuitry for communication and control (red rectangle) of the wireless charging receiver functionality.

<https://www.renesas.com/us/en/document/dst/p9221-r-datasheet>



Wireless Power Receiver for 15W Applications

P9221-R Datasheet

Description

The P9221-R is a high-efficiency, Qi-compliant wireless power receiver targeted for applications up to 15W. Using magnetic inductive charging technology, the receiver converts an AC power signal from a resonant tank to a programmable regulated 9V or 12V DC output voltage. The integrated, low $R_{DS(on)}$ synchronous rectifier and ultra-low dropout linear (LDO) regulator offer high efficiency, making the product ideally suited for battery-operated applications.

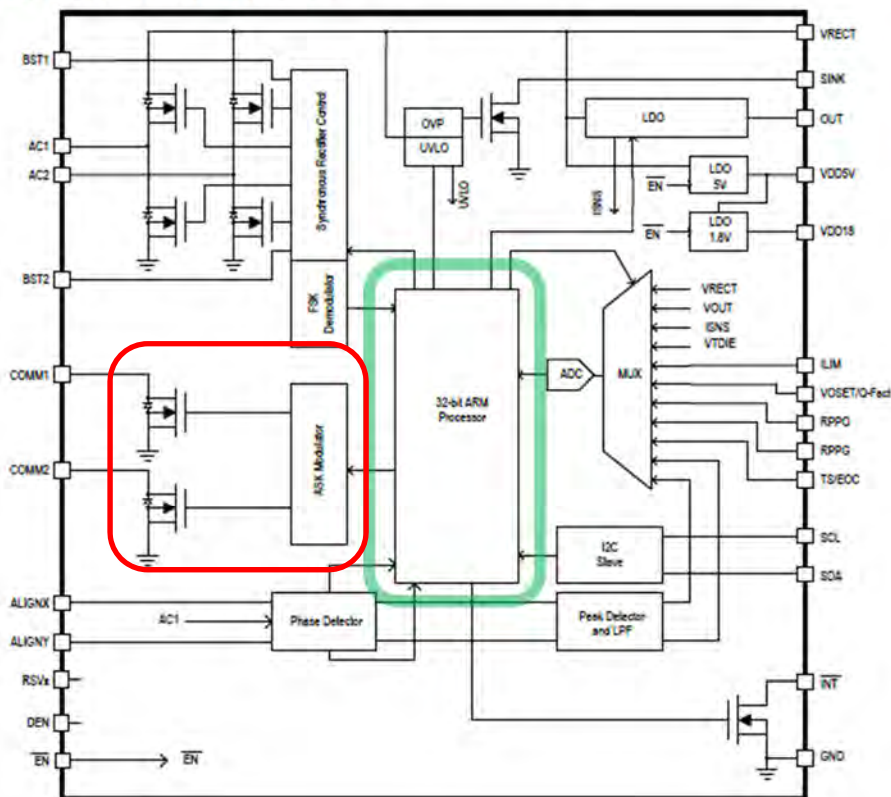
Features

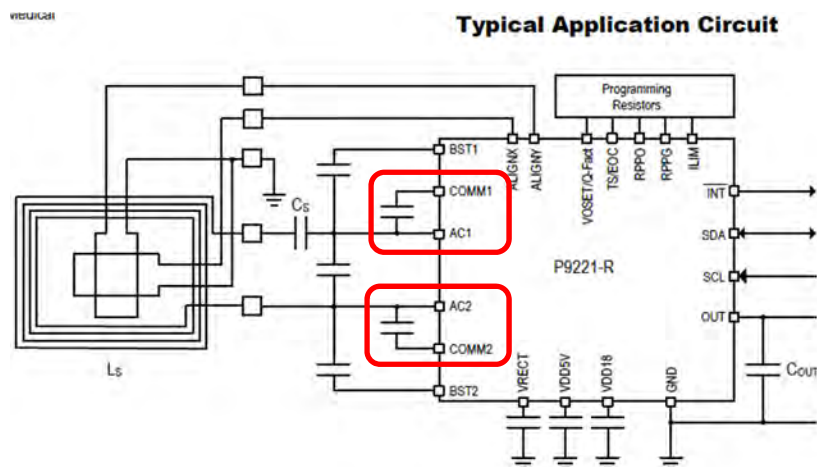
- Single-chip solution supporting up to 15W applications
- WPC-1.2.3 compliant
- Patented over-voltage protection clamp eliminating external capacitors
- 87% peak DC-to-DC efficiency with P9242-R Tx
- Full synchronous rectifier with low $R_{DS(on)}$ switches



7. Functional Block Diagram

Figure 17. Functional Block Diagram





Communication (including communication of the identification information) is achieved wirelessly by switching the FETs to connect and disconnect the capacitors shown in the Red rectangles above to ground by the microcontroller, as described below.



9. Communication Interface

9.1 Modulation/Communication

The wireless medium power charging system uses two-way communication: receiver-to-transmitter and transmitter-to receiver.

Receiver-to-transmitter communication is accomplished by modulating the load seen by the receiver's inductor; the communication is purely digital and symbols 1's and 0's ride on top of the power signal that exists between the two coils. Modulation is done with amplitude-shift keying (ASK) modulation using internal switches to connect external capacitors from AC1 and AC2 to ground (see Figure 17) with a bit rate of 2Kbps. To the transmitter, this appears as an impedance change, which results in measurable variations of the transmitter's output waveform. The power transmitter detects this as a modulation of coil current/voltage to receive the packets. See sections 9.2 and 9.3 for details for ASK modulation.

Transmitter-to-receiver communication is accomplished by frequency-shift keying (FSK) modulation over the power signal frequency. The power receiver P9221-R has the means to demodulate FSK data from the power signal frequency and use it in order to establish the handshaking protocol with the power transmitter.

During the Identification and Configuration Phase, the P9221 communicates unique receiver ID information to the base unit.



10.3 Identification and Configuration Phase

The identification and configuration phase is the part of the protocol that the power transmitter executes in order to identify the power receiver and establish a default power transfer contract. This protocol extends the digital ping in order to enable the power receiver to communicate the relevant information.

In this phase, the power receiver identifies itself and provides information for a default power transfer contract:

- It sends the configuration packet.
- If the power transmitter does not acknowledge the request (does not transmit FSK modulation), the power receiver will assume 5W output power.

The P9221-R has specific register locations for the unique receiver ID communicated by the 9221-R ASIC during wireless charging, as shown below.



11. Functional Registers

The following tables provide the address locations, field names, available operations (R or RW), default values, and functional descriptions of all the internally accessible registers contained within the P9221-R. The default I²C slave address is 61_{HEX}. The address of each register has a two-byte structure. For example, the low byte of major firmware revision must be read with two bytes address with 00_{HEX} and 04_{HEX}.

Table 9. Device Identification Register

Address and Bit	Register or Bit Field Name	R/W	Default	Function and Description
0000 _{HEX} [7:0]	Part_number_L	R	20 _{HEX}	P9221-R chip identification low byte
0001 _{HEX} [7:0]	Part_number_H	R	92 _{HEX}	P9221-R chip identification high byte

Similarly, the wireless power transceiver ASIC (e.g., IDT/Renesas P9320S) included in the S22 Ultra comprises, in part, an identification component including a microcontroller and communication circuitry, along with software/firmware that communicates with the base unit in accordance with the WPC Standard as required by this portion of Claim 1. *See*, for example, the publicly available P9415-R data sheet at 1, 14, 21, 23, 40 (believed to representative of the wireless transceiver ASIC included in the S22 Ultra, e.g., the P9320S).

<https://www.renesas.com/us/en/document/dst/p9415-r-datasheet>



15W Wireless Power Receiver with WattShare™ Mode

P9415-R Datasheet

Description

The P9415-R is a highly integrated single-chip wireless power transmitter/receiver IC (TRx) that can be configured to receive or transmit an AC power signal through magnetic induction.

When the device is configured as a wireless power transmitter, it uses an on-chip full/half-bridge inverter, a PWM generator, a modulator/demodulator for communication, and a microcontroller to produce an AC power signal to drive external L-C tank. As a receiver, the P9415-R receives an AC power signal from a wireless transmitter and converts it into rectified output voltage, which can be used to power devices or supply the charger input in mobile applications. The P9415-R integrates a high-efficiency Synchronous Full Bridge Rectifier and control circuitry to modulate the load to send message packets to the Transmitter (Tx) to optimize power delivery.

The P9415-R features Multiple-time programmable (MTP) non-volatile memory that enables customers to customize the design parameters such as default output voltage and FOD thresholds.

The P9415-R includes over-temperature and voltage protection. Fault conditions associated with power transfer are managed by an industry-leading 32-bit ARM® Cortex®-M0 processor offering a high level of programmability while consuming extremely low standby power. The processor can also control GPIOs to indicate operating and fault modes. The device is available in an ultra-small 53-WLCSP package.

Features

- Delivers up to 15W as a receiver
- WattShare™ (TRx) mode with up to 5W Tx capability
- 24kB Multiple-time programmable (MTP) non-volatile memory
- WPC 1.3 Specification hardware ready
- 2.5V Under-Voltage Lockout (UVLO) threshold for expanding the charging area
- Internal reverse current sense for WattShare™ mode
- Reliable VRECT over-voltage clamping
- Internal IOUT filtering to remove the battery charger current ripple
- Supports Bi-Directional communications
- Supports X-Y alignment coils
- The device is capable of delivering 30W using a custom firmware
- Embedded 32-bit ARM® Cortex®-M0 processor
- Supports I2C 400kHz standard interface and GPIOs
- Package: 6 × 9 ball array, 2.82 × 4.22 × 0.50 mm, 53-WLCSP with 0.40mm ball pitch

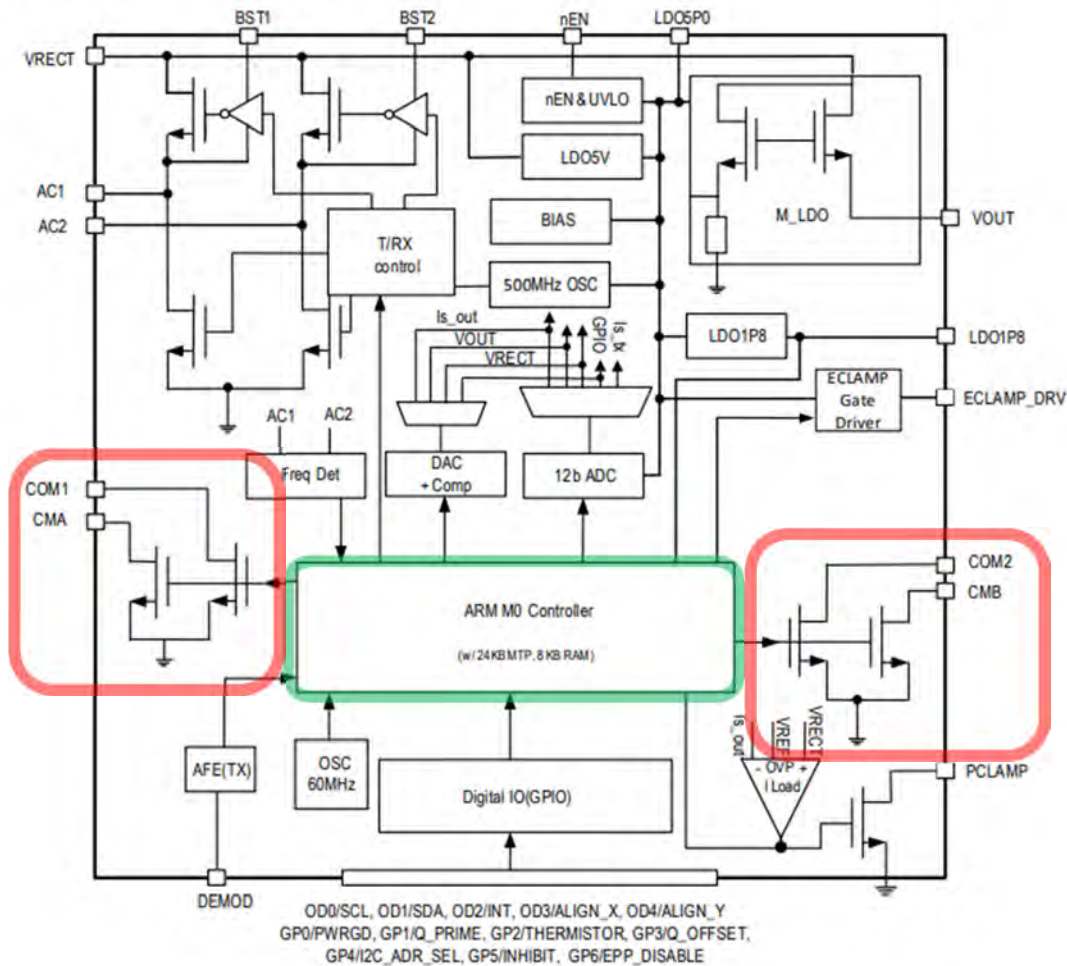
Typical Applications Schematic

—[DEMOC]—VSNS

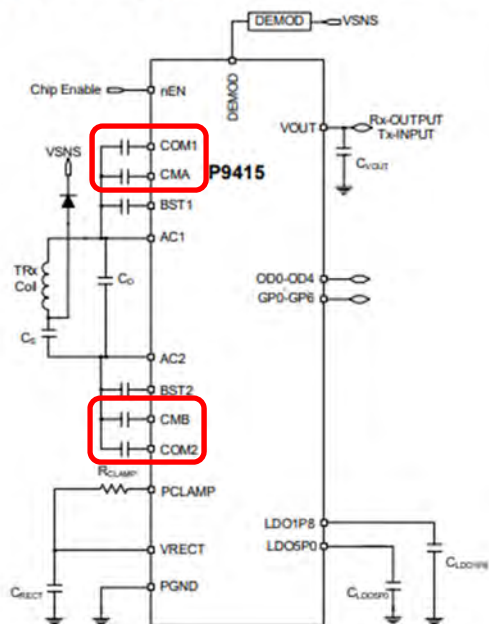
8. Theory of Operation

The P9415-R is a highly integrated wireless power receiver IC for mobile devices. The device can receive up to 15W wirelessly using near-field magnetic induction. The P9415-R Rx will operate in WPC mode when the digital ping frequency is below 190 kHz from the transmitter.

Figure 15. Internal Block Diagram



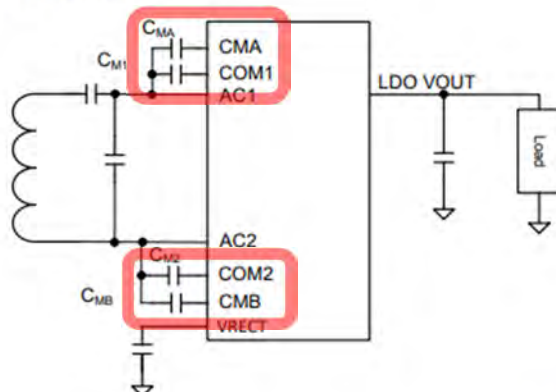
Typical Applications Schematic



8.2.5 WPC Modulation/Communication

The P9415-R operates in WPC using a single LC tank Rx coil and requires AC modulation capacitor connections for WPC communication. The LC tank also should be tuned to achieve maximum efficiency (C_{MA} , C_{MB} , C_{M1} , C_{M2} connected to pins CMA, CMB COM1, COM2) in order to accomplish WPC modulation.

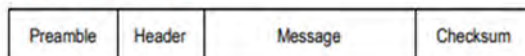
Figure 16. Rx Modulation Components



Receiver-to-transmitter communication is completed by modulating the load applied to the receiver's inductor. To the transmitter, this appears as an impedance change, which results in measurable variations of the transmitter's output waveform. Modulation is done with AC Modulation, using internal switches to connect external capacitors from AC1 and AC2 to ground.

The P9415-R communicates with the base via communication packets or decodes messages sent by WPC Rx's. Each communication packet has the following structure:

Figure 17. Communication Packet Structure



According to the WPC specification, the power receiver communicates with the power transmitter using backscatter modulation. The load seen by the power transmitter's inductor is modulated on the receiver side to send packets. The power transmitter demodulates these signals as a modulation of coil current/voltage to decode and receive packets.

During the Identification and Configuration Phase, the P9415-R communicates unique receiver ID information to the base unit.



P9415-R Datasheet

8.2.10 Identification and Configuration (ID and Config)

In this phase, the P9415-R sends or expects the following packets:

- Identification Packet
- Configuration Packet

After the transmission of the Configuration Packet, the P9415-R proceeds to the Negotiation phase.

11. List of Registers

Table 10. Chip ID (0x00, 0x01)

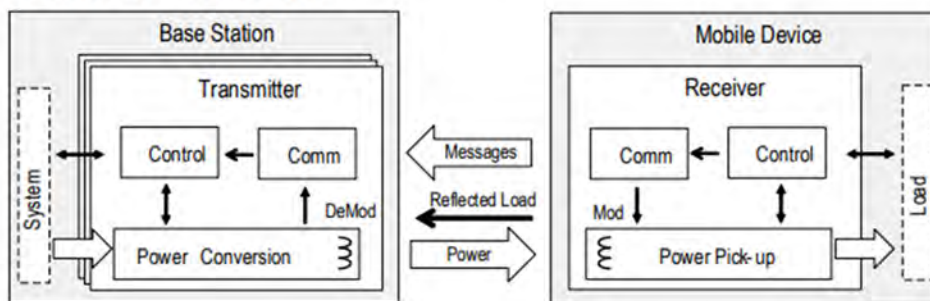
Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x00 [7:0]	Chip_ID_L	R	0x15	Chip ID low byte
0x01 [7:0]	Chip_ID_H	R	0x94	Chip ID high byte

6. Wireless Power Charging System

A wireless power charging system has a base station with one or more transmitters that make power available via DC-to-AC inverter(s), and transmit the power over a strongly-coupled inductor pair (magnetic induction) or over a loosely-coupled inductor pair (magnetic resonance) to a receiver in a mobile device. A WPC¹ system uses near field magnetic induction between coils and can be a free-positioning or magnetically-guided type of system.

In WPC systems, the amount of power transferred to the mobile device is controlled by the receiver. The receiver sends communication packets to the transmitter to increase power, decrease power, or maintain the power level. The bit rate for Rx-to-Tx communication link is 2kbps for WPC receivers and is amplitude modulated (ASK) on top of the power link that exists.

Figure 2. Block Diagram of WPC System



Per the WPC Standard, the wireless charger base unit (the Power Transmitter in WPC) uses this identification information from the receiver to identify the receiver. For instance, WPC 1.1.2 Standard, Part 1, Interface Definition, page 124 (see also, WPC 1.2.4 Standard, Parts 1 and 2, Interface Definitions, page 46).

- *identification & configuration* In this phase, the Power Transmitter identifies the selected Power Receiver, and obtains configuration information such as the maximum amount of power that the Power Receiver intends to provide at its output. The Power Transmitter uses this information to create a Power Transfer Contract. This Power Transfer Contract contains limits for several parameters that characterize the power transfer in the *power transfer* phase. At any time before proceeding to the *power transfer* phase, the Power Transmitter may decide to terminate the extended Digital Ping—e.g. to discover additional Power Receivers. This reverts the system to the *selection* phase.

Samsung earbud products

As shown above, the Buds and the Buds2 are interoperable with WPC, with the Buds2 being specifically WPC/Qi-certified. The Buds include a separate microcontroller and associated electronics and the Buds2 includes an integrated wireless power ASIC (e.g., the Samsung MUA01), both of which form an identification component as specified by this part of the claim.

Samsung wearables

The representative Galaxy Watches include receiver circuitry comprising an identification component as claimed that identifies the Watches to the charger. Specifically, they include a wireless power receiver ASIC (such as the above-mentioned Renesas P9222S) that comprises in part an identification component.

The P9222S ASIC included in the representative Watches comprises, in part, an identification component including a microcontroller and communication circuitry, along with software/firmware that communicates with the base unit in accordance with the WPC Standard as required by this portion of Claim 1. *See*, for example, the publicly available P9222 datasheet. This includes a microcontroller (green rectangle) and two communication FETs for modulating CM1 and CMA and two additional FETs for modulating CM2 and CMB (red rectangles). On information and belief, the Renesas P9222R datasheet is representative of the relevant parts of the operation of the Renesas P9222S.

<https://www.renesas.com/us/en/document/dst/p9222-rrn-datasheet>

Block Diagram

Figure 1. Simplified Block Diagram

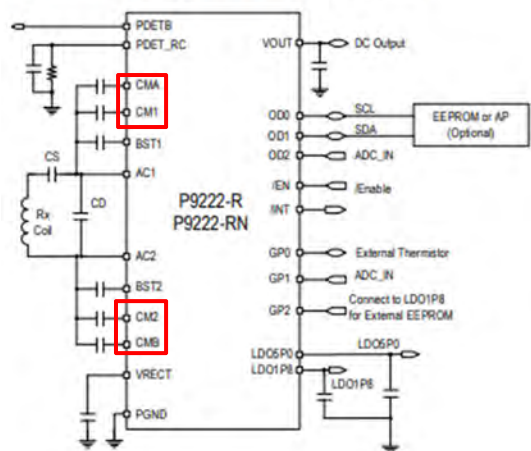
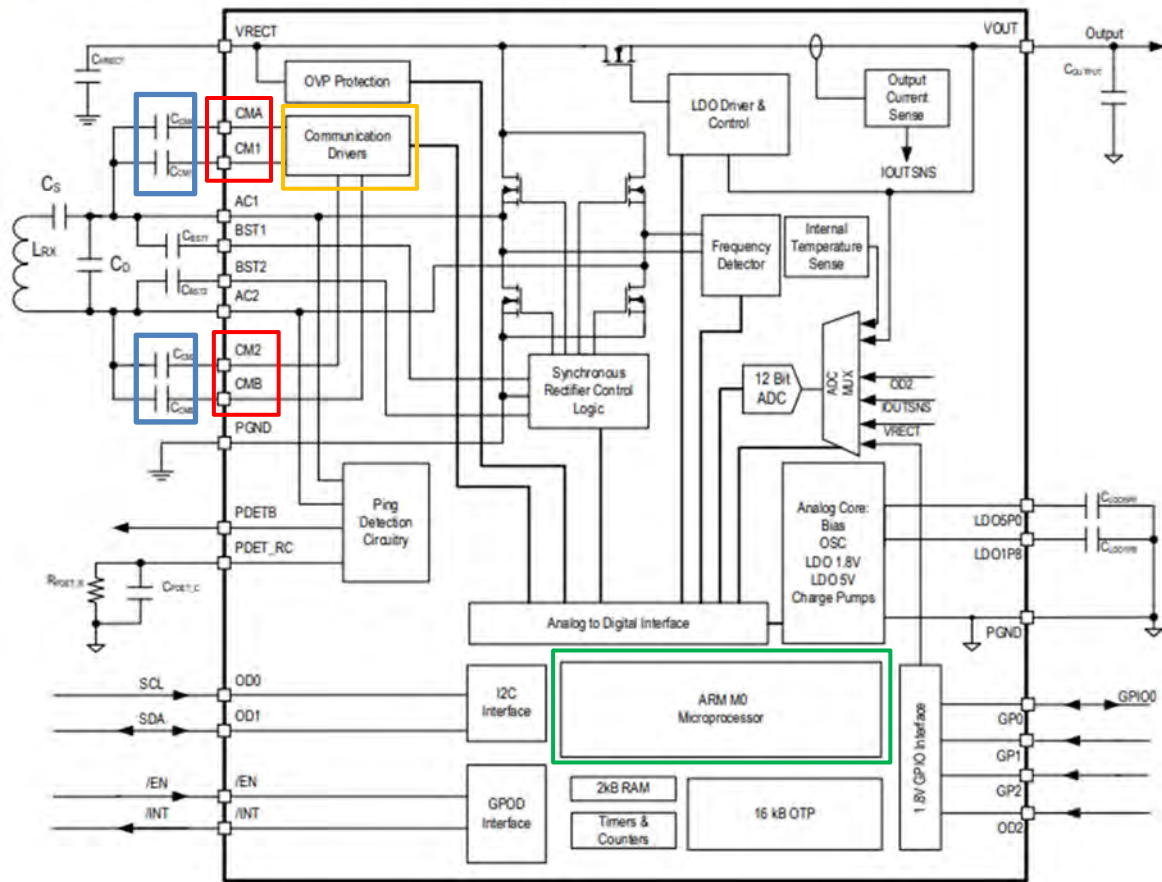


Figure 2. P9222-R/RN Block and Application Diagram



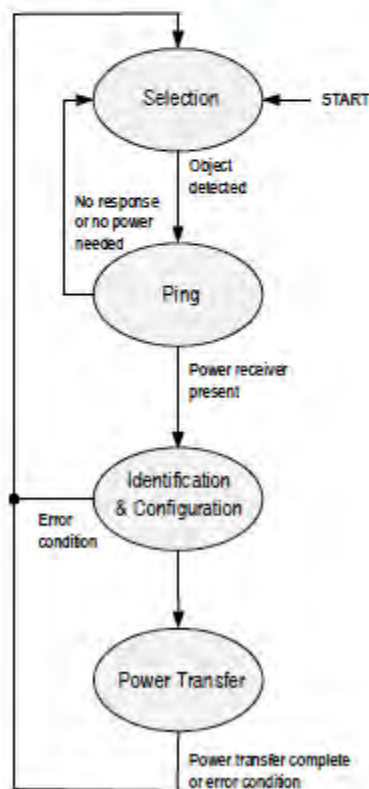
7.5 System Feedback Control

The P9222-R/RN is fully compatible with WPC (Baseline Power Profile) and has all the necessary circuitry to communicate with the base station via WPC communication packets. The overall WPC system behavior between the transmitter and the receiver follows the state machine shown in Figure 25.

The P9222-R/RN goes through four phases:

1. Selection
2. Ping
3. Identification and Configuration
4. Power Transfer

Figure 25. WPC System Feedback Control BPP Mode



7.5.3 Identification and Configuration

In the "Identification and Configuration" phase, the P9222-R/RN sends or expects the following packets:

- Identification Packet
- Configuration Packet

After the transmission of the Configuration Packet, the P9222-R/RN proceeds to the "Power Transfer" phase.

11. Registers

The P9222-R/RN uses the standard I²C slave implementation protocol to communicate with a host AP or other I²C peripherals. The communication protocol is implemented using 8 bits for data and 16 bits for addresses. The default slave address of the P9222-R/RN is 0x61.

The following tables list address locations, field names, available operations (R or RW), default values, and functional descriptions of internally accessible registers contained within the P9222-R/RN. The OTP registers are loaded each time the device is powered and cannot be changed except by new firmware programmed into a blank device. The SRAM registers are available to make setting changes after the device is powered. These changes are reset to default when the power is cycled or the device is reset.

Table 11. Chip Part Number ID Register, Chip_ID_L (0x00), Chip_ID_H (0x01)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x00 [7:0]	Chip_ID_L	R	0x22	Chip ID low byte
0x01 [7:0]	Chip_ID_H	R	0x92	Chip ID high byte

With this identification component (i.e. the ASIC and associated components), the Watches communicate identification information to a charger during the ‘Identification and Configuration’ phase. More generally, the Watches communicate with a charger using the WPC/Qi-Standard communication protocol (or a protocol substantially similar thereto in respects relevant to the 440 patent), though the Watches are believed not to be WPC certified and are believed to deviate from the WPC Standard in respects not relevant to the 440 patent.

Following the WPC Standard, the Watches communicate a manufacturer code, a unique basic identifier, and the version of the WPC Standard per which they substantially communicate. *See* WPC 1.1.2 Standard, Part 1, Interface Definition at pages 135-136, 147; *see also* WPC 1.2.4 Standard, pages 74, 100.

System Description
Wireless Power Transfer

Version 1.1.2

Communications Interface

6.3.8 Identification Packet (0x71)

Table 6-12 defines the format of the message contained in an Identification Packet.

Table 6-12: Identification

	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
B ₀	Major Version				Minor Version			
B ₁	(msb) Manufacturer Code (lsb)							
B ₂								
B ₃	Ext	(msb) Basic Device Identifier (lsb)						
⋮								
B ₆								

Major Version The combination of this field and the Minor Version field identifies to which revision of the System Description Wireless Power Transfer the Power Receiver complies. The Major Version field shall contain the binary coded digit value 0x1.

Minor Version The combination of this field and the Major Version field identifies to which minor revision of the System Description Wireless Power Transfer the Power Receiver complies. The Minor Version field shall contain the binary coded digit value 0x1.

Manufacturer Code The bit string contained in this field identifies the manufacturer of the Power Receiver, as specified in [PRMC].

Ext If this bit is set to ZERO, the bit string

Manufacturer Code || Basic Device Identifier

identifies the Power Receiver. If this bit is set to ONE, the bit string

Manufacturer Code || Basic Device Identifier || Extended Device Identifier

identifies the Power Receiver (see also Section 6.3.9).

Basic Device Identifier The bit string contained in this field contributes to the identification of the Power Receiver. A Power Receiver manufacturer should ensure that the combination of Basic Device Identifier and Manufacturer ID is sufficiently unique. Embedding a serial number of at least 20 bits in the Basic Device Identifier is sufficient. Alternatively, using a (pseudo) random number generator to dynamically generate part of the Basic Device Identifier is sufficient as well, provided that the generated part complies with the following requirements:

- The generated part shall comprise at least 20 bits.
- All possible values shall occur with equal probability.
- The Power Receiver shall not change the generated part while the Power Signal is applied.
- The Power Receiver shall retain the generated part for at least 2 s if the Power Signal is interrupted or removed.

(Informative) *These requirements ensure that the scanning procedure of a type B1 Power Transmitter proceeds correctly; see also Annex C.2.*

a means for avoiding overcharging one or both of the mobile device and the battery inductively; and

The 440 Claim 1 Accused Products meet this part of 440 claim 1. At least four forms of overcharge protection in the accused products satisfy this claim element, individually and combined. First, as described in this section, the 440 Claim 1 Accused Products include a means (e.g., a wireless power receiver/transceiver ASIC) to send an “end power transfer” message to the wireless charger base station unit, signaling to the base unit to stop inductive charging and preventing overcharging following the WPC Standard protocol. Second, as described in the WPC standard and throughout this document, the Accused Products communicate voltage/current/power requirements to the charger for regulation by the charger, which the charger then uses for closed-loop control of the voltage/current/power delivered to the product. This is a further form of overcharge protection. Third, as described with respect to the “regulator” element below, regulators are present in each of the accused products. Because the regulator limits the voltage, current, or power delivered, thereby reducing the charge delivered, and is configured to provide this regulated, limited power to the battery and can also be shut down if needed, the regulator is a means for avoiding overcharging one or both the mobile device and the battery. Fourth, in addition to a regulator in the receiver ASIC, the accused products include Battery Charger or Power Management (PMIC) ICs that charge the battery. These Battery Charger ICs include means for avoiding overcharging one or both the mobile device and the battery.

Samsung Galaxy smartphones

The representative P9221-R and associated software/firmware included in the Galaxy S7 smartphone supports overcharge protection as described above, per the WPC Standard.

See, for example, WPC 1.1.2 Standard, Part 1, Interface Definition, page 124.

System Description	
Wireless Power Transfer	
Communications Interface	Version 1.1.2

6.3.2 End Power Transfer Packet (0x02)

Table 6-3 defines the format of the message contained in an End Power Transfer Packet.

Table 6-5: End Power Transfer

	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
B ₀	End Power Transfer Code							

End Power Transfer Code This field identifies the reason for the End Power Transfer request, as listed in Table 6-6. The Power Receiver shall not transmit End Power Transfer Packets that contain any of the values that Table 6-6 lists as reserved.

Table 6-6: End Power Transfer values

Reason	Value
Unknown	0x00
Charge Complete	0x01

The aforementioned “End Power Transfer” can be triggered for a variety for reasons to avoid overcharging the battery included in the S7. For example, the representative P9221-R ASIC and its external circuitry and software/firmware implement this functionality, as illustrated below. See, for example, Ex. I at 18, 24.

<https://www.renesas.com/us/en/document/dst/p9221-r-datasheet>

10.6 Power Transfer Phase

In this phase, the P9221-R controls the power transfer by means of the following control data packets:

- Control Error Packets
- Received Power Packet (RPP, FOD-related)
- End Power Transfer (EPT) Packet

Once the “identification and configuration” phase is completed, the transmitter initiates the power transfer mode. The P9221-R control circuit measures the rectifier voltage and sends error packets to the transmitter to adjust the rectifier voltage to the level required to maximize the efficiency of the linear regulator and to send to the transmitter the actual received power packet for foreign object detection (FOD) to guarantee safe, efficient power transfer.

In the event of an EPT issued by the application, the P9221-R turns off the LDO and continuously sends EPT packets until the transmitter removes the power and the rectified voltage on the receiver side drops below the UVLO threshold.

8.9 External Temperature Sensing and End of Charge – TS/EOC

The P9221-R has a temperature sensor input which can be used to monitor an external temperature by using a thermistor. The built-in comparator's reference voltage is 0.6V and 0.1V in the P9221-R, and it is used for monitoring the voltage level on the TS/EOC pin as described by Equation 1.

$$V_{TS} = V_{VDD18} \times \frac{NTC}{R + NTC}$$

Equation 1

Where NTC is the thermistor's resistance and R is the pull-up resistor connected to VDD18 pin. The over-temperature shutdown is triggered when the TS pin voltage is between 0.6V and 0.1V; for more information, see Figure 24.

When the TS/EOC pin is less than 0.1V, the End of Charge (EOC) function is activated, and the P9221-R will send the End Power Transfer (EPT) packet to the transmitter terminating the power delivery.

Moreover, per the WPC Standard, the wireless power ASIC (e.g., the IDT/Renesas P9221-R ASIC) during the Power Transfer Phase communicates its wireless receiver output voltage or current to the base unit for closed loop feedback control of the voltage or current, thereby avoiding overcharging. See WPC 1.1.2 Standard, Part 1, Interface Definitions at page 124; see also WPC 1.2.4 Standard at 46.

Throughout the *power transfer* phase, the Power Transmitter and Power Receiver control the amount of power that is transferred. The Figure 5-2 illustrates a schematic diagram of the power transfer control loop, which basically operates as follows: The Power Receiver selects a desired Control Point—a desired output current and/or voltage, a temperature measured somewhere in the Mobile Device, etc. In addition, the Power Receiver determines its actual Control Point. Note that the Power Receiver may use any approach to determine a Control Point. Moreover, the Power Receiver may change this approach at any time during the *power transfer* phase. Using the desired Control Point and actual Control Point, the Power Receiver calculates a Control Error Value—for example simply taking the (relative) difference of the two output voltages or currents—such that the result is negative if the Power Receiver requires less power in order to reach its desired Control Point, and positive if the Power Receiver requires more power in order to reach its desired Control Point. Subsequently, the Power Receiver transmits this Control Error Value to the Power Transmitter.

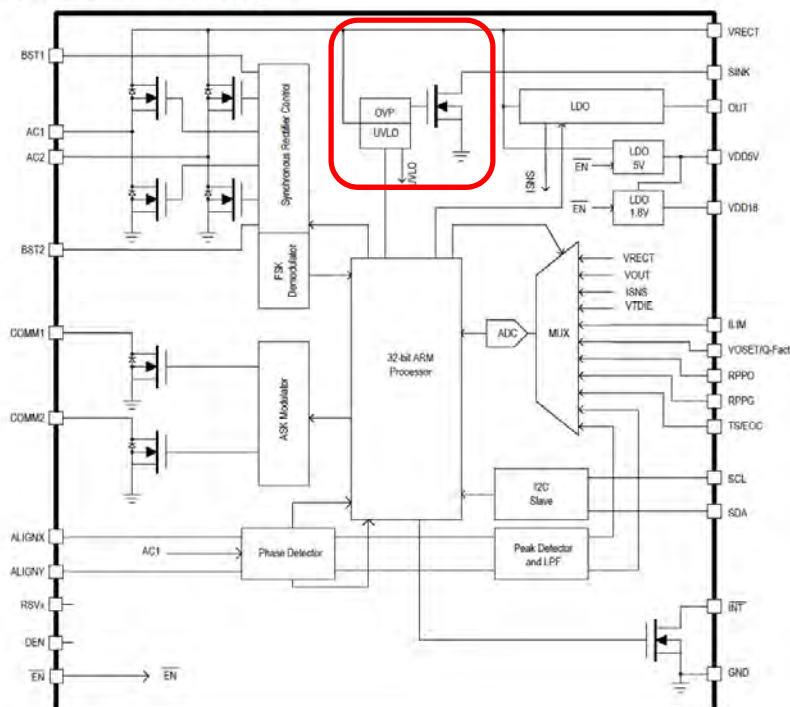
⁶Note that it is up to the Power Transmitter implementation to determine whether this stand-by mode of operation is part of the *selection* phase or is separate from the *selection* phase.

The P9221 also includes an output LDO (red rectangle below) that is used to regulate the output power or shut off power output to avoid overcharging the battery.



7. Functional Block Diagram

Figure 17. Functional Block Diagram



8.1 LDO – Low Dropout Regulators

The P9221-R has three low-dropout linear regulators. The main regulator is used to provide the power required by the battery charger where the output voltage can be set to either 9V or 12V. For more information about setting the output voltage, see section 8.2. It is important to connect a minimum of 30µF ceramic capacitance to the OUT pin.

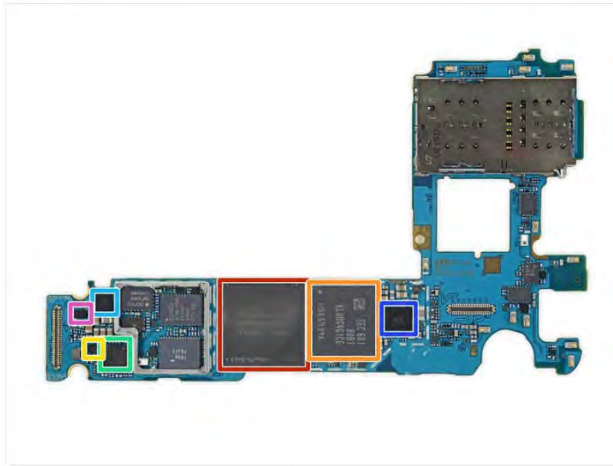
The other two regulators, VDD5V and VDD18, are to bias the internal circuitry of the receiver. The LDOs must have local 1µF ceramic capacitors placed as close as possible to the pins.

In the event of an EPT issued by the application, the P9221-R turns off the LDO and continuously sends EPT packets until the transmitter removes the power and the rectified voltage on the receiver side drops below the UVLO threshold.

The Galaxy S7 also includes a Maxim Integrated MAX77854EWZ PMIC / battery charger for charging the battery that includes means for avoiding overcharging the battery.

<https://www.ifixit.com/Teardown/Samsung+Galaxy+S7+Teardown/56686>

Step 11



- Our friends at [Chipworks](#) may have beaten us to the punch, but that doesn't stop us from giving this board our due diligence. Squirreled away under the EMI shields, we find:
 - SK Hynix [H9KNNNCTUMU-BRNMH](#) 4 GB LPDDR4 memory layered over the Qualcomm [MSM8996](#) Snapdragon 820
 - Samsung [KLUG4G1CE-B0B1](#) 32 GB MLC universal flash storage 2.0
 - DSP Group [DBMD4](#) audio/voice processor
 - Qualcomm [WCD9335](#) audio codec
 - Maxim Integrated MAX98506BEWV audio amplifier
 - **Maxim Integrated MAX77854EWZ power management w/ li-ion battery charger**
 - ON Semiconductor load switch

Upon information and belief, the Maxim Integrated MAX77854EWZ PMIC / battery charger is similar in battery charging operation to Maxim Integrated MAX77840 which includes many features to avoid overcharging the battery.

<https://www.analog.com/media/en/technical-documentation/data-sheets/max77840.pdf>

Charger States

The MAX77840 utilizes several charging states to safely and quickly charge batteries. Figure 2 shows an exaggerated view of a Li+/Li-Poly battery progressing through the following charge states when there is no system load and the die and the battery are close to room temperature: prequalification → fast-charge → top-off → done.

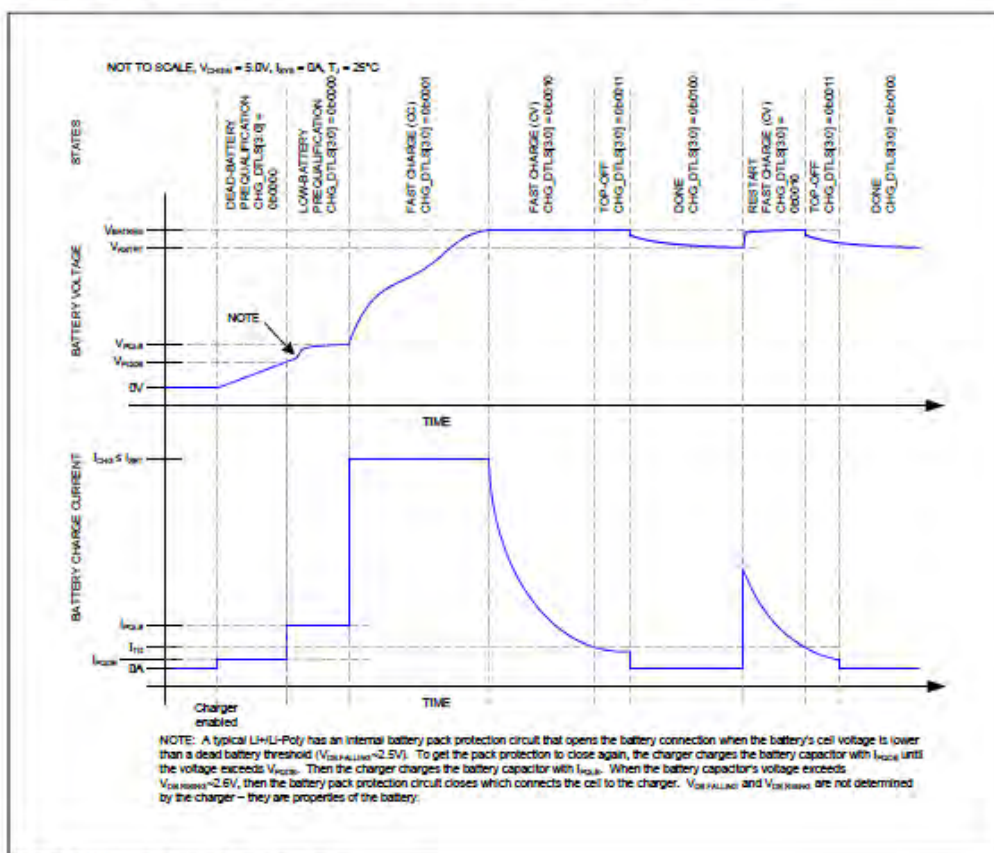


Figure 2. MAX77840 Typical Charging Profile

Similarly, the wireless transceiver ASIC along with the software/firmware included in the Galaxy S22 Ultra smartphone supports overcharge protection as described above, per the WPC Standard.

See, for example, WPC 1.2.4 Standard, Parts 1 & 2: Interface Definitions, page 94



5.2.3.2 End Power Transfer Packet (0x02)

Table 28 defines the format of the message contained in an End Power Transfer Packet.

Table 28. End Power Transfer

	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
B ₀	End Power Transfer Code							

End Power Transfer Code. This field identifies the reason for the End Power Transfer request, as listed in Table 29. The Power Receiver shall not transmit End Power Transfer Packets that contain any of the values that Table 29 lists as reserved.

Table 29. End Power Transfer values

Reason	Value	Recommended usage of the values (Informative)
Unknown	0x00	The Receiver may use this value if it does not have a specific reason for terminating the power transfer or if none of the other values listed in this table is appropriate.
Charge Complete	0x01	The Receiver should use this value if it determines that the battery of the Mobile Device is fully charged. On receipt of an End Power Transfer Packet containing this value, the Transmitter should set any "charged" indication on its user interface that is associated with the Receiver.
Internal Fault	0x02	The Receiver may use this value if it has encountered some internal problem, e.g. a software or logic error.
Over Temperature	0x03	The Receiver should use this value if it has measured a temperature within the Mobile Device that exceeds a limit.
Over Voltage	0x04	The Receiver should use this value if it has measured a voltage within the Mobile Device that exceeds a limit.
Over Current	0x05	The Receiver should use this value if it has measured a current within the Mobile Device that exceeds a limit.
Battery Failure	0x06	The Receiver should use this value if it has determined a problem exists with the Mobile Device battery.
Reserved	0x07	The End Power Transfer Value = 0x07 (reconfigure) has been deprecated, and should not be used. It may result in unpredictable Power Transmitter behavior.
No Response	0x08	The Receiver should use this value if it determines that the Transmitter does not respond to Control Error Packets as expected (i.e. it does not increase or decrease its Primary Cell current appropriately).
Reserved	0x09	—

As in the P9221-R, the "End Power Transfer" in the representative P9415-R can be triggered for a variety for reasons to avoid overcharging the battery included in the S22 Ultra. For example, the P9415-R ASIC and its external circuitry and software/firmware implement this functionality, as illustrated below. See, for example, the P9415-R datasheet at pages 26, 27.

<https://www.renesas.com/us/en/document/dst/p9415-r-datasheet>

8.2.10 Identification and Configuration (ID and Config)

In this phase, the P9415-R sends or expects the following packets:

- Identification Packet
- Configuration Packet

After the transmission of the Configuration Packet, the P9415-R proceeds to the Negotiation phase.

8.2.11 Negotiation

The Power Receiver negotiates with the Power Transmitter to fine-tune the Power Transfer Contract. For this purpose, the Power Receiver sends negotiation requests to the Power Transmitter, where the Power Transmitter can grant or deny.

8.2.12 Calibration

The Power Receiver provides its Received Power back to the Power Transmitter.

8.2.13 Power Transfer

In this phase, the P9415-R controls the power transfer by means of the following Control Data Packets:

- Control Error Packets
- Rectified Power Packet
- End Power Transfer Packet

8.2.14 Renegotiation

In this phase, the Power Receiver can make adjustments to the Power Transfer Contract, if required. If necessary, this phase can be aborted prematurely without changing the Power Transfer Contract.

8.2.15 End of Power Transfer (EPT)

In the event of EPT, the device turns off the LDO only after the AP instructs the P9415-R to continuously send End of Power (EPT) packets until the transmitter removes the power and the rectifier voltage on the receiver side drops below the UVLO threshold.

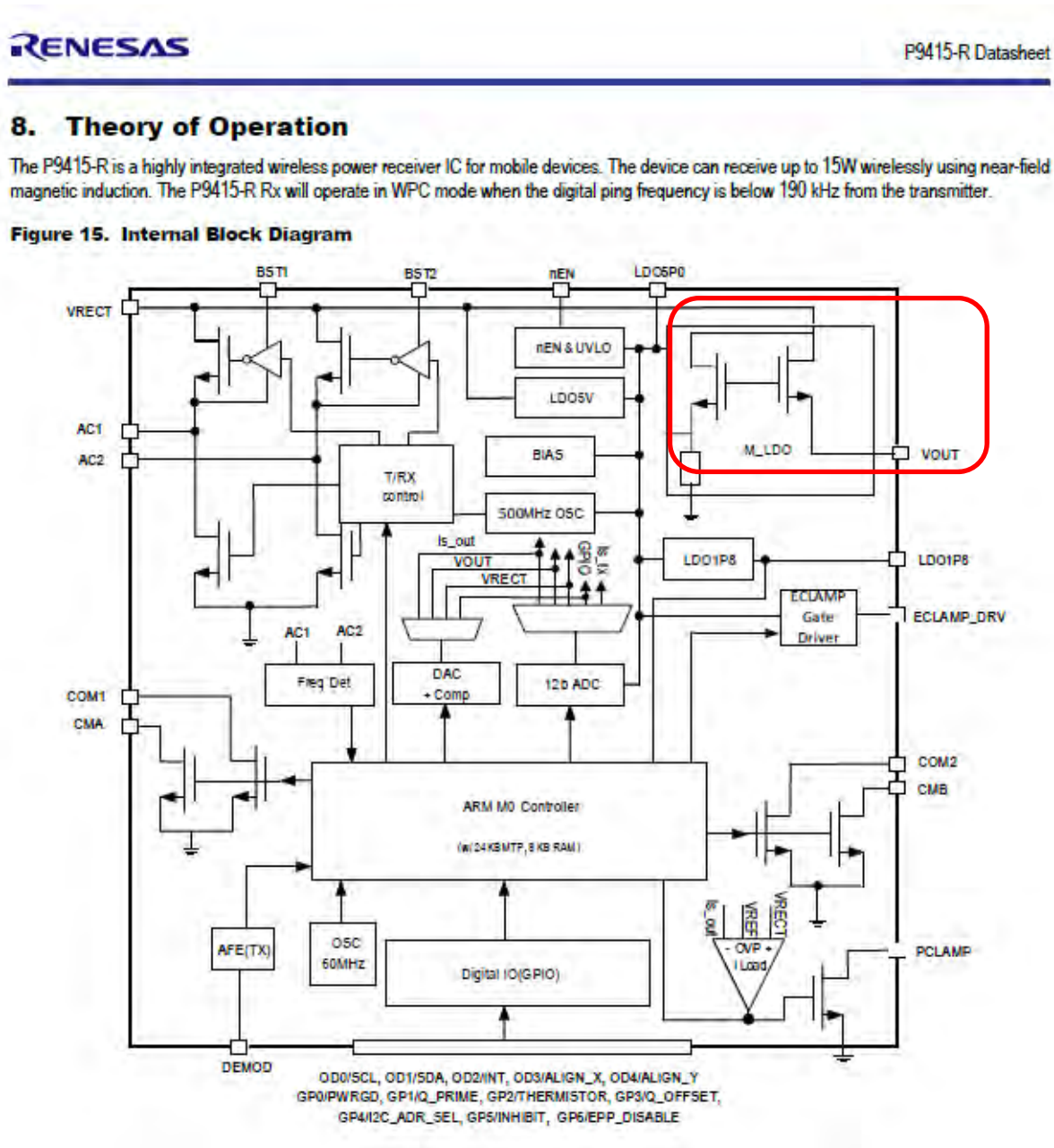
Similar to the S7 receiver operation, the representative P9415-R as shown above, during the Power Transfer Phase controls and regulates the output voltage and power delivered to the battery.

See WPC 1.1.2 Standard, Part 1, Interface Definitions at page 124; *see also* WPC 1.2.4 Standard at 46.

Throughout the *power transfer* phase, the Power Transmitter and Power Receiver control the amount of power that is transferred. The Figure 5-2 illustrates a schematic diagram of the power transfer control loop, which basically operates as follows: The Power Receiver selects a desired Control Point—a desired output current and/or voltage, a temperature measured somewhere in the Mobile Device, etc. In addition, the Power Receiver determines its actual Control Point. Note that the Power Receiver may use any approach to determine a Control Point. Moreover, the Power Receiver may change this approach at any time during the *power transfer* phase. Using the desired Control Point and actual Control Point, the Power Receiver calculates a Control Error Value—for example simply taking the (relative) difference of the two output voltages or currents—such that the result is negative if the Power Receiver requires less power in order to reach its desired Control Point, and positive if the Power Receiver requires more power in order to reach its desired Control Point. Subsequently, the Power Receiver transmits this Control Error Value to the Power Transmitter.

⁶Note that it is up to the Power Transmitter implementation to determine whether this stand-by mode of operation is part of the *selection* phase or is separate from the *selection* phase.

The P9415-R also includes an output regulator (red rectangle) as a means of avoiding overcharging one or both the mobile device and the battery.



The 9415 datasheet also describes handling of WPC EPT messages.

8.2.15 End of Power Transfer (EPT)

In the event of EPT, the device turns off the LDO only after the AP instructs the P9415-R to continuously send End of Power (EPT) packets until the transmitter removes the power and the rectifier voltage on the receiver side drops below the UVLO threshold.

The S22 Ultra also includes a battery charger IC.

<https://www.techinsights.com/blog/samsung-galaxy-s22-ultra-teardown>



Figure 1. Samsung Galaxy S22 board shot

On information and belief, such a Battery Charger has a means of avoiding overcharging the battery. As an example of such a feature in battery chargers, see datasheet for a similar NXP battery charger below:

<https://www.nxp.com/docs/en/data-sheet/PCA9481AUK-SDS.pdf>

PCA9482UK

7 A 2:1, 1:2, and 1:1 mode switched capacitor direct charger

Rev. 1.0 — 8 November 2022

Short data sheet

1 General description

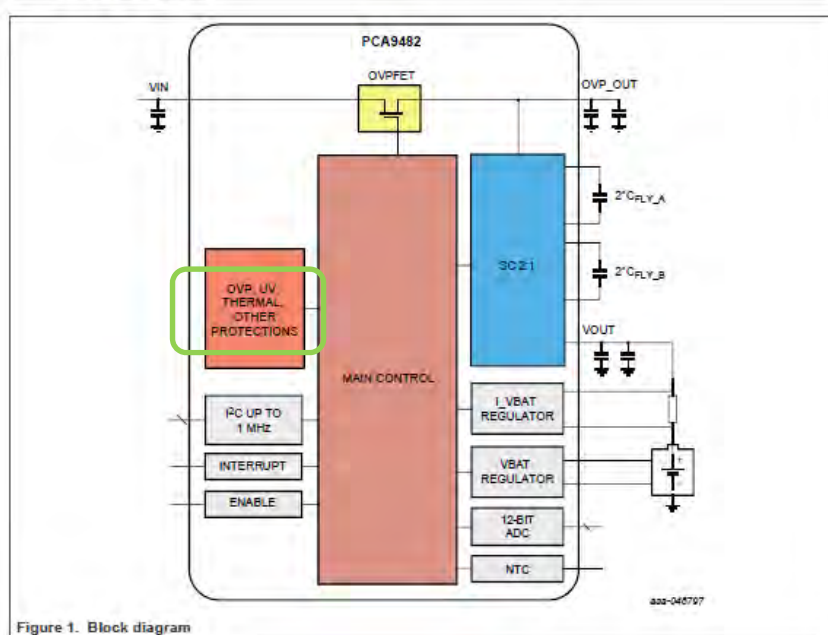
The PCA9482UK is a highly-integrated switched-capacitor converter with an embedded OVPFET, targeted to provide two times the output current for fast charging applications with a 1-cell battery. The device works in 2:1 switching operation with very high efficiency (>96.5 %, at $V_{OUT} = 4\text{ V}$, $I_{OUT} = 5\text{ A}$), in 1:2 switching operation or in 1:1 mode with forward and reverse direction.

As absolute maximum voltage for each VIN and VOUT, VIN input is designed to support up to 16.5 V with no pre-biased scheme and 20 V with the pre-bias enabled for USB VBUS, and VOUT input is designed to support up to 7 V with the pre-bias enabled for a 1-cell battery application.

The device provides multiple safety schemes such as OV (Overvoltage), UV (Undervoltage), switching pin short, thermal shutdown and others.

The device features all the functions with I²C-bus interface, with up to 1 MHz.

5 Block diagram



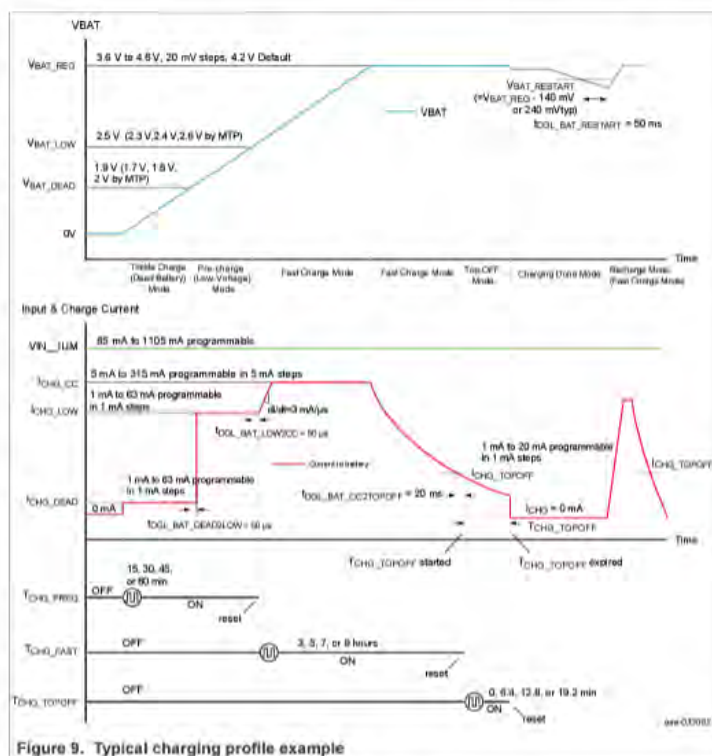
The representative NXP battery charger has extensive capabilities to measure the battery status and avoid overcharging the battery.

<https://www.nxp.com/docs/en/data-sheet/PCA9420DS.pdf>

NXP Semiconductors

PCA9420

Power management IC for low-power microcontroller applications



Samsung earbud products

The power management circuitry associated software/firmware executing on the representative Buds/Buds2, as well as the regulator circuitry and battery charger electronics, constitute at least in part means for avoiding overcharging as specified by this portion of the claim. They do so per the WPC Standard, which requires such overcharge protection as set forth above. The Buds include a separate microcontroller and associated electronics, and the Buds2 includes an integrated wireless power ASIC (e.g., the Samsung MUA01); both include associated software/firmware and battery charging electronics that operate substantially the same as in the above smartphones.

The Buds/Buds2 and associated software/firmware support overcharge protection as described above, per the WPC Standard.

See, for example, WPC 1.1.2 Standard, Part 1, Interface Definition, page 124.

System Description	
Wireless Power Transfer	
Communications Interface	Version 1.1.2

6.3.2 End Power Transfer Packet (0x02)

Table 6-3 defines the format of the message contained in an End Power Transfer Packet.

Table 6-5: End Power Transfer

	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
B ₀	End Power Transfer Code							

End Power Transfer Code This field identifies the reason for the End Power Transfer request, as listed in Table 6-6. The Power Receiver shall not transmit End Power Transfer Packets that contain any of the values that Table 6-6 lists as reserved.

Table 6-6: End Power Transfer values

Reason	Value
Unknown	0x00
Charge Complete	0x01

The aforementioned “End Power Transfer” can be triggered for a variety for reasons to avoid overcharging the battery included in the Buds/Buds2.

For example, during the Power Transfer Phase, the system controls and regulates the output voltage and power delivered to the battery.

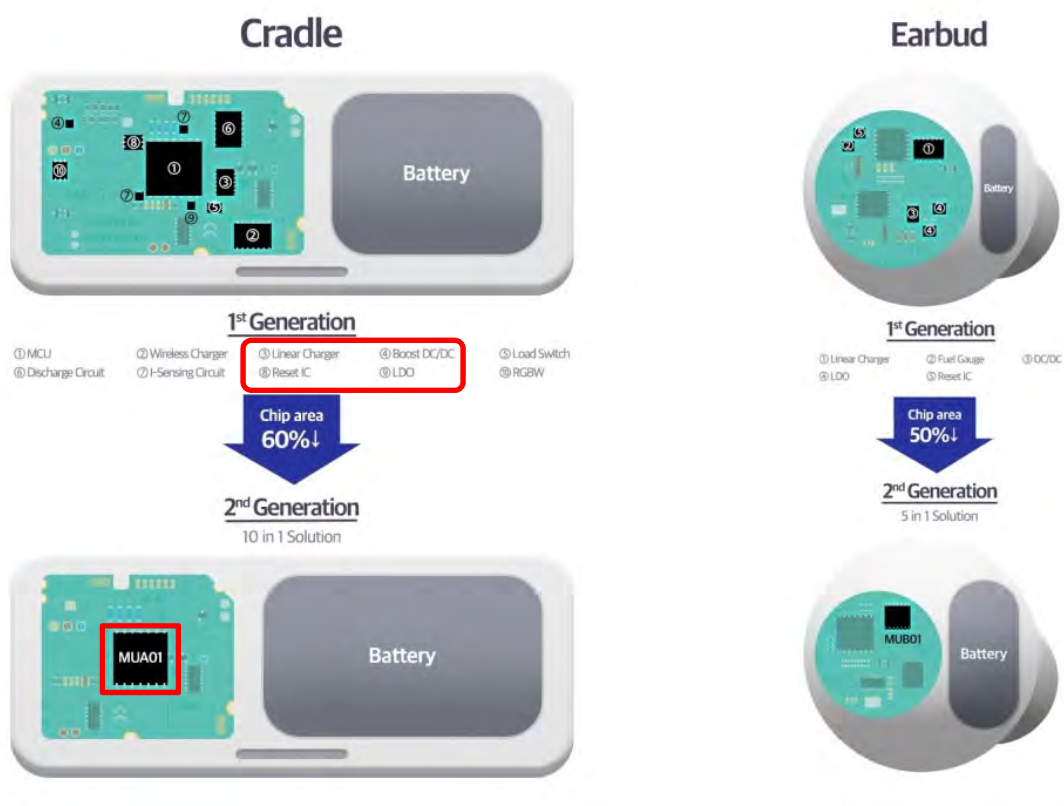
See WPC 1.1.2 Standard, Part 1, Interface Definitions at page 124; *see also* WPC 1.2.4 Standard at 46.

Throughout the *power transfer* phase, the Power Transmitter and Power Receiver control the amount of power that is transferred. The Figure 5-2 illustrates a schematic diagram of the power transfer control loop, which basically operates as follows: The Power Receiver selects a desired Control Point—a desired output current and/or voltage, a temperature measured somewhere in the Mobile Device, etc. In addition, the Power Receiver determines its actual Control Point. Note that the Power Receiver may use any approach to determine a Control Point. Moreover, the Power Receiver may change this approach at any time during the *power transfer* phase. Using the desired Control Point and actual Control Point, the Power Receiver calculates a Control Error Value—for example simply taking the (relative) difference of the two output voltages or currents—such that the result is negative if the Power Receiver requires less power in order to reach its desired Control Point, and positive if the Power Receiver requires more power in order to reach its desired Control Point. Subsequently, the Power Receiver transmits this Control Error Value to the Power Transmitter.

⁶Note that it is up to the Power Transmitter implementation to determine whether this stand-by mode of operation is part of the *selection* phase or is separate from the *selection* phase.

The representative Buds/Buds2 cases include a regulator and a battery charger IC as claimed. In particular, they include a regulator and linear charger coupled to the output of the receiver to regulate the voltage/current provided to the battery, including in the MUA01 ASIC in the Buds2 case shown below.

<https://www.sammobile.com/news/samsung-launches-industry-first-power-chipsets-true-wireless-earbuds/>



Samsung wearables

The wireless power receiver in the Watch4 (such as the P9222-R/RN, which is believed to be representative of the Renesas P9222S identified in the iFixit teardown below) sends an End Of Charge message to the base unit to avoid overcharging of the battery, following the protocol of the WPC Standard, as set forth above with respect to the smartphones. The wireless power receiver along with associated software/firmware constitutes a “means for avoiding overcharging” as specified by this part of the claim.

The P9222S has multiple means of avoiding overcharging the mobile device and the battery. The P9222S terminates the Power Transfer Phase as outlined below in the datasheet of the representative P9222-R/RN.



7.5.4 Power Transfer

In the "Power Transfer" phase, the P9222-R/RN controls the power transfer by means of the following control data packets:

- Control Error Packets (CEP)
- Rectified Power Packet (RPP)
- End Power Transfer Packet (EPT)

7.5.4.1 End Power Transfer (EPT) Packet

In the event of an EPT, the P9222-R/RN turns off only after the AP instructs the P9222-R/RN to continuously send End Power Transfer packets until the transmitter removes the power and the rectifier voltage on the receiver side drops below the under-voltage lock-out (UVLO) threshold (see Table 5).

Moreover, per the WPC Standard, the wireless power ASIC (e.g., the IDT/Renesas P9222 ASIC) during the Power Transfer Phase communicates its wireless receiver output voltage or current to the base unit for closed loop feedback control of the voltage or current, thereby avoiding overcharging. See WPC 1.1.2 Standard, Part 1, Interface Definitions at page 124; *see also* WPC 1.2.4 Standard at 46.

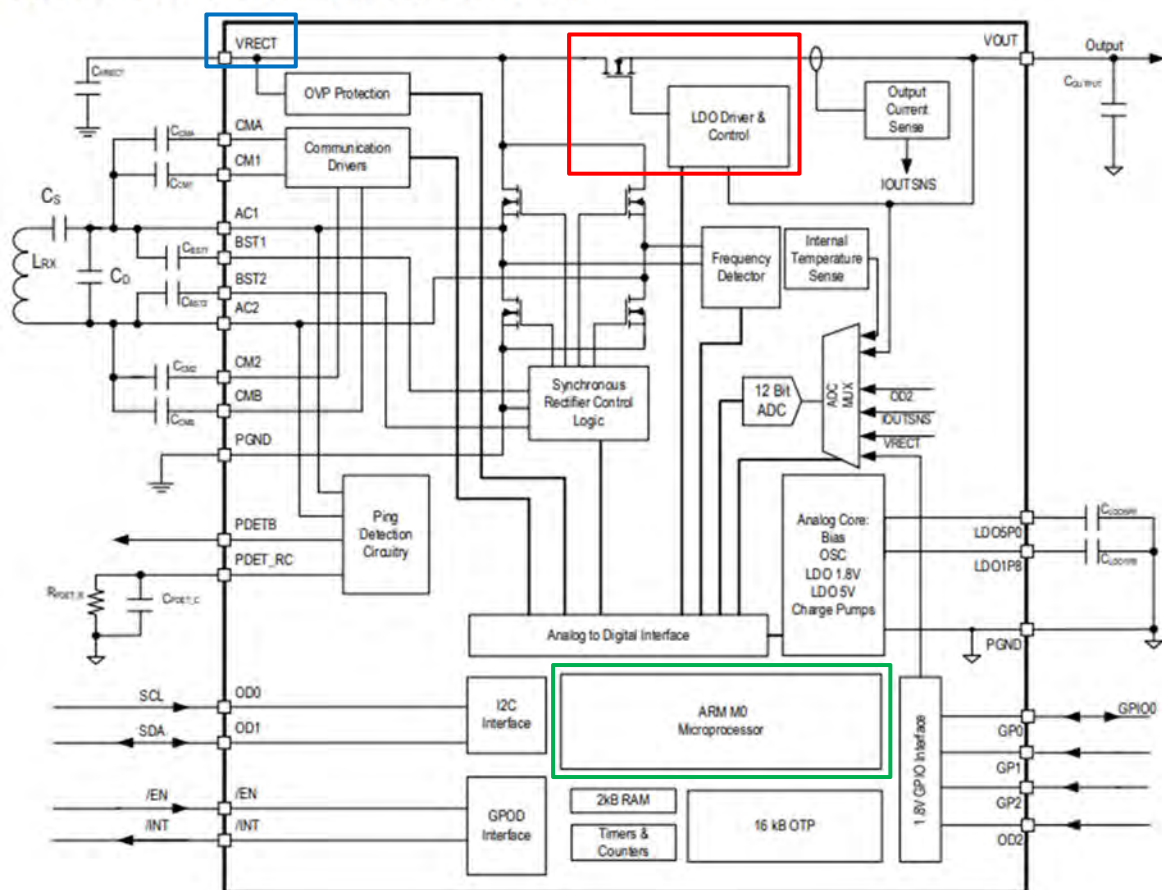
Throughout the *power transfer* phase, the Power Transmitter and Power Receiver control the amount of power that is transferred. The Figure 5-2 illustrates a schematic diagram of the power transfer control loop, which basically operates as follows: The Power Receiver selects a desired Control Point—a desired output current and/or voltage, a temperature measured somewhere in the Mobile Device, etc. In addition, the Power Receiver determines its actual Control Point. Note that the Power Receiver may use any approach to determine a Control Point. Moreover, the Power Receiver may change this approach at any time during the *power transfer* phase. Using the desired Control Point and actual Control Point, the Power Receiver calculates a Control Error Value—for example simply taking the (relative) difference of the two output voltages or currents—such that the result is negative if the Power Receiver requires less power in order to reach its desired Control Point, and positive if the Power Receiver requires more power in order to reach its desired Control Point. Subsequently, the Power Receiver transmits this Control Error Value to the Power Transmitter.

⁶Note that it is up to the Power Transmitter implementation to determine whether this stand-by mode of operation is part of the *selection* phase or is separate from the *selection* phase.

The Watch4 includes a regulator to regulate the receiver output to avoid overcharging the battery. For instance, in the representative 9222 ASIC receiver circuit, the red rectangle shows the regulator and its driver that is coupled to the rectified voltage (V_{rect} – blue rectangle) and regulates the output voltage provided by the receiver. This regulator is controlled by the main Microprocessor shown in the green rectangle to optimize battery charging and to avoid overcharging of the battery.

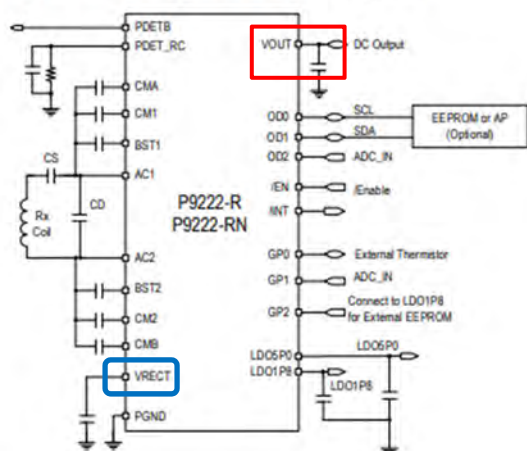
<https://www.renesas.com/us/en/document/dst/p9222-rn-datasheet>

Figure 2. P9222-R/RN Block and Application Diagram



Block Diagram

Figure 1. Simplified Block Diagram



9. Examples of User Customizing P9222-R/RN Operating Parameters

9.1 LDO Output Voltage (VOUT) Configuration

The default VOUT voltage of the P9222-R/RN is 5.0V. The user can change the default Vout voltage in accordance with specific user design requirements and store the modified configuration in the external EEPROM, or an external AP can adjust VOUT voltage continuously via the I2C interface. In addition, an external MCU can continuously read the battery voltage and change VOUT to lower the losses in the battery charger to optimize the total system efficiency. The P9222-R/RN configurable Vout voltage range is from 3.5V to 12V.

On information and belief, the Watch4 also includes a battery charger IC that operates similarly to the S7 and S22 Ultra battery charger IC discussed above and avoids overcharging the battery.

a regulator, coupled to the output of the receiver or to the battery, that regulates an output voltage or output current provided by the receiver, to the mobile device or battery, to be within a range of parameters for the mobile device or the battery;

The 440 Claim 1 Accused Products meet this part of the 440 claim 1, for example, by way of the output Low Drop Out Regulator (LDO), DC/DC regulator and/or PMICs included therein, that regulate the output of the wireless power receiver to control the voltage/current provided to the battery and/or the microcontroller of receiver.

Samsung Galaxy smartphones

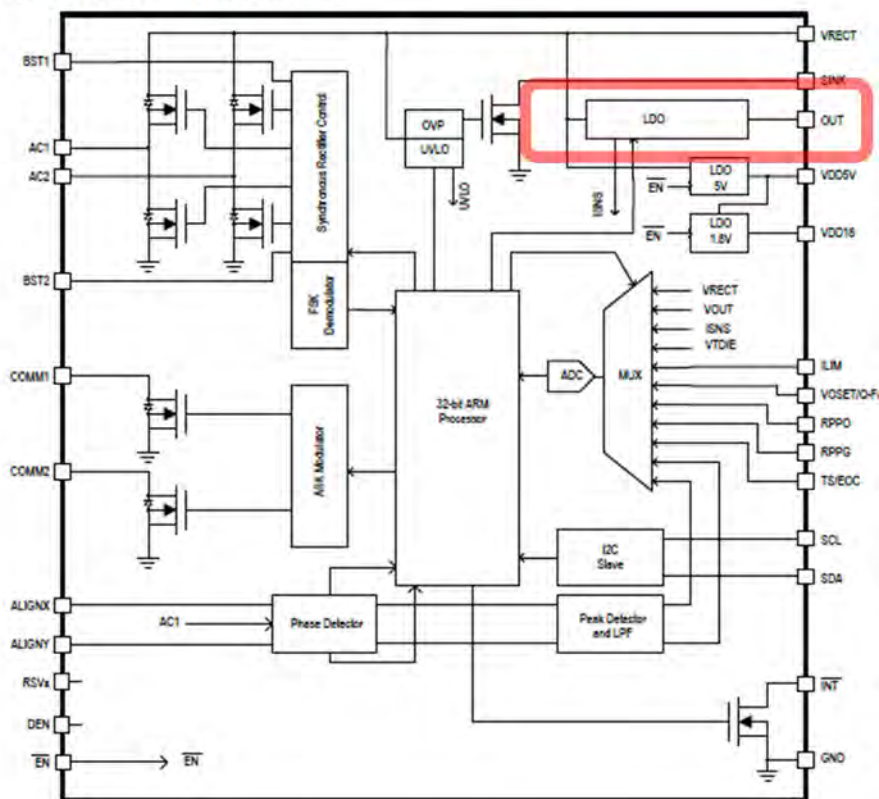
The wireless receiver ASIC and/or additional power management integrated circuits (PMICs) included in the Galaxy S7 smartphone include an LDO (low dropout regulator) that acts as the regulator as specified in this part of the claim. For example, as illustrated below, the LDO included in the representative P9221-R ASIC regulates the output voltage received at the “OUT” pin (as shown in the red rectangle). See P9221-R Datasheet at pages 15, 16.

<https://www.renesas.com/us/en/document/dst/p9221-r-datasheet>



7. Functional Block Diagram

Figure 17. Functional Block Diagram



8.1 LDO – Low Dropout Regulators

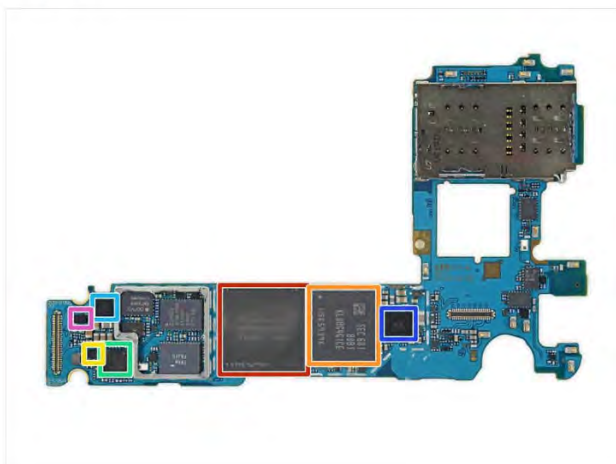
The P9221-R has three low-dropout linear regulators. The main regulator is used to provide the power required by the battery charger where the output voltage can be set to either 9V or 12V. For more information about setting the output voltage, see section 8.2. It is important to connect a minimum of 30µF ceramic capacitance to the OUT pin.

The other two regulators, VDD5V and VDD18, are to bias the internal circuitry of the receiver. The LDOs must have local 1µF ceramic capacitors placed as close as possible to the pins.

The battery charger in the S7 also includes a regulator coupled to the output of the receiver or the battery that regulates an output voltage or current to the mobile device or battery.

<https://www.ifixit.com/Teardown/Samsung+Galaxy+S7+Teardown/56686>

Step 11



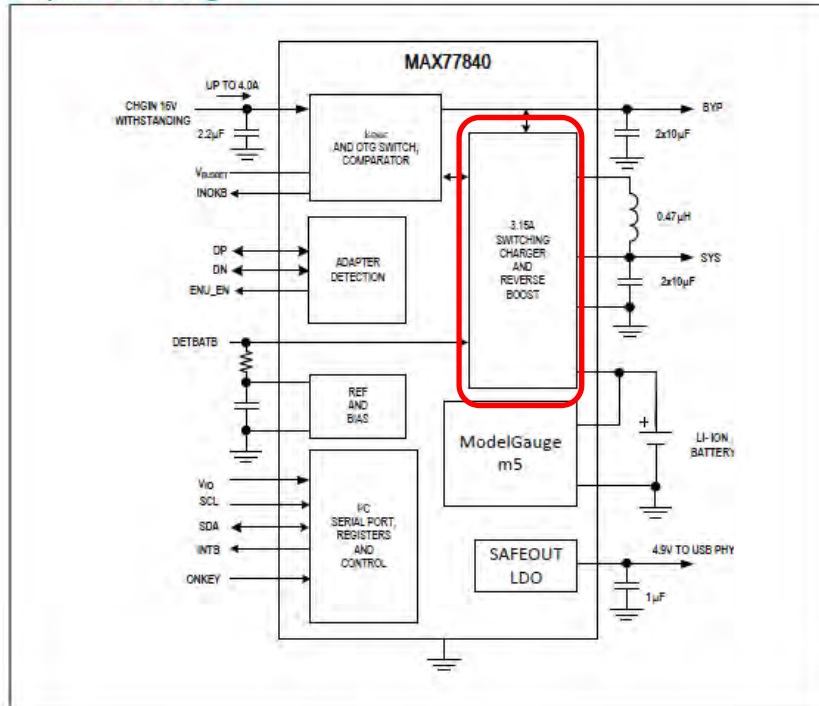
- Our friends at [Chipworks](#) may have beaten us to the punch, but that doesn't stop us from giving this board our due diligence. Squirreled away under the EMI shields, we find:
 - SK Hynix [H9KNNNCTUMU-BRNMH](#) 4 GB LPDDR4 memory layered over the Qualcomm [MSM8996](#) Snapdragon 820
 - Samsung [KLUG4G1CE-B0B1](#) 32 GB MLC universal flash storage 2.0
 - DSP Group [DBMD4](#) audio/voice processor
 - Qualcomm [WCD9335](#) audio codec
 - Maxim Integrated MAX98506BEWV audio amplifier
 - Maxim Integrated MAX77854EWZ power management w/ li-ion battery charger
 - ON Semiconductor load switch

Upon information and belief, the Maxim Integrated MAX77854EWZ PMIC / battery charger is similar in battery charging operation to Maxim Integrated MAX77840 which includes a regulator for regulating an output voltage or current provided by the receiver to the mobile device or battery to be within a range of parameters for the mobile device or the battery.

<https://www.analog.com/media/en/technical-documentation/data-sheets/max77840.pdf>

MAX77840 3A Buck Charger with ModelGauge m5 Fuel Gauge and USB BC1.2 Detection

Simplified Block Diagram

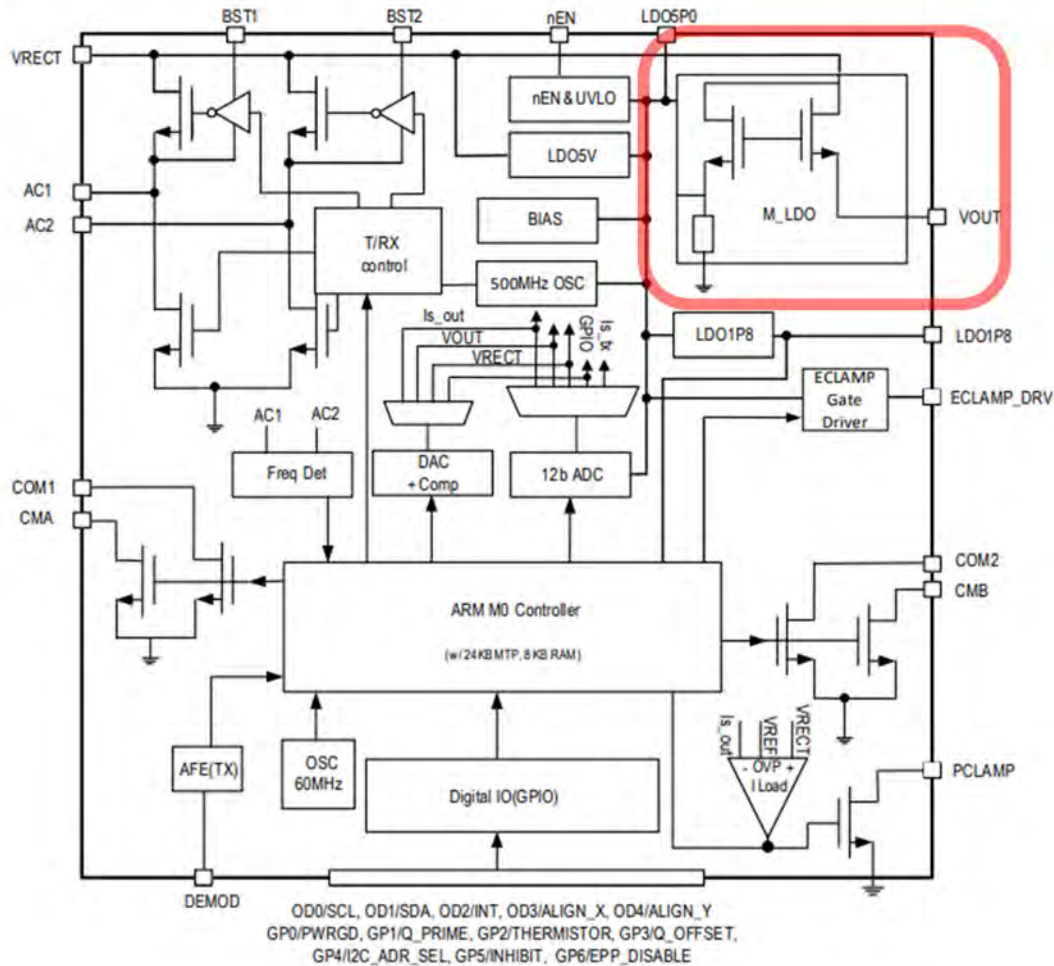


Similarly, the wireless power transceiver ASIC and/or PMICs included in the S22 Ultra include an LDO that functions as a regulator as claimed. For example, as illustrated below, the Main LDO, M_LDO included in the representative P9415-R ASIC regulates the output voltage received at the “VOUT” pin. See P9415-R Datasheet at pages 21, 27.

8. Theory of Operation

The P9415-R is a highly integrated wireless power receiver IC for mobile devices. The device can receive up to 15W wirelessly using near-field magnetic induction. The P9415-R Rx will operate in WPC mode when the digital ping frequency is below 190 kHz from the transmitter.

Figure 15. Internal Block Diagram



8.3.6 LDO Regulators

The P9415-R has three LDOs. The Main LDO (VOUT pin) is programmable from 5V to 20V and LDO5P0 is powered by VRECT. LDO1P8 is powered by LDO5P0. Both LDO5P0 and LDO1P8 are used for supplying power to internal low voltage blocks. The LDOs must have local ceramic bypass capacitors placed near the P9415-R.

A battery charger in the S22 Ultra also includes a regulator to regulate the output voltage of the wireless power receiver.

<https://www.techinsights.com/blog/samsung-galaxy-s22-ultra-teardown>

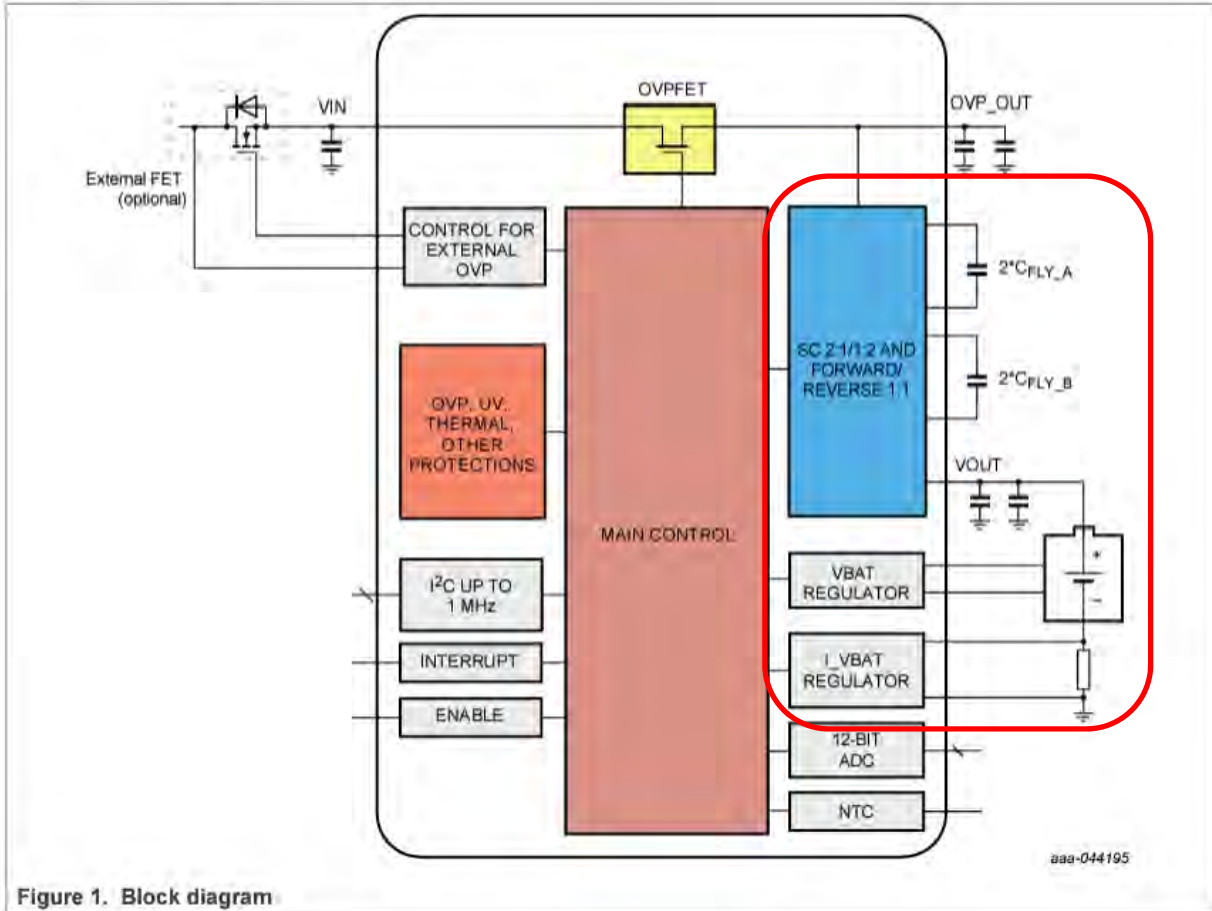


Figure 1. Samsung Galaxy S22 board shot

On information and belief, such a Battery Charger regulates the output voltage or current to the mobile device or battery to be within a range of parameters for the mobile device or battery.

<https://www.nxp.com/docs/en/data-sheet/PCA9481AUK-SDS.pdf>

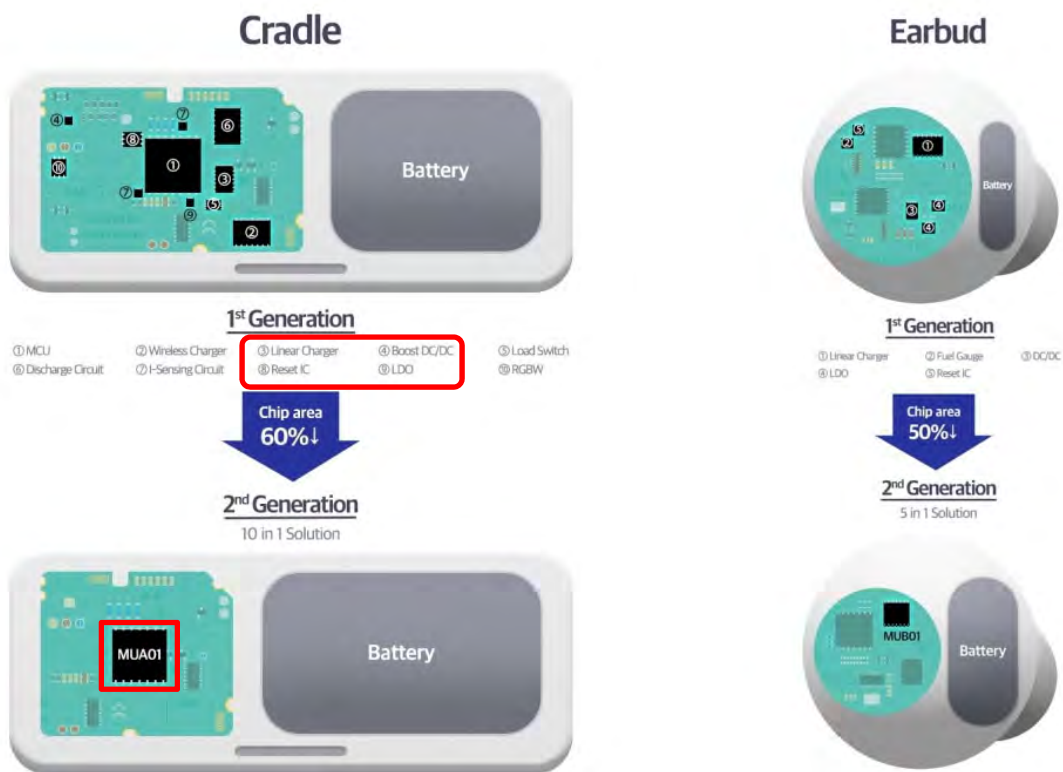
5 Block diagram



Samsung earbud products

The representative Buds/Buds2 cases include a receiver regulator and a battery charger IC as claimed. In particular, they include a regulator and linear charger coupled to the output of the receiver to regulate the voltage/current provided to the battery, in the MUA01 ASIC in the Buds2 case shown below.

<https://www.sammobile.com/news/samsung-launches-industry-first-power-chipsets-true-wireless-earbuds/>



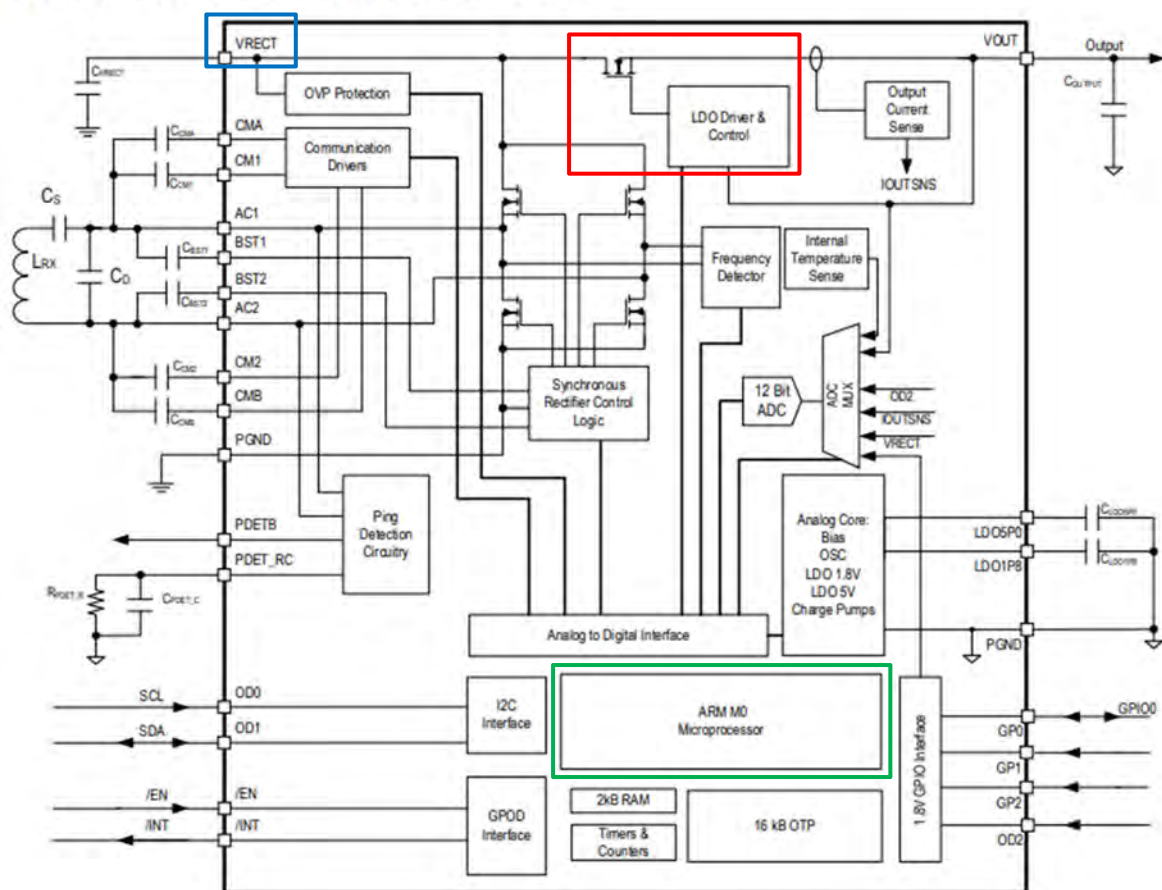
Samsung wearables

The representative Watch4 includes a receiver ASIC regulator and a battery charger / power management circuitry including regulators that regulate the output voltage/current provided from the output of the receiver to the battery as specified by this part of the claim, e.g., in a P9222 ASIC or the like.

The Watch4 includes a voltage regulator as specified by this part of the claim. For instance, in the representative 9222 ASIC receiver circuit, the red rectangle shows the regulator and its driver that is coupled to the rectified voltage (V_{rect} – blue rectangle) and regulates the output voltage provided by the receiver. This regulator is controlled by the main Microprocessor shown in the green rectangle.

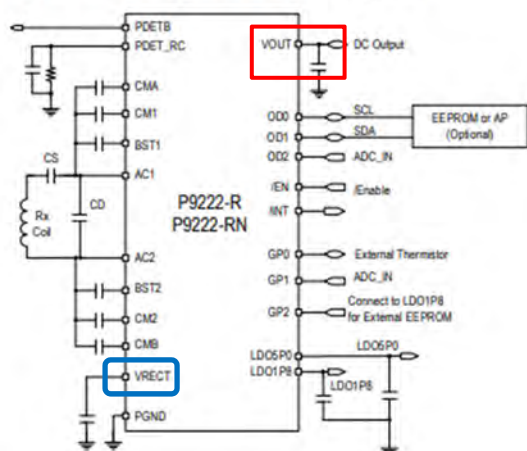
<https://www.renesas.com/us/en/document/dst/p9222-rrn-datasheet>

Figure 2. P9222-R/RN Block and Application Diagram



Block Diagram

Figure 1. Simplified Block Diagram



5.11 Low Drop-Out (LDO) Regulators

The P9222-R/RN has three LDO regulators. The primary VOUT LDO is powered by VRECT. The VOUT LDO can be programmed to any voltage between 3.5V and 10V; however, the output voltage setting should be compatible with the wireless Tx capability and coil type. The LDO5P0 is powered directly from VRECT, and LDO1P8 is powered from LDO5P0. Both are used for supplying power to internal low-voltage blocks. The LDOs must have local ceramic bypass capacitors placed near the P9222-R/RN. For recommended values, follow the application schematic in Figure 36.

5.3 Startup

When a mobile device containing the P9222-R/RN is placed on a WPC "Qi" charging pad, it responds to the transmitter's "ping" signal by rectifying the AC power from the transmitter and storing it on a capacitor connected to VRECT. During the "ping" phase, once the rectifier provides a voltage at the VRECT pin above the UVLO threshold, the digital section of the P9222-R/RN enables communication. The control loop of the P9222-R/RN adjusts the rectifier voltage by sending Control Error Packets (CEPs) to the transmitter before and after it enables the VOUT LDO.

The VOUT LDO is enabled when the power transfer phase is initiated and the voltage at VRECT (i.e., the output of the full-wave synchronous rectifier reaches the target voltage that includes headroom in addition to the LDO VOUT target voltage). For example, if the VOUT voltage target is 5V, the target VRECT voltage is VOUT plus headroom. If the VRECT target voltage is not reached within 1 second after entering the power transfer phase, the VOUT LDO will be enabled automatically.

RENESAS

P9222-R/RN Datasheet

9. Examples of User Customizing P9222-R/RN Operating Parameters

9.1 LDO Output Voltage (VOUT) Configuration

The default VOUT voltage of the P9222-R/RN is 5.0V. The user can change the default Vout voltage in accordance with specific user design requirements and store the modified configuration in the external EEPROM, or an external AP can adjust VOUT voltage continuously via the I2C interface. In addition, an external MCU can continuously read the battery voltage and change VOUT to lower the losses in the battery charger to optimize the total system efficiency. The P9222-R/RN configurable Vout voltage range is from 3.5V to 12V.

wherein different mobile devices and batteries can have different charging characteristics associated therewith; and

The 440 Claim 1 Accused Products meet this part of the 440 claim 1, as the specific charging characteristics of various devices and batteries differ from other devices/batteries. For example, the Galaxy S7 smartphone and/or the battery included therein has different charging characteristics than the Galaxy S22 smartphone and/or the battery included therein and similarly the different Galaxy Watches have different charging characteristics.

Samsung Galaxy smartphones

The S7 has the following charging characteristics:

<https://www.wirelesspowerconsortium.com/products/1549>

SAMSUNG MOBILE PHONE GALAXY S7 (SM-G930V)



BRAND
Samsung Mobile Phone

PRODUCT NAME
Galaxy S7

MANUFACTURER PART NUMBER
SM-G930V

PRODUCT TYPE
Power Class 0 Receiver

REGISTRATION DATE
February 24, 2016



ADDITIONAL DETAILS

Qi Registration id	1549
Version	1.1.2
Currently licensed	Yes
Power profile	Basic Power Profile
Maximum received power	5 watts

The S22 Ultra has the following charging characteristics, at least some of which are different than those of the S7:

<https://www.wirelesspowerconsortium.com/products/12711>

SAMSUNG ELECTRONICS GALAXY S22 ULTRA (SM-S9080)



BRAND
Samsung Electronics

PRODUCT NAME
Galaxy S22 Ultra

MANUFACTURER PART NUMBER
SM-S9080

PRODUCT TYPE
Power Class 0 Receiver

REGISTRATION DATE
March 16, 2022



ADDITIONAL DETAILS

Qi Registration id	12711
Version	1.2.4
Currently licensed	Yes
Power profile	Basic Power Profile
Maximum received power	4.4 watts

Samsung earbuds products

Illustrated below are some of the charging characteristics of the case of the representative Buds/Buds2, which differ from those of other devices.

Buds

<https://www.tomsguide.com/us/samsung-galaxy-buds,review-6229.html>

Samsung claims its 58-mAH battery can sustain the Galaxy Buds for 6 hours, and the earbuds lived up to the hype. I spent the day running errands, commuting from Manhattan to the Bronx and back, and still had enough juice to do an hour at the gym. The Buds tapped out at the 5-hour and 46-minute mark. That's significantly longer than the AirPods' runtime (estimated: 5 hours, actual time: 4:29).

Once the Buds start running low on battery, you have two ways to recharge: the charging case or your Galaxy S10 smartphone. I was disappointed to learn that the charging case's 252-mAH battery offers only an additional 7 hours of battery life. The AirPods' case offers 24 hours of charge, allowing for multiple recharges.

Buds2

<https://www.wirelesspowerconsortium.com/products/11427>

SAMSUNG ELECTRONICS GALAXY BUDS2 (SM-R177)

**BRAND**

Samsung Electronics

PRODUCT NAME

Galaxy Buds2

MANUFACTURER PART NUMBER

SM-R177

PRODUCT TYPE

Power Class 0 Receiver

REGISTRATION DATE

August 19, 2021

DESCRIPTION

GALAXY BUDS 2

ADDITIONAL DETAILS

Qi Registration id	11427
Version	1.2.4
Currently licensed	Yes
Power profile	Basic Power Profile
Maximum received power	2 watts



Samsung wearables

Illustrated below are some of the charging characteristics of the case of the representative Watch4 which differ from those of other devices.

Watch4

<https://www.ifixit.com/Teardown/Samsung+Galaxy+Watch4+and+Watch4+Classic+Teardown/144595>
(Galaxy Watch4)

Step 7



TOOL USED ON THIS STEP:
Spudger

\$3.99



- The watches' fuel tanks are hidden under the motherboards and nestled within plastic midframes.
- ① Thankfully, both can be removed without any heat—so long as you have a sturdy [spudger](#) on hand. (Just don't poke too hard—the usual [li-ion battery](#) cautions apply here.)
- The Watch4 Classic 46 mm accommodates a 1.40 Wh (361 mAh @ 3.88 V) battery—while its 40 mm little sister, the Watch4, houses a 0.95 Wh (247 mAh @ 3.88 V) battery.
- ① Compared to the Watch3 with 1.3 Wh (340 mAh @ 3.85 V), this represents a modest upgrade. With 1.62 Wh, the [2021 Mi Watch](#) still packs a bit more power—and the [Apple Watch Series 6 \(44 mm\)](#) twiddles its thumbs at the bottom of the stack with 1.17 Wh.

Step 7



TOOL USED ON THIS STEP:
Spudger

\$3.99



- The watches' fuel tanks are hidden under the motherboards and nestled within plastic midframes.
- ① Thankfully, both can be removed without any heat—so long as you have a sturdy [spudger](#) on hand. (Just don't poke too hard—the usual [li-ion battery](#) cautions apply here.)
- The Watch4 Classic 46 mm accommodates a 1.40 Wh (361 mAh @ 3.88 V) battery—while its 40 mm little sister, the Watch4, houses a 0.95 Wh (247 mAh @ 3.88 V) battery.
- ① Compared to the Watch3 with 1.3 Wh (340 mAh @ 3.85 V), this represents a modest upgrade. With 1.62 Wh, the [2021 Mi Watch](#) still packs a bit more power—and the [Apple Watch Series 6 \(44 mm\)](#) twiddles its thumbs at the bottom of the stack with 1.17 Wh.

wherein the receiver communicates with the base unit to detect, identify and authenticate the receiver with the base unit, as provided by the identification component, determine and then activate one or more primary coils of the base unit which are aligned with the receiver coil, verify the continued presence of the receiver near the base unit, and communicate information describing the characteristics of the mobile device or the battery, for use by the base unit to provide power transfer to the receiver and to the mobile device and the battery according to their particular charging characteristics.

The 440 Claim 1 Accused Products meet this part of 440 claim 1 per the WPC Standard protocol with which they communicate with the charger.

Samsung Galaxy smartphones

The Galaxy S7 communicates with the wireless charger base unit to configure and control wireless charging.

Per WPC, the communicated information is described at a high level below. *E.g.*, WPC 1.2.4 Standard, Introduction, page 9.



the electronics of an appropriate load to which it is connected. Conventional transformers use the same effect to achieve inductive power transfer between a primary and a secondary coil that are strongly coupled by means of a magnetic core.

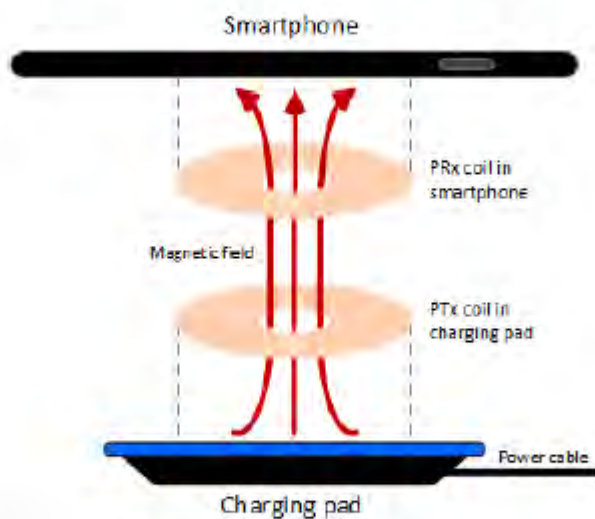
Although a Qi-based system is similar to a conventional transformer in the sense that power is transferred from a first coil to a second coil, it is also very different because of the much lower magnetic coupling between those coils. A conventional transformer has a magnetic coupling coefficient close to one, whereas a Qi-based system typically has a magnetic coupling coefficient in the range of 0.5 or below.

In the Qi-based system illustrated in Figure 4, power is transferred from the PTx contained in the Qi charging pad to a PRx contained in the Qi smartphone. Before charging begins, the PRx and PTx communicate with each other to establish that the mobile device is indeed capable of being charged, whether it needs to be charged, how much power is required, etc. In short, the communication ensures an appropriate power transfer from the power transmitter to the power receiver. The communication channel can also be used to trigger location based services by providing an SSID, a Bluetooth link, or a unique ID.

When charging begins, the power transmitter runs an alternating electrical current through its coil(s), which generates an alternating magnetic field in accordance with Faraday's law. This magnetic field is in turn picked up by the coil inside the power receiver and transformed by a power converter back into an alternating electrical current that can be used to charge the battery.

A critical feature of the magnetic field is that it can transfer through any non-metallic, non-ferrous materials, such as plastics, glass, water, wood, and air. In other words, wires and connectors are not needed between the power transmitter and power receiver.

Figure 6. Qi wireless power transfer using magnetic induction



Also see WPC 1.1.2 Standard, Part 1, Interface Definition at page 139.

System Description
Wireless Power Transfer

Version 1.1.2

Communications Interface

6 Communications Interface

6.1 Introduction

The Power Receiver communicates to the Power Transmitter using backscatter modulation. For this purpose, the Power Receiver modulates the amount of power, which it draws from the Power Signal. The Power Transmitter detects this as a modulation of the current through and/or voltage across the Primary Cell. In other words, the Power Receiver and Power Transmitter use an amplitude modulated Power Signal to provide a Power Receiver to Power Transmitter communications channel.

Further, WPC 1.1.2 Standard, Part 1, Interface Definition at pages 124 and 136 describes that the S7 communicates information with the base unit to allow the base unit to detect, uniquely identify, and authenticate the receiver in the S7 and communicate information describing the characteristics of the mobile device or battery (including the WPC version for the receiver in the mobile device or battery), as indicated below.

5.3.3 Identification & configuration phase

In the *identification & configuration* phase, the Power Receiver shall transmit the following sequence of Packets:

- If the Power Receiver enters the *identification & configuration* phase from the *ping* phase, an Identification Packet.
- If the Ext bit of the preceding Identification Packet is set to ONE, an Extended Identification Packet.

Version 1.1.2	System Description Wireless Power Transfer	Communications Interface
---------------	---	--------------------------

6.3.8 Identification Packet (0x71)

Table 6-12 defines the format of the message contained in an Identification Packet.

Table 6-12: Identification

	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
B ₀	Major Version				Minor Version			
B ₁	(msb) Manufacturer Code (lsb)							
B ₂								
B ₃	Ext	(msb) Basic Device Identifier (lsb)						
B ₄								
B ₅								

Major Version The combination of this field and the Minor Version field identifies to which revision of the System Description Wireless Power Transfer the Power Receiver complies. The Major Version field shall contain the binary coded digit value 0x1.

Minor Version The combination of this field and the Major Version field identifies to which minor revision of the System Description Wireless Power Transfer the Power Receiver complies. The Minor Version field shall contain the binary coded digit value 0x1.

Manufacturer Code The bit string contained in this field identifies the manufacturer of the Power Receiver, as specified in [PRMC].

Ext If this bit is set to ZERO, the bit string

Manufacturer Code || Basic Device Identifier

identifies the Power Receiver. If this bit is set to ONE, the bit string

Manufacturer Code || Basic Device Identifier || Extended Device Identifier

identifies the Power Receiver (see also Section 6.3.9).

Basic Device Identifier The bit string contained in this field contributes to the identification of the Power Receiver. A Power Receiver manufacturer should ensure that the combination of Basic Device Identifier and Manufacturer ID is sufficiently unique. Embedding a serial number of at least 20 bits in the Basic Device Identifier is sufficient. Alternatively, using a (pseudo) random number generator to dynamically generate part of the Basic Device Identifier is sufficient as well, provided that the generated part complies with the following requirements:

- The generated part shall comprise at least 20 bits.
- All possible values shall occur with equal probability.
- The Power Receiver shall not change the generated part while the Power Signal is applied.
- The Power Receiver shall retain the generated part for at least 2 s if the Power Signal is interrupted or removed.

(Informative) These requirements ensure that the scanning procedure of a type B1 Power Transmitter proceeds correctly; see also Annex C.2.

System Description
Wireless Power Transfer

System Control

Version 1.1.2

power transfer to a Power Receiver, the Power Transmitter proceeds to the *ping* phase—and eventually to the *power transfer* phase. On the other hand, if the Power Transmitter does not select a Power Receiver for power transfer—and is not actively providing power to a Power Receiver for an extended amount of time—the Power Transmitter should enter a stand-by mode of operation.⁶ See [Part 2] for performance requirements on such a mode of operation.

- *ping* In this phase, the Power Transmitter executes a Digital Ping, and listens for a response. If the Power Transmitter discovers a Power Receiver, the Power Transmitter may extend the Digital Ping, i.e. maintain the Power Signal at the level of the Digital Ping. This causes the system to proceed to the *identification & configuration* phase. If the Power Transmitter does not extend the Digital Ping, the system shall revert to the *selection* phase.
- *identification & configuration* In this phase, the Power Transmitter identifies the selected Power Receiver, and obtains configuration information such as the maximum amount of power that the Power Receiver intends to provide at its output. The Power Transmitter uses this information to create a Power Transfer Contract. This Power Transfer Contract contains limits for several parameters that characterize the power transfer in the *power transfer* phase. At any time before proceeding to the *power transfer* phase, the Power Transmitter may decide to terminate the extended Digital Ping—e.g. to discover additional Power Receivers. This reverts the system to the *selection* phase.

Also per the WPC Standard, upon being powered inductively by the base unit, the receiver in the S7 communicates information including a Signal Strength Packet with the base unit to enable the base unit to determine and activate one or more charging coils aligned with the receiver coil of the S7 so that a base unit with a single charging coil can determine if its charging coil is adequately aligned with the receiver coil for charging, and so that a base unit including multiple charging coils can determine which of its coil(s) is aligned with the receiver coil for charging. The following citation from WPC 1.1.2 Standard, Part 1, Interface Definition at page 136 illustrates that the S7 must communicate a Signal Strength Packet. Using that Signal Strength Packet, the base unit can assess coil alignment.

5.3.2 Ping phase

If the Power Receiver responds to the Digital Ping, the Power Receiver shall transmit either a Signal Strength Packet, or an End Power Transfer Packet as its first Packet. The Power Receiver shall transmit this first Packet immediately upon entering the *ping* phase.

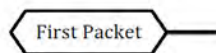


Figure 5-8: Power Receiver timing in the *ping* phase

After the Power Receiver has transmitted a Signal Strength Packet, the Power Receiver shall proceed to the *identification & configuration* phase. After the Power Receiver has transmitted an End Power Transfer Packet, shall remain in the *ping* phase. In that case, the Power Receiver should transmit additional End Power Transfer Packets.⁸

6.3.1 Signal Strength Packet (0x01)

Table 6-4 defines the format of the message contained in a Signal Strength Packet

Table 6-4: Signal Strength

	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
B ₀	Signal Strength Value							

Signal Strength Value The unsigned integer value in this field indicates the degree of coupling between the Primary Cell and Secondary Coil, with the purpose to enable Power Transmitters that use Free Positioning to determine the Primary Cell that provides optimum power transfer (see also Annex C). To determine the degree of coupling, the Power Receiver shall monitor the value of a suitable variable during a Digital Ping. Examples of such variables are:

- The rectified voltage.
- The open circuit voltage (as measured at the output disconnect switch).
- The received Power (if the rectified voltage is actively or passively clamped during a Digital Ping).

The variable that is chosen shall result in a Signal Strength Value that increases monotonically with increasing degree of coupling. The Signal Strength Value is reported as

$$\text{Signal Strength Value} = \frac{U}{U_{\max}} \cdot 256,$$

The following citation from WPC 1.1.2 Standard, Part 1, Annex C, page 157 illustrates how single coil and multi-coil chargers use the Signal Strength Packet to assess coil alignment and to determine and activate one or more coils for power transfer.

System Description
Wireless Power Transfer

Version 1.1.2

Annex C

Annex C Power Receiver Localization (Informative)

This Annex C discusses several aspects that relate to the discovery of Power Receivers amongst the objects that the Power Transmitter has discovered on its Interface Surface.

C.1 Guided Positioning

In the case of Guided Positioning, discovery and localization of a Power Receiver is straightforward: The Power Transmitter should simply execute a Digital Ping, as defined in Section 5.2.1. If the Power Transmitter receives a Signal Strength Packet or an End Power Transfer Packet, it has discovered and located a Power Receiver. Otherwise, the object is not a Power Receiver.

C.2 Primary Coil array based Free Positioning

In the case of Free Positioning, discovery and localization of a Power Receiver is less straightforward. This Annex C.2 discusses one example approach, which is particularly suited to a Primary Coil array based Power Transmitter. In this approach, the Power Transmitter first discovers and locates the objects that are present on its Interface Surface (e.g. using any of the methods discussed in Annex B). This results in a set of Primary Cells, which represents the locations of potential Power Receivers. For each of the Primary Cells in this set, the Power Transmitter executes a Digital Ping (Section 5.2.1), removing the Power Signal after receipt of a Signal Strength Packet (or an End Power Transfer Packet, or after a time out).¹⁵ This yields a new set of Primary Cells, namely those which report a Signal Strength Value that exceeds a certain threshold—which the Power Transmitter chooses. Finally, the Power Transmitter executes an extended Digital Ping (Sections 5.2.1 and 5.2.2) for each of the Primary Cells in this new set in order to identify the discovered Power Receivers. In order to select the most appropriate Primary Cells for power transfer from the set, the Power Transmitter should take the situations discussed in Annex C.2.1, C.2.2, and C.2.3 into account.

Page 124 of WPC 1.1.2 Standard, Part 1, Interface Definition, explains that the S7 communicates information with the base unit to enable the base unit to verify the continued presence of the receiver near the base unit. This is achieved by communicating regularly with the base unit during all phases, including the Power Transfer phase, to control the power transfer.

At any time a user can remove a Mobile Device that is receiving power. The Power Transmitter can recognize such an event from a time-out in the communications from the Power Receiver, or from a violation of the Power Transfer Contract. As a result, the Power Transmitter aborts the power transfer and the system reverts to the *selection* phase.

Per the WPC Standard, the S7 communicates its charging characteristics to the base unit so that the base unit knows how to provide wireless power transfer to the S7. See WPC 1.1.2 Standard, Part 1, Interface Definition at pages 124, 126.

- *identification & configuration* In this phase, the Power Transmitter identifies the selected Power Receiver, and obtains configuration information such as the maximum amount of power that the Power Receiver intends to provide at its output. The Power Transmitter uses this information to create a Power Transfer Contract. This Power Transfer Contract contains limits for several parameters that characterize the power transfer in the *power transfer* phase. At any time before proceeding to the *power transfer* phase, the Power Transmitter may decide to terminate the extended Digital Ping—e.g. to discover additional Power Receivers. This reverts the system to the *selection* phase.

6.3.7 Configuration Packet (0x51)

Table 6-11 defines the format of the message contained in a Configuration Packet.

Table 6-11: Configuration

	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
B ₀	Power Class		Maximum Power					
B ₁	Reserved							
B ₂	Prop	Reserved			ZERO	Count		
B ₃	Window Size					Window Offset		
B ₄	Reserved							

Power Class This field contains an unsigned integer value that indicates the Power Receiver's Power Class. Power Receivers that comply with this version 1.1.2 of the System Description Wireless Power Transfer, Volume I, Part 1, shall set this field to 0.

Maximum Power Apart from a scaling factor, the unsigned integer value contained in this field indicates the maximum amount of power, which the Power Receiver expects to provide at the output of the rectifier. This maximum amount of power is calculated as follows:

$$P_{\max} = \left(\frac{\text{Maximum Power}}{2} \right) \times 10^{\text{Power Class}} \text{ W.}$$

Moreover, per the WPC Standard, the wireless power ASIC (e.g., the IDT/Renesas P9221-R ASIC) included in the S7, during the Power Transfer phase, communicates its wireless receiver output voltage or current to the base unit for closed loop feedback control of the voltage or current. See WPC 1.1.2 Standard, Part 1, Interface Definitions at page 124; *see also* WPC 1.2.4 Standard at 46.

Throughout the *power transfer* phase, the Power Transmitter and Power Receiver control the amount of power that is transferred. The Figure 5-2 illustrates a schematic diagram of the power transfer control loop, which basically operates as follows: The Power Receiver selects a desired Control Point—a desired output current and/or voltage, a temperature measured somewhere in the Mobile Device, etc. In addition, the Power Receiver determines its actual Control Point. Note that the Power Receiver may use any approach to determine a Control Point. Moreover, the Power Receiver may change this approach at any time during the *power transfer* phase. Using the desired Control Point and actual Control Point, the Power Receiver calculates a Control Error Value—for example simply taking the (relative) difference of the two output voltages or currents—such that the result is negative if the Power Receiver requires less power in order to reach its desired Control Point, and positive if the Power Receiver requires more power in order to reach its desired Control Point. Subsequently, the Power Receiver transmits this Control Error Value to the Power Transmitter.

⁶Note that it is up to the Power Transmitter implementation to determine whether this stand-by mode of operation is part of the *selection* phase or is separate from the *selection* phase.

These operations are performed, at least in part, by the representative IDT/Renesas P9221-R ASIC (or the like), which has a microcontroller programmed to perform the communication in accordance with the WPC Standard to communicate information describing the characteristics of the mobile device or the battery, for use by the base unit to provide power transfer to the receiver, and as described in this part of the claim. See P9221-R Datasheet at page 24:

<https://www.renesas.com/us/en/document/dst/p9221-r-datasheet>

10.6 Power Transfer Phase

In this phase, the P9221-R controls the power transfer by means of the following control data packets:

- Control Error Packets
- Received Power Packet (RPP, FOD-related)
- End Power Transfer (EPT) Packet

Once the "identification and configuration" phase is completed, the transmitter initiates the power transfer mode. The P9221-R control circuit measures the rectifier voltage and sends error packets to the transmitter to adjust the rectifier voltage to the level required to maximize the efficiency of the linear regulator and to send to the transmitter the actual received power packet for foreign object detection (FOD) to guarantee safe, efficient power transfer.

In the event of an EPT issued by the application, the P9221-R turns off the LDO and continuously sends EPT packets until the transmitter removes the power and the rectified voltage on the receiver side drops below the UVLO threshold.

Like the S7, the Galaxy S22 Ultra also communicates with the wireless charger base unit to configure and control wireless charging. For example, see WPC 1.2.4 Standard, Parts 1 & 2: Interface Definitions at page 108.



5.3 Power Transmitter to Power Receiver communications interface

5.3.1 Introduction

The Power Transmitter communicates to the Power Receiver using Frequency Shift Keying, in which the Power Transmitter modulates the Operating Frequency of the Power Signal.

5.3.2 Physical and data link layers (PTx to PRx)

This section defines both the physical layer and the data link layer of the Power Transmitter to Power Receiver communications interface. The data link layer supports both Packets and Responses. The format of a Packet is defined in Section 5.3.2.3. The format of a Response is defined in Section 5.3.2.4.

5.3.2.1 Modulation scheme

The Power Transmitter shall switch its Operating Frequency between the Operating Frequency f_{op} in the unmodulated state and the Operating Frequency f_{mod} in the modulated state. The difference between these two frequencies is characterized by two parameters:

- **Polarity.** This parameter determines whether the difference between f_{mod} and f_{op} is positive or negative.

NOTE In both the Configuration Packet and a Specific Request Packet that has its Request field set to 0x03 (FSK Parameters), the Power Receiver encodes the positive polarity as a ZERO and the negative polarity as a ONE. In addition, note that a negative polarity typically increases the voltage induced in the Secondary Coil, and therefore should be used with care.

- **Depth.** This parameter determines the magnitude of the difference between f_{op} and f_{mod} .

NOTE Both the Configuration Packet and the Specific Request Packet (Request 0x03, FSK Parameters)) encode the modulation depth in a two-bit unsigned integer value.

For any given Operating Frequency f_{op} , and depending on the polarity and depth parameters, f_{mod} shall be chosen such that the time difference between a single cycle of f_{mod} and a single cycle of f_{op} is in the range that is defined in Table 52.

NOTE The minimum time difference in this Table corresponds to a single cycle of a 32 MHz clock.

Further, WPC 1.2.4 Standard, Parts 1 & 2: Interface Definitions at pages 46, 54, 100-101, describes that the S22 Ultra communicates information with the base unit to allow the base unit to detect, identify, and authenticate the receiver in the S22 Ultra, as indicated below.

- **identification & configuration** In this phase, the Power Transmitter identifies the selected Power Receiver, and obtains configuration information such as the maximum amount of power that the Power Receiver intends to provide at its output. The Power Transmitter uses this information to create a Power Transfer Contract. This Power Transfer Contract contains limits for several parameters that characterize the power transfer in the *power transfer* phase. At any time before proceeding to the *power transfer* phase, the Power Transmitter may decide to terminate the extended Digital Ping (for example, to discover additional Power Receivers). This reverts the system to the *selection* phase.

5.1.2.3 Identification & configuration phase (PTx perspective)

In the *identification & configuration* phase, the Power Transmitter shall identify the Power Receiver and collect configuration information. For this purpose, the Power Transmitter shall correctly receive the following sequence of Packets in the order shown and without changing its Operating Point.

1. If the Power Transmitter enters the *identification & configuration* phase from the *ping* phase, an Identification Packet.
2. If the Ext bit of the preceding Identification Packet is set to ONE, an Extended Identification Packet.

5.2.3.8 Identification Packet (0x71)

Table 35 defines the format of the message contained in an Identification Packet.

Table 35. Identification

	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
B ₀	Major Version				Minor Version			
B ₁	(MSB) Manufacturer Code (LSB)							
B ₂								
B ₃	Ext	(MSB) Basic Device Identifier (LSB)						
⋮								
B ₆								

Major Version. The combination of this field and the Minor Version field identifies to which revision of this Specification the Power Receiver complies. The Major Version field shall contain the binary coded digit value 0x1.

Minor Version. The combination of this field and the Major Version field identifies to which minor revision of this Specification the Power Receiver complies. The Minor Version field shall be set according to the power profile of the Power Receiver.

Table 36. Minor Version field settings

PRx Power Profile	Minor Version Setting	Neg Bit
Baseline Power Profile	0x1 or 0x2	ZERO
Extended Power Profile	0x2	ONE

Manufacturer Code. The bit string contained in this field identifies the manufacturer of the Power Receiver, as specified in the Power Receiver Manufacturer Codes, Wireless Power Consortium.

Ext

- If this bit is set to ZERO, the bit string
Manufacturer Code || Basic Device Identifier
identifies the Power Receiver.

- If this bit is set to ONE, the bit string
Manufacturer Code || Basic Device Identifier || Extended Device Identifier
identifies the Power Receiver (see Section 5.2.3.10, *Extended Identification Packet (0x81)*).

Basic Device Identifier. The bit string contained in this field contributes to the identification of the Power Receiver. A Power Receiver manufacturer should ensure that the combination of Basic Device Identifier and Manufacturer ID is sufficiently unique. Embedding a serial number of at least 20 bits in the Basic Device Identifier is sufficient. Alternatively, using a (pseudo) random number generator to dynamically generate part of the Basic Device Identifier is sufficient as well, provided that the generated part complies with the following requirements.

- The generated part shall comprise at least 20 bits.
- All possible values shall occur with equal probability.
- The Power Receiver shall not change the generated part while the Power Signal is applied.
- The Power Receiver shall retain the generated part for at least 2 seconds if the Power Signal is interrupted or removed.

NOTE These requirements ensure that the scanning procedure of a type B1 Power Transmitter proceeds correctly. See Annex B.2, *Primary Coil array based Free Positioning*.

5.2.3.9 Wireless Power ID Packets (0x54 and 0x55)

Table 37 shows the format of the message payload contained in the Wireless Power Identification Packets.

Table 37. WP Identification Packets

	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
B ₀	(MSB) WPID (LSB)							
B ₁								
B ₂								
B ₃	(MSB) CRC (LSB)							
B ₄								

The fields of these data Packets have the following purpose:

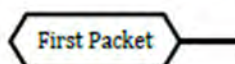
- **CRC**—unsigned integer. This field shall contain the Cyclic Redundancy Check (CRC) of the WPID field in this Packet. The CRC-16 value shall be calculated as defined in Section 5.2.3.9.1.
- **WPID**—bit string. This field shall contain the 24 most significant bits (Packet 0x54) or the 24 least significant bits (Packet 0x55) of the identifier that uniquely identifies the Power Receiver. For more information, see Section 5.1.3.4.2.4.

Also per the WPC Standard, the S22 Ultra communicates information including the Signal Strength Packet with the base unit to enable the base unit to determine and activate one or more charging coils aligned with the receiver coil of the S22 Ultra so that a base unit with a single charging coil can determine if its charging coil is adequately aligned with the receiver coil for charging, and so that a base unit including multiple charging coils can determine which of its coil(s) is aligned with the receiver coil for charging. The following citations from WPC 1.2.4 Standard, Parts 1 & 2: Interface Definitions at pages 74, 93 illustrate that the S22 Ultra communicates a Signal Strength Packet. Using that Signal Strength Packet, the base unit can assess coil alignment.

5.1.3.2 Ping phase (PRx perspective)

If the Power Receiver responds to the Digital Ping, the Power Receiver shall transmit either a Signal Strength Packet or an End Power Transfer Packet as its first Packet. The Power Receiver shall transmit this first Packet immediately upon entering the *ping* phase.

Figure 28. Power Receiver timing in the ping phase



After the Power Receiver has transmitted a Signal Strength Packet, the Power Receiver shall proceed to the *identification & configuration* phase. After the Power Receiver has transmitted an End Power Transfer Packet, it shall remain in the *ping* phase. In that case, the Power Receiver should transmit additional End Power Transfer Packets.⁶

5.2.3 Logical layer (PRx to PTx)

This section defines the format of the messages used by the Power Receiver to Power Transmitter communications interface.

5.2.3.1 Signal Strength Packet (0x01)

Table 27 defines the format of the message contained in a Signal Strength Packet.

Table 27. Signal strength

	b7	b6	b5	b4	b3	b2	b1	b0
B ₀	Signal Strength Value							

Signal Strength Value. The unsigned integer value in this field indicates the degree of coupling between the Primary Cell and Secondary Coil, with the purpose to enable Power Transmitters that use Free Positioning to determine the Primary Cell that provides optimum power transfer (see also Annex B, *Power Receiver Localization (Informative)*). To determine the degree of coupling, the Power Receiver shall monitor the value of a suitable variable during a Digital Ping. Examples of such variables are:

- The rectified voltage.
- The open circuit voltage (as measured at the output disconnect switch).
- The received Power (if the rectified voltage is actively or passively clamped during a Digital Ping).

The variable that is chosen shall result in a Signal Strength Value that increases monotonically with an increasing degree of coupling. The Signal Strength Value is reported as

$$\text{Signal Strength Value} = \frac{U}{U_{\max}} \cdot 256,$$

where U is the monitored variable and $U_{\max}$ is the maximum value that the Power Receiver expects during a Digital Ping.

NOTE The Power Receiver shall set the Signal Strength Value to 255 in the case that $U \geq U_{\max}$.

Page 46 of WPC 1.2.4 Standard, Parts 1 & 2: Interface Definitions, explains that the S22 Ultra also communicates information with the base unit to enable the base unit to verify the continued presence of the receiver near the base unit. This is achieved by communicating regularly with the base unit during all phases, including the Power Transfer phase, to control the power transfer.

At any time, a user can remove a Mobile Device that is receiving power. The Power Transmitter can recognize such an event from a time-out in the communications from the Power Receiver, or from a violation of the Power Transfer Contract. As a result, the Power Transmitter aborts the power transfer and the system reverts to the *selection* phase.

Per the WPC Standard, and like the S7, the S22 Ultra communicates its charging characteristics to the base unit so that the base unit knows how to provide wireless power transfer to the smartphone. See WPC 1.2.4 Standard, Parts 1 & 2: Interface Definitions at pages 46 and 98.

- *identification & configuration* In this phase, the Power Transmitter identifies the selected Power Receiver, and obtains configuration information such as the maximum amount of power that the Power Receiver intends to provide at its output. The Power Transmitter uses this information to create a Power Transfer Contract. This Power Transfer Contract contains limits for several parameters that characterize the power transfer in the *power transfer* phase. At any time before proceeding to the *power transfer* phase, the Power Transmitter may decide to terminate the extended Digital Ping (for example, to discover additional Power Receivers). This reverts the system to the *selection* phase.

5.2.3.7 Configuration Packet (0x51)

Table 34 defines the format of the message contained in a Configuration Packet.

Table 34. Message in a Configuration Packet

	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
B ₀	Power Class		Maximum Power Value					
B ₁	Reserved							
B ₂	Prop	Reserved			ZERO		Count	
B ₃	Window Size					Window Offset		
B ₄	Neg	Polarity*	Depth*		Reserved			

* In the Baseline Power Profile, these bits are Reserved.

Power Class This field shall be set to '00'.

Maximum Power Value

(Baseline Power Profile) Apart from a scaling factor, the unsigned integer value contained in this field indicates the maximum amount of power that the Power Receiver expects to provide at the output of the rectifier. This maximum amount of power is calculated as follows:

$$P_{\max} = \left(\frac{\text{Maximum Power Value}}{2} \right) \times 10^{\text{Power Class } W}.$$

Per the WPC Standard, the WPC certified IDT/Renesas P9415-R ASIC representative of the wireless transceiver ASIC included in the S22 Ultra, during the Power Transfer phase, communicates its wireless

receiver output voltage or current to the base unit for closed loop feedback control of the voltage or current. See WPC 1.2.4 Standard, Parts 1 & 2: Interface Definitions at page 46.

Throughout the power transfer phase, the Power Transmitter and Power Receiver control the amount of power that is transferred. Figure 17 illustrates a schematic diagram of the power transfer control loop, which basically operates as follows: the Power Receiver selects a desired Control Point: a desired output current and/or voltage, a temperature measured somewhere in the Mobile Device, etc. In addition, the Power Receiver determines its actual Control Point. The Power Receiver may use any approach to determine a Control Point. Moreover, the Power Receiver may change this approach at any time during the power transfer phase. Using the desired Control Point and actual Control Point, the Power Receiver calculates a Control Error Value—for example, by simply taking the (relative) difference of the two output voltages or currents. The result is negative if the Power Receiver requires less power in order to reach its desired Control Point and positive if the Power Receiver requires more power in order to reach its desired Control Point. Subsequently, the Power Receiver transmits this Control Error Value to the Power Transmitter.

These operations are performed, at least in part, by the representative IDT/Renesas P9415-R ASIC, which has a microcontroller programmed to perform the communication in accordance with the WPC Standard to communicate information describing the characteristics of the mobile device or the battery, for use by the base unit to provide power transfer to the receiver, and as described in this part of the claim. See P9415-R Datasheet at page 26.

8.2.13 Power Transfer

In this phase, the P9415-R controls the power transfer by means of the following Control Data Packets:

- Control Error Packets
- Rectified Power Packet
- End Power Transfer Packet

8.2.14 Renegotiation

In this phase, the Power Receiver can make adjustments to the Power Transfer Contract, if required. If necessary, this phase can be aborted prematurely without changing the Power Transfer Contract.

8.2.15 End of Power Transfer (EPT)

In the event of EPT, the device turns off the LDO only after the AP instructs the P9415-R to continuously send End of Power (EPT) packets until the transmitter removes the power and the rectifier voltage on the receiver side drops below the UVLO threshold.

Samsung earbuds products

Being WPC-compatible devices, the representative Buds/Buds2 cases also communicate as specified by this part of the claim, e.g., in accordance with WPC 1.2.4. See cites to WPC 1.2.4 for the S22 Ultra smartphone directly above.

Samsung wearables

The wireless receivers included in the representative Watch4 communicate the information specified by this part of the claim following the WPC Standard protocol as set forth above with respect to the smartphones, including a unique ID, a manufacturer code, a WPC version, and a signal strength packet. Thus, the Watches also satisfy this part of the claim.

That the representative Watch4 communicates with the base unit as claimed is also reflected by the representative 9222 datasheet, e.g.:

7.5 System Feedback Control

The P9222-R/RN is fully compatible with WPC (Baseline Power Profile) and has all the necessary circuitry to communicate with the base station via WPC communication packets. The overall WPC system behavior between the transmitter and the receiver follows the state machine shown in Figure 25.

The P9222-R/RN goes through four phases:

1. Selection
2. Ping
3. Identification and Configuration
4. Power Transfer

7.5.4 Power Transfer

In the "Power Transfer" phase, the P9222-R/RN controls the power transfer by means of the following control data packets:

- Control Error Packets (CEP)
- Rectified Power Packet (RPP)
- End Power Transfer Packet (EPT)

3. A system for use with a mobile device for charging or powering the mobile device inductively by a universal base unit for charging of different mobile devices and/or batteries of different charging characteristics associated therewith, comprising:

As detailed below by representative products, the 440 Accused Products that can provide wireless power are accused under this claim ("440 Claim 3 Accused Products"). The 440 Claim 3 Accused Products fit the description in this introductory part of the claim as each is capable of inductively charging different mobile devices, watches and/or batteries as specified by this introductory part of the claim. The 440 Claim 3 Accused Products include Samsung smartphones with the Wireless PowerShare feature and Samsung wireless chargers.

Samsung Galaxy smartphones

The S10 and S22 Ultra smartphones are representative of the Samsung smartphones that are 440 Claim 3 Accused Products. The S10 and S22 Ultra are able to wirelessly charge various mobile devices/batteries having different charging characteristics inductively via the Wireless PowerShare feature.

The S10 and S22 Ultra include a universal base unit for powering/charging mobile devices as specified in the introductory claim language. The S10's and S22 Ultra's Wireless PowerShare feature enables the smartphones to inductively transfer power to other devices/batteries having different charging characteristics.

https://www.samsung.com/latin_en/support/mobile-devices/how-to-use-wireless-powershare/

Device-to-device charging



If the battery on your device is getting low, automatically transfer power from your S10.

Simply activate "Wireless PowerShare" on your notification panel, then place the other device on the center of your S10 with their backs facing.

Please note: The location of the charging coil may vary by device model. You may need to adjust the devices until they connect with each other properly.

Separate the devices when enough power has been transferred or wait until the other device is fully charged.

<https://www.samsung.com/us/support/answer/ANS00082564>

Compatible Samsung devices



Most Qi-Compatible Samsung devices can be charged with Wireless PowerShare, but check out the full list of compatible devices just in case. The speed and power of the charge will vary by device.

Devices that can share power and can also be charged with Wireless PowerShare:

- Galaxy S21, S21+, and S21 Ultra
- Note20 5G and Note20 Ultra 5G
- Galaxy Note10, Note10+, and Note10+ 5G
- Galaxy Fold and Z Fold2
- Galaxy Z Flip and Galaxy Z Flip 5G
- Galaxy S20 5G, S20+ 5G, S20 Ultra 5G, and S20 FE
- Galaxy S10e, S10, S10+, and S10 5G

Devices that can be charged by Wireless PowerShare:

- Galaxy Buds, Galaxy Buds2, Galaxy Buds+, Galaxy Buds Live, and Galaxy Buds Pro
- Galaxy Watch, Galaxy Watch3, Galaxy Watch4, Galaxy Watch4 Classic, Gear Sport, and Gear S3
- Galaxy S7/S7 Edge, S8/S8+, S9/S9+, Note8, and Note9
- Galaxy Watch Active and Galaxy Watch Active2

Samsung wireless chargers

Representative Samsung wireless chargers that are 440 Claim 3 Accused Products include:

- **Representative Wireless Charger Pads/Stands/Docks:** 930 Stand, 5200 Duo Pad, 5400 Duo Pad, 6300 Trio Pad, Samsung SmartThings Station EP-P9500, and EP-OR825 Watch charger;
- **Representative Wireless Charger Portable Batteries:** 3300 Charger Battery;
- **Representative Car Mount Wireless Chargers:** the 5300 Car Mount Charger.

They are WPC-compatible chargers that can wirelessly/inductively charge various mobile devices/batteries having various charging characteristics.

The 930 Stand can wirelessly charge various mobile devices/batteries.

<https://www.samsung.com/us/mobile/mobile-accessories/phones/fast-charge-wireless-charging-stand-black-sapphire-ep-ng930tbugus/>

Mojo Mobility Inc v. Samsung Elecs. Co. Ltd., et al., No. 2:22-cv-00398 (E.D. Tex.)
Ex. 2 to Feb. 28, 2023 P.R. 3-1 Contentions: Infringement of U.S. Patent 9,577,440 by Samsung

SAMSUNG Mobile TV & Audio Appliances Computing Displays #YouMake Gift Ideas Offers Explore Support For Business Q W B

Home / Mobile Accessories / All Mobile Accessories / Phones

Fast Charge Wireless Charging Stand SUPPORT OVERVIEW BENEFITS SPECS REVIEWS RELATED

Fast Charge Wireless Charging Stand [Wishlist](#)
EP-NG930BFGUS ★★★★★ 4.2 (375) [Share your product experience](#)

Fast and convenient wireless charging for your compatible Galaxy phones, and other Qi-compatible devices
Portable, attractive angled design allows for easy access to your smartphone while charging

Get Stock Alerts
May we send you an alert when this product is available? X

Email
Phone Number (optional)

NOTIFY ME

☐ Let's keep in touch! For the best of receive promotional email and text (text may be submitted) from Samsung Electronics America to the number provided above. The Samsung Privacy Policy explains how we use your information. You do not have to consent to receive text messages to receive any promotional services from us. Unsubscribing will stop text messages.

[WHERE TO BUY](#)



<https://www.wirelesspowerconsortium.com/products/1542>

SAMSUNG WIRELESS CHARGER STAND (EP-NG930)

BRAND
SAMSUNG

PRODUCT NAME
Wireless Charger Stand

MANUFACTURER PART NUMBER
EP-NG930

PRODUCT TYPE
Power Class 0 Transmitter

REGISTRATION DATE
February 20, 2016

ADDITIONAL DETAILS

Qi Registration id	1542
Version	1.2.1
Currently licensed	Yes
Power profile	Basic Power Profile
Transmitter design	A28
Automotive Charger for inline assembly	No
Compliant Automotive Guidelines	No
Evaluation module	No
Potential power level	5 watts
Subsystem for integration in other products	No



The 5200 Duo Pad can wirelessly charge various mobile devices/batteries.

<https://222.samsung.com/us/mobile/mobile-accessories/phones/wireless-charger-Duo-Pad-pad-black-ep-p5200tbegus/>



Qi certified

The Wireless Charger Duo Pad is Qi certified meaning any Qi compatible products can charge on it, including the Samsung Galaxy S10, Galaxy Note9, Apple iPhone 8, iPhone X, and Google Pixel 3 .

https://www.samsung.com/hk_en/mobile-accessories/wireless-charger-duo-pad-p5200-ep-p5200twegww/

Charge yourself and a friend

Recharge your Galaxy S10e, S10, or S10+ and your Galaxy Watch Active at the same time. Or lend a charger spot to a friend. There are two distinct charging zones, so you can easily charge two phones, a phone and your Galaxy Watch, or whatever configuration you may need.



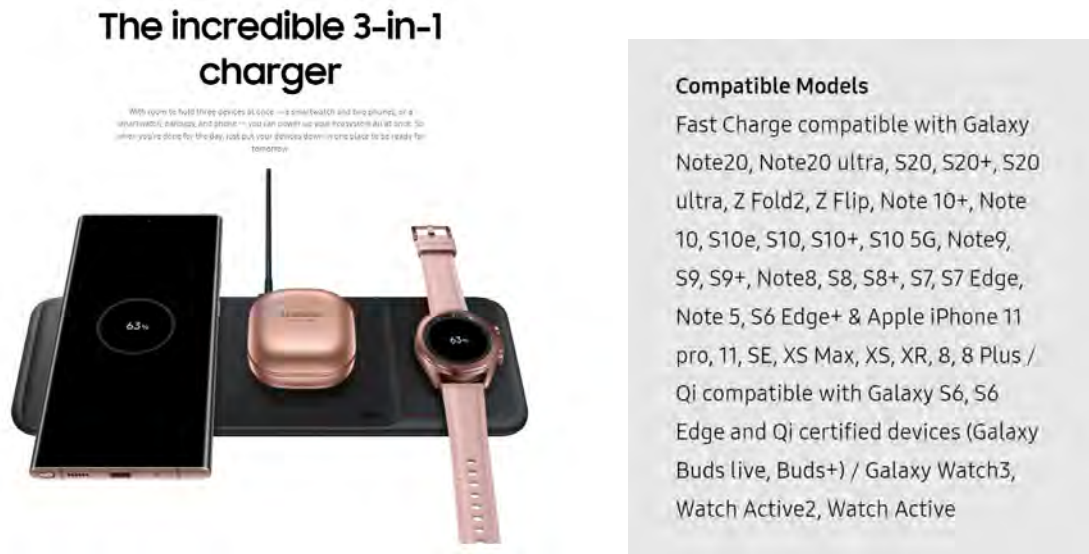
The 5400 Duo Pad can wirelessly charge various mobile devices/batteries.

<https://www.samsung.com/us/mobile/mobile-accessories/phones/15w-wireless-charger-duo-cable-dark-gray-ep-p5400cbegus/>



The 6300 Trio Pad can wirelessly charge various mobile devices/batteries.

[Wireless Charger Trio, White Mobile Accessories - EP-P6300TWEGUS | Samsung US](#)



The EP-P9500 Station is a Samsung Wireless Fast Charger for charging various mobile devices and batteries and a hub for Smart Home connectivity.

<https://www.samsung.com/us/mobile/mobile-accessories/phones/smarththings-station-with-travel-adapter-white-ep-p9500twegus/#benefits>

Set it down for super fast charging.

Don't go too far away. With Super Fast Wireless Charging, SmartThings Station will charge your compatible phone in no time.²

²25W Super Fast Wireless Charging requires Super Fast Charging-capable device. Included 25W or above power adapter is required. Super Fast Wireless Charging speed depends on battery level and other factors. Use only Samsung-approved chargers and cables; do not use any worn or damaged chargers or cables. Incompatible charger or cable can cause serious injury or damage to your device.



Simple, intuitive connection

Start your smart life in a snap. Link your hub through a pop-up on your SmartThings app, then connect your devices seamlessly with QR scanning.³ Preset your devices on the SmartThings app and you're now ready to customize your smart home setup to perfection.

The 3300 Charger Battery can wirelessly charge various mobile devices including smartphones, earbud cases, and watches with various charging characteristics.

<https://www.samsung.com/us/mobile/mobile-accessories/phones/25w-wireless-portable-battery--silver-eb-u3300xjegus/>

Fast charging, no cord required

In addition to its Super Fast Charging via cable, you can rest your phone on the pack to get a wireless recharge. Powering up to 7.5W, it can wirelessly charge a range of devices, so you can share with a friend, even if they don't have Galaxy.



The 5300 Car Mount Charger can wirelessly charge various WPC-compatible smartphones with various charging characteristics.

<https://www.samsung.com/us/mobile/mobile-accessories/phones/wireless-car-charger-black-ep-h5300cbegus/>

Wireless Car Charger, Black

\$2.50/mo for 24 mos
Total **\$59.99***

[ADD TO CART](#)

[BENEFITS](#) [SPECS](#) [REVIEWS](#) [SUPPORT](#)

[Chat with an Expert](#)

Wireless Car Charger, Black

EP-H5300CBEGUS ★★★★★ 2.8 (15) [Share your product experience](#)

- Charge your mobile device wirelessly in your car with ease. It's the perfect companion for your Galaxy Z Fold3.
- Car Adapter not included. USB-C to USB-A cable included.

Free Shipping and easy returns: Get it by Sep. 27

Ship to: 78701

Wireless Car Charger, Black	\$59.99
Total	\$2.50/mo for 24 mos at 0% APR* \$59.99

[Earn 2% back in rewards](#)

[ADD TO CART](#)

[WHERE TO BUY](#)

Supported payment types:

<https://www.wirelesspowerconsortium.com/products/11748>

SAMSUNG WIRELESS CAR CHARGER (EP-H5300)

**BRAND**

Samsung

PRODUCT NAME

Wireless Car Charger

MANUFACTURER PART NUMBER

EP-H5300

PRODUCT TYPE

Power Class 0 Transmitter

REGISTRATION DATE

October 12, 2021

**ADDITIONAL DETAILS**

Qi Registration id	11748
Version	1.2.4
Currently licensed	Yes
Power profile	Basic Power Profile
Transmitter design	A36
Automotive Charger for inline assembly	No
Compliant Automotive Guidelines	No
Evaluation module	No
Potential power level	5 watts
Subsystem for integration in other products	No
Samsung Proprietary Extension	Yes



The EP-OR825 (825 Watch Dock) can wirelessly charge Samsung watches such as the Watch4.

<https://www.samsung.com/levant/mobile-accessories/galaxy-watch-active2-charger-or825-ep-or825bbegww/>



Galaxy Watch Active Wireless Charger

EP-OR825BBEGWW

★ ★ ★ ★ ★ 2.1 (46) [Write a review](#)

- Compact, portable design
- Compact, portable design
- Wireless charging on the go

Choose your

Color: Black



Galaxy Watch Active Wireless Charger

a universal base unit including one or more primary coils therein, each primary coil having a generally planar shape so that when a current is passed through the primary coil a magnetic field is generated in a direction perpendicular to the plane of the primary coil; wherein the perpendicular magnetic field inductively generates a current in a matching secondary coil or coils within a mobile device placed close to and aligned with the base unit, to charge or power the mobile device;

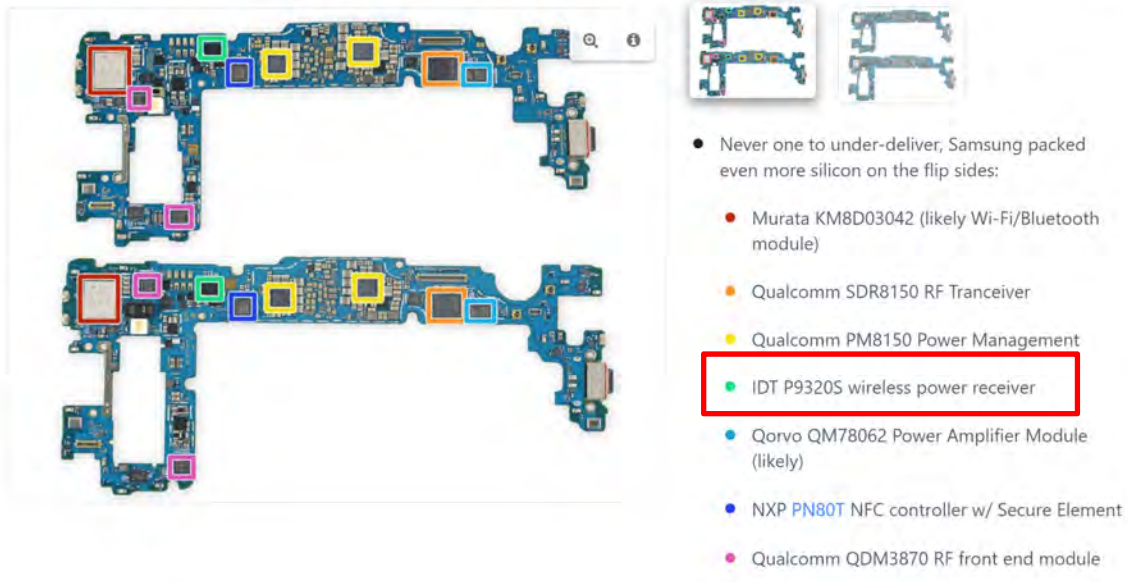
The 440 Claim 3 Accused Products include one or more primary coils, each having a generally planar shape so that when a current is passed through a coil, a magnetic field is generated in a direction that is substantially perpendicular to the plane of the primary coil, thereby inductively charging/powering mobile devices/batteries with the induced current.

Samsung Galaxy smartphones

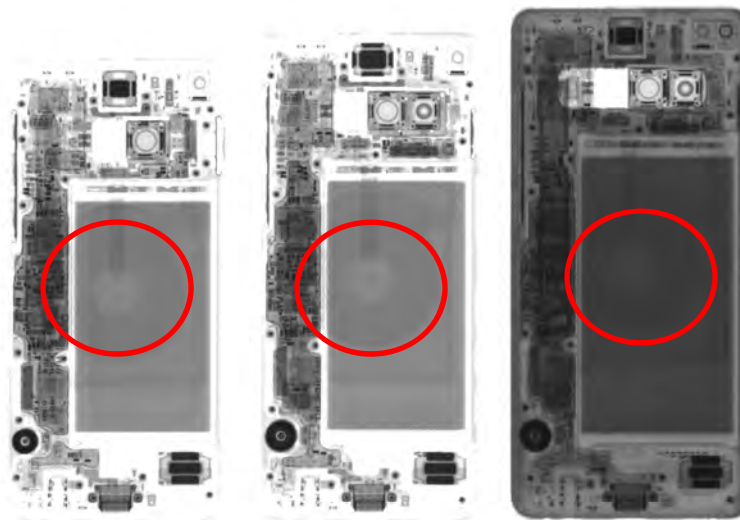
The S10 and S22 Ultra smartphones each includes one or more generally planar shape primary coils as described above and are therefore able to inductively charge other devices/batteries via Wireless PowerShare. Moreover, the S10 and S22 Ultra each includes a wireless transceiver ASIC, such as the IDT/Renesas P9320S, for which the IDT/Renesas P9415-R is believed to be representative for a which a datasheet is publicly available.

S10: <https://www.ifixit.com/Teardown/Samsung+Galaxy+S10+and+S10e+Teardown/120331>

Step 10

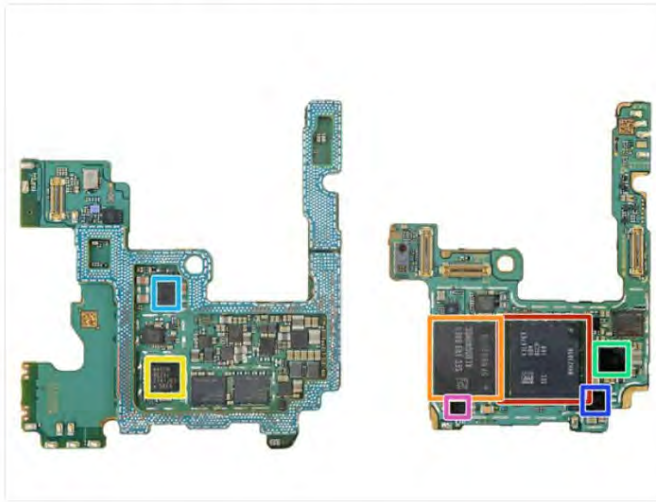


Step 2



S22 Ultra: <https://www.ifixit.com/Guide/Samsung+Galaxy+S22+Ultra+Chip+ID/148073>

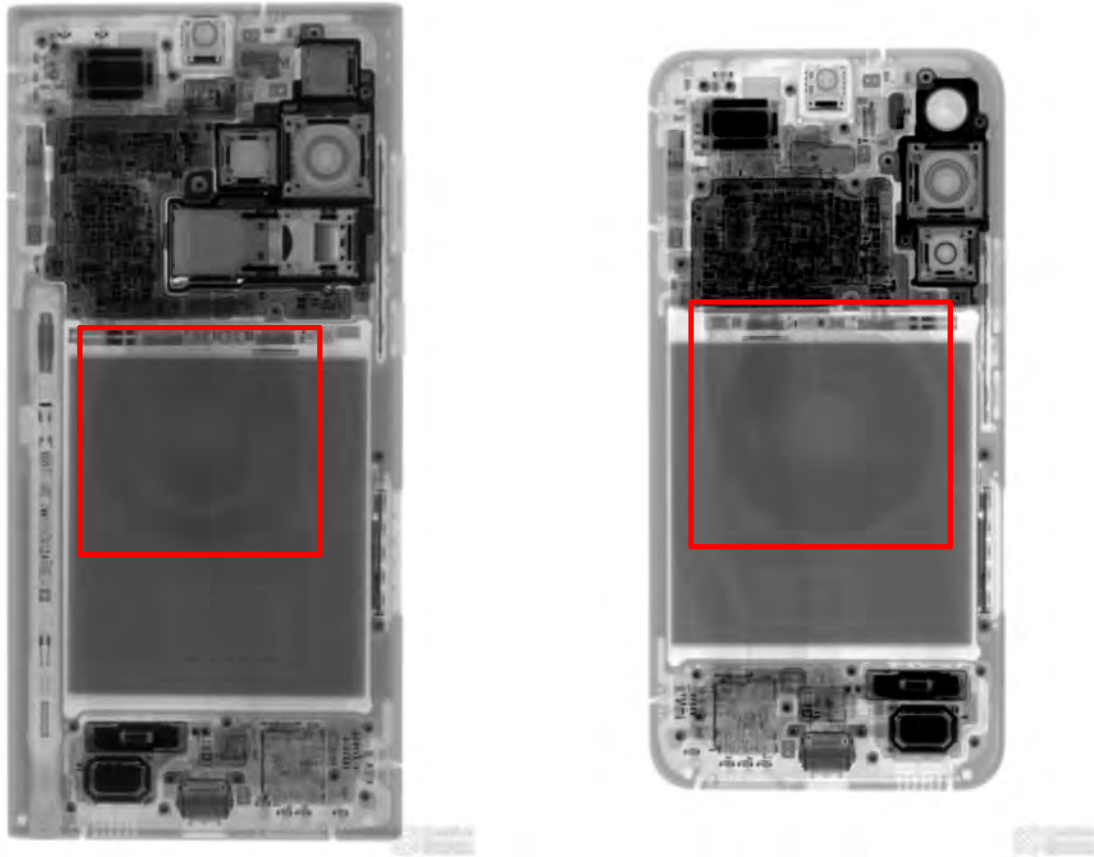
Step 1 Main Board Side 1



- IC Identification Pt. 1:
 - Qualcomm [SM8450](#) Snapdragon 8 Gen 1 Octa-Core Processor layered under a Samsung K3LK7K70BM-BGCP 8 GB Mobile LPDDR5 SDRAM Memory
 - Samsung [KLUDG4UHC-B0E1](#) 128 GB NAND Flash Memory (UFS 3.1)
 - Wacom WEZ02 Digitizer Controller
 - Maxim MAX77705C Power Management
 - **Renesas P9320S Wireless Power Transceiver**
 - NXP Semiconductor PCA9468 Battery Charger
 - Cirrus Logic CS35L40 Audio Amplifier

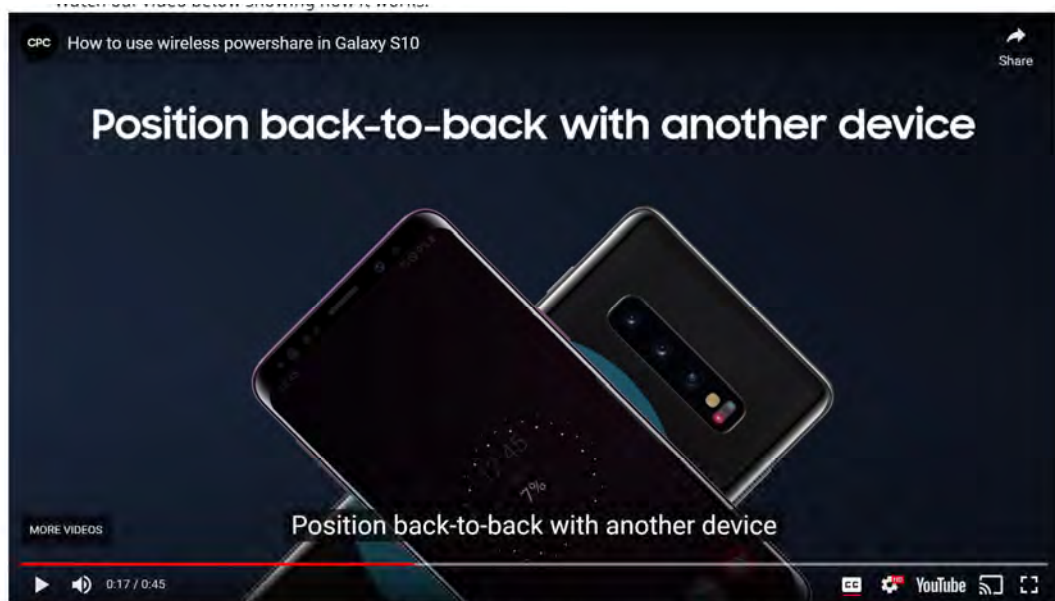
S22 Ultra: <https://www.ifixit.com/News/57567/galaxy-s22-teardowns-apple-is-making-samsung-sweat>

X-ray examination



On the left is the Note-succeeding Samsung Galaxy S22 Ultra, with the "vanilla" S22 on the right.

https://www.samsung.com/latin_en/support/mobile-devices/how-to-use-wireless-powershare/

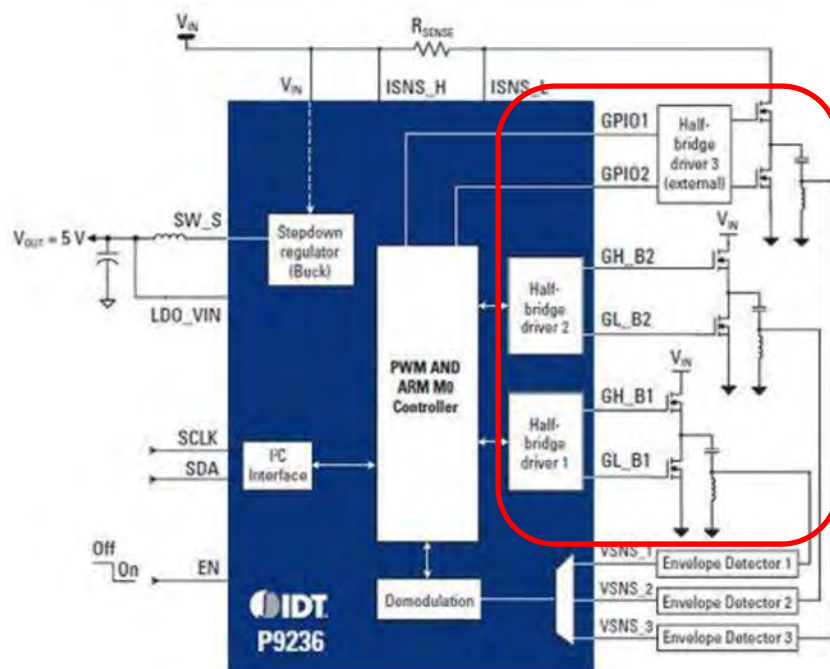


Samsung wireless chargers

The 440 Claim 3 Accused Products which are wireless chargers as illustrated below by representative products each include one or more generally planar shape primary coils and are able to inductively charge other devices/batteries, as shown below.

Moreover, each includes include a wireless charging transmitter ASIC (e.g., the IDT/Renesas P9236 ASIC) (herein the “9236” ASIC) with associated external capacitors, field effect transistors (FETs), and other circuitry, as shown in the following 9236 datasheet.

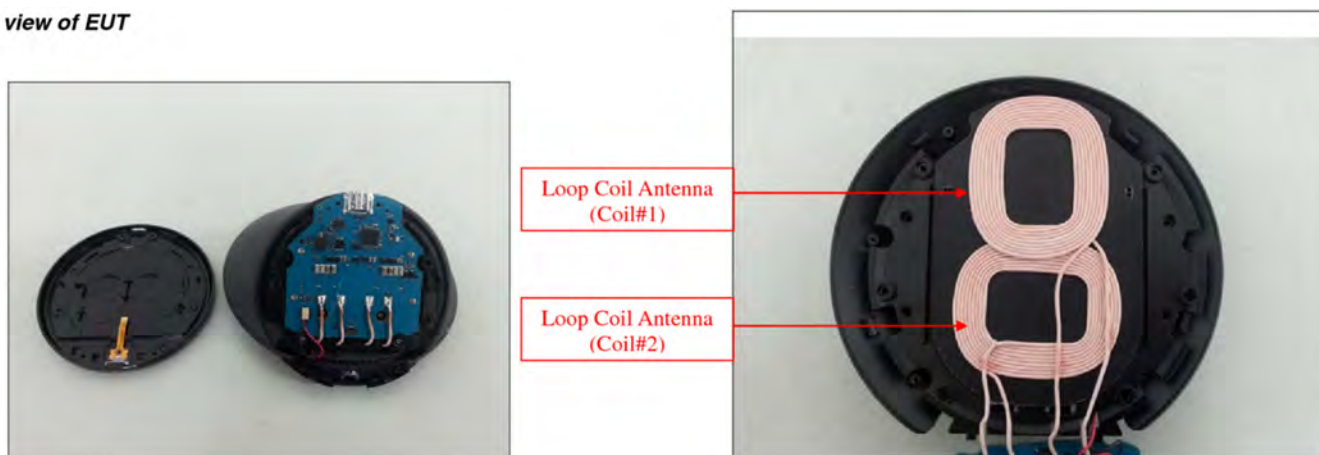
https://archive.eetindia.co.in/www.eetindia.co.in/ART_8800706913_1800008_NP_7a10c6fc.HTM



The 930 Stand includes two generally planar shape charging coils (identified as loop coil antennas [Coil #1 and Coil #2] in the images below). As can be seen in the FCC photos below, Coil 1 has a larger vertical primary axis, while Coil 2 has a larger horizontal primary axis, and Coil 1 and Coil 2 overlap each other. Coil 1's larger vertical primary axis is to better support charging devices placed vertically on the charging stand while the larger horizontal primary axis of Coil 2 is to better support charging devices placed horizontally on the charging stand.

<https://fccid.io/A3LEPNG930/Internal-Photos/Internal-Photos-2909922>

Internal view of EUT

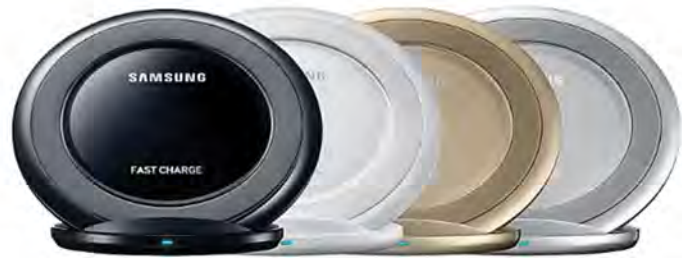


The following is a Samsung webpage describing the 930 Stand.

<https://www.samsung.com/us/mobile/mobile-accessories/phones/fast-charge-wireless-charging-stand-black-sapphire-ep-ng930tbugus/>

About This Product

Take your wireless charging experience to the next level with the Fast Charge Wireless Charging Stand. The new wireless charging stand allows you to charge your compatible Galaxy device up to 1.4x faster than standard wireless charging transmitters*. Using Samsung's Fast Charge technology, the stand can transfer a faster charge to the device when used with the included Fast Charge wall charger. The Fast Charge Wireless Charging Stand is closing the gap in speed between wireless and wired charging! The stand is also backwards compatible for any Qi-enabled device so you can charge those devices wirelessly at standard speeds.



Wireless charging convenience

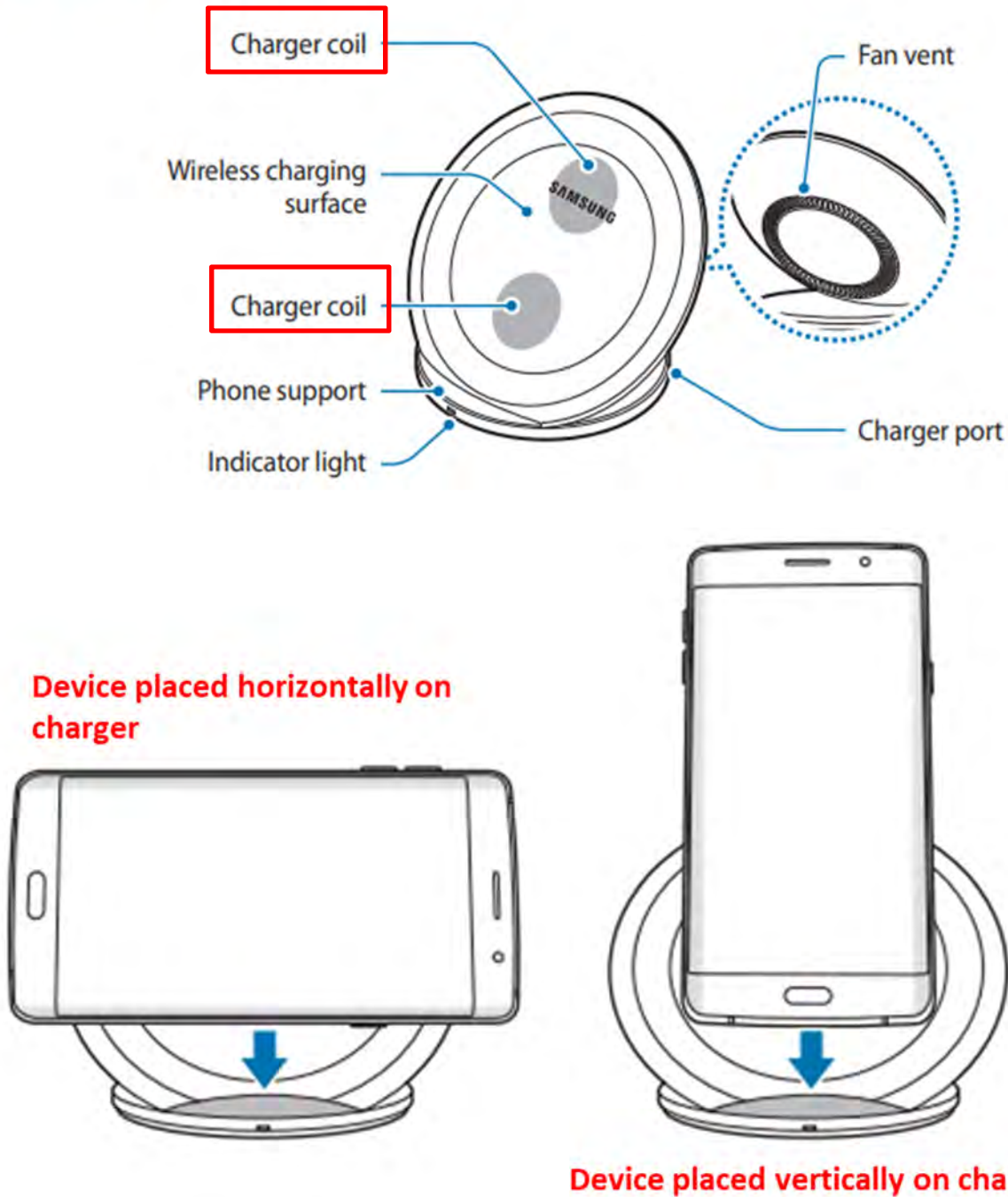
Say goodbye to tangled wires and lost charging cables. The Samsung Wireless Charging Stand utilizes Qi Inductive Charging Technology that eliminates the need to fumble with charging cables each time you want to charge your device. Perfect for at home or the office, the dedicated charging stand is always at the ready, providing wireless power whenever you set your device on the stand. The stand was designed to allow you to still use your device while charging, propping it up so you can navigate music, review notifications and answer calls without having to interrupt charging.



The following are from a Samsung User Manual describing the 930 Stand.

https://downloadcenter.samsung.com/content/UM/201612/20161208181829351/EP-NG930_UM_Rev.2.3_161208.pdf

Device layout



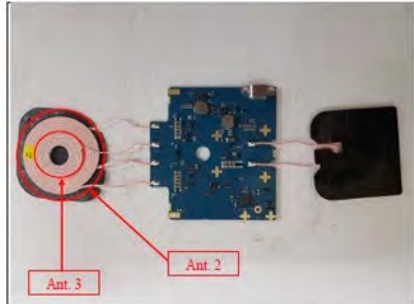
The 5200 Duo includes three generally planar shape charging coils (identified as antennas [Ant. 1-3] in the images below), of which the two on the product right-side (Ant. 2 and 3) are concentric (for charging a watch [Ant. 3] or another smartphone or earbud case [Ant. 2]) (Ant. 2 and 3 are shown on the left-side of the FCC pictures below, which show the interior of the product and have inverted the coil sides of the

product). Antenna 1 on the product left-side (right-side of the FCC pictures) is for charging of a smartphone at up to Samsung Wireless Fast Charge 2.0 speeds.

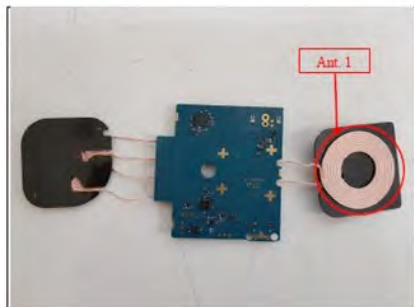
The following FCC pictures show the three charging coils in the 5200 Duo Pad (Ant. 1-3) (with the product right and left sides reversed as described above).

<https://fcc.report/FCC-ID/A3LEPP5200/4144771>

SGS
Top view of PCB



Bottom view of PCB



The following is a Samsung webpage describing the 5200 Duo Pad.

<https://www.samsung.com/us/mobile/mobile-accessories/phones/wireless-charger-Duo-Pad-pad-black-ep-p5200tbeus/>



**Charge a
phone
and a
smartwatch**

The Wireless Charger Duo Pad can charge your Samsung smartwatch too. Gear S3, Gear Sport, and Galaxy Watch can charge in the same location as your phone by simply placing your watch on the charging pad.

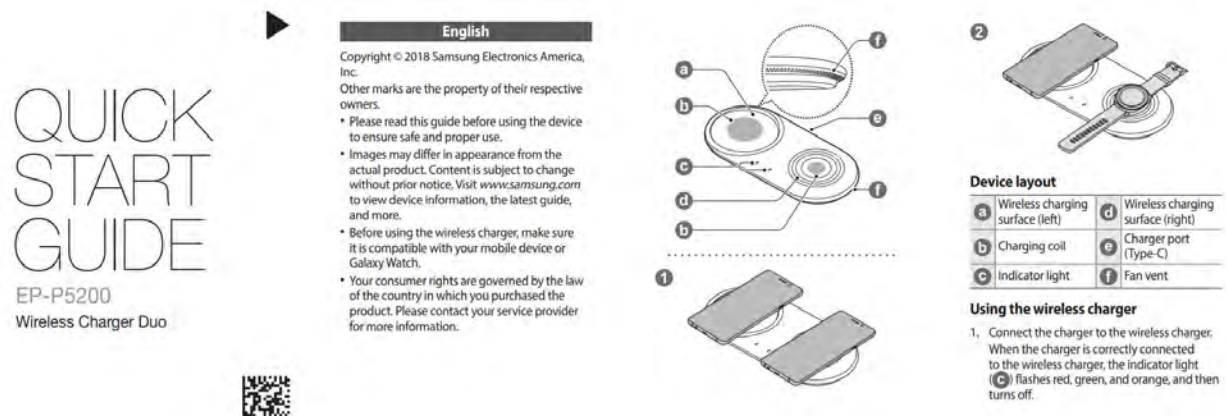


**Charge
two
phones**

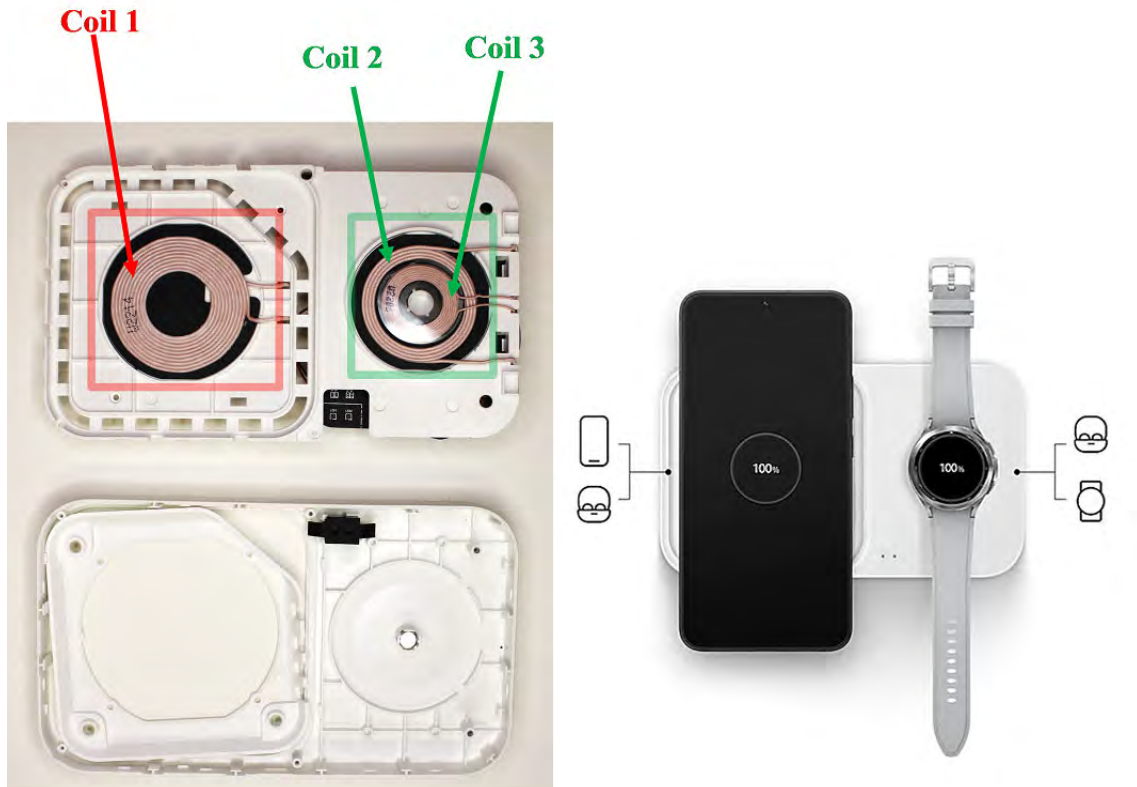
Charge up to two smartphones by simply setting them down. Advanced Qi wireless charging technology enables you to charge your device without plugging in a cable.²

The following is a Samsung Quick Start Guide describing the 5200 Duo Pad.

<https://fcc.report/FCC-ID/A3LEPP5200/4144766.pdf>



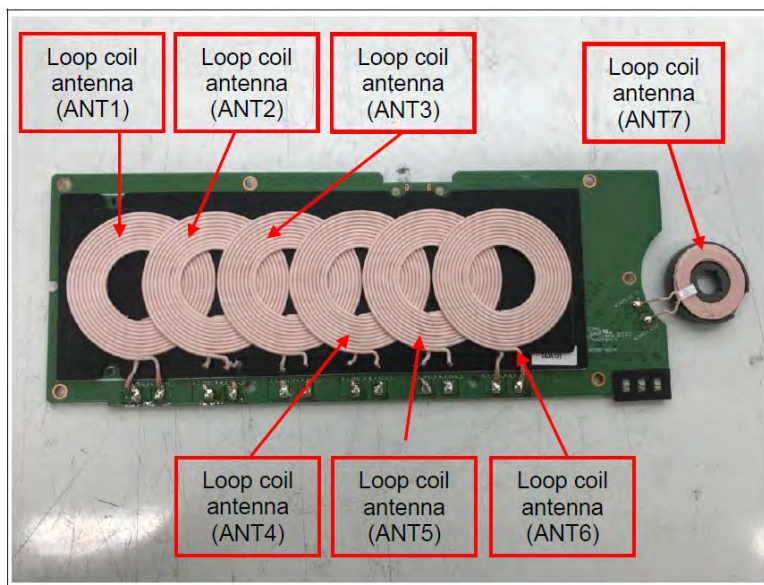
The 5400 Duo Pad includes three charging coils of which the two on the right side are concentric (inner coil for charging a watch and outer coil for charging an earbud case), as shown below. The coil on the left is for charging a smartphone or earbud case.



The 6300 Trio Pad includes seven charging coils (Ant. 1-7), of which the six on the left side of the pad are overlapping, as shown below. The coils on the left are for charging one or multiple smartphones and earbud cases, and the right-side smaller single coil is for charging a watch.

<https://fcc.report/FCC-ID/A3LEPP6300/4940796.pdf>

View of Antenna



j

[Wireless Charger Trio, White Mobile Accessories - EP-P6300TWEGUS | Samsung US](#)

The incredible 3-in-1 charger

With space to hold three devices at once — a smartphone and two others, of all shapes and sizes — you can charge all your devices at once. So when you're doing for the day, hold out your devices when it's time to be ready for tomorrow.



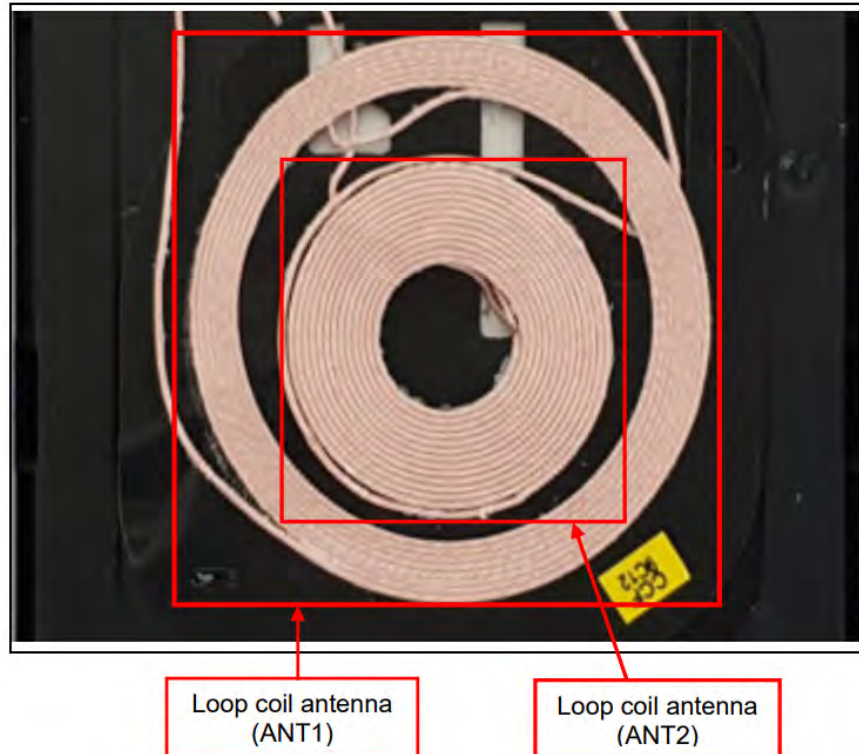
The SmartThings EP-P9500 is a multi-function SmartThings product including a Samsung Wireless Fast Charger. The Charger includes a single coil as shown below for charging a smartphone or accessory such as an earbud case.



The 3300 Wireless Charger Battery includes two charging coils, one inside the other. The inner coil is for charging a watch; the outer coil is for charging a smartphone or an earbud case.

<https://fcc.report/FCC-ID/A3LEBU3300/4624577>





The 5300 Car Mount Charger includes two charging coils (ANT. 1-2), ANT 1 having a horizontal primary axis, ANT 2 having a vertical primary axis to accommodate devices being clipped in different orientations.

<https://fcc.report/FCC-ID/ZCAEPH5300/5517329>

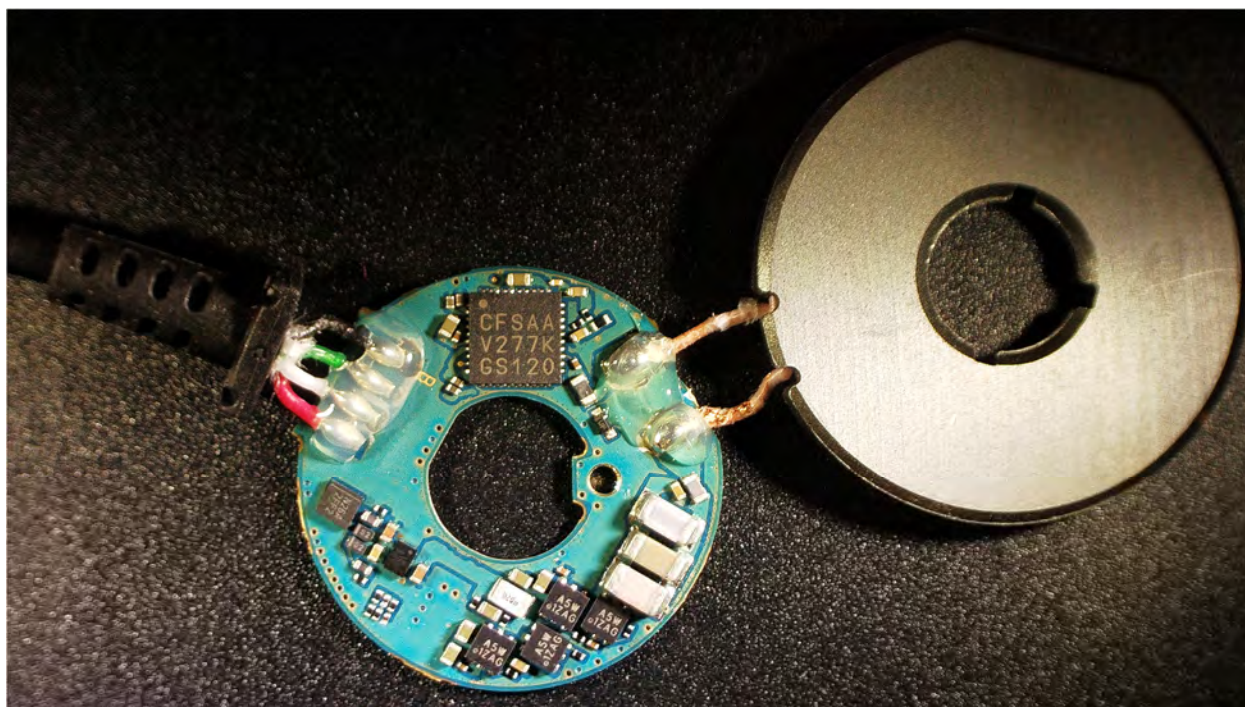
EUT Constructional Details (EUT Photos)



The EP-OR825 (825 Watch Dock) includes a charging coil as specified by this part of the claim, as shown below.

<https://fcc.report/FCC-ID/A3LEPOR825/4320461>





wherein one or both of the mobile device and a battery have a receiver and particular charging characteristics associated therewith; an identification component associated with the mobile device or battery, which is configured to provide wireless identification of the receiver to the base unit; a means for avoiding overcharging one or both of the mobile device and battery inductively; and a regulator coupled to the output of the receiver or to the battery that regulates an output voltage or output current provided by the receiver, to the mobile device or battery, to be within a range of parameters for the mobile device or the battery; wherein different mobile devices and batteries can have different charging characteristics associated therewith; and

The various mobile devices the 440 Claim 3 Accused Products can charge, e.g., S7 and S22 Ultra smartphones, Buds, Buds2, and Watch4, have/include the characteristics/components specified by this part of the claim, as detailed above with respect to '440 Claim 1. Moreover, the various mobile devices the 440 Claim 3 Accused Products can wirelessly charge have different charging characteristics (e.g., the S7, S22 Ultra, Buds, Buds2, Watch and Watch4 have different charging characteristics as shown above).

wherein the receiver communicates with the base unit to detect, identify, and authenticate the receiver with the base unit, as provided by the identification component; determine and then activate one or more primary coils of the base unit which are aligned with the receiver coil; verify the continued presence of the receiver near the base unit; and communicate information describing the characteristics of the mobile device or the battery, for use by the base unit to provide power transfer to the receiver and to the mobile device and the battery according to their particular charging characteristics.

The 440 Claim 3 Accused Products configure and control the wireless powering/charging in response to communication from the receiver as specified by this part of the claim. For example, the 440 Claim 3

Accused Products can wirelessly charge S7 and S22 Ultra smartphones and Watch4, and the S7 and S22 Ultra smartphones and Watch and Watch4 communicate with the base unit as described by this part of the claim as detailed above with respect to '440 claim 1. The 440 Claim 3 Accused Products configure and control the wireless powering/charging of a S7 or S22 Ultra smartphone or a Watch or Watch4 as specified by this part of the claim based on communication from mobile device.

A high-level description of the information communicated by the receiver to a base unit in WPC to detect, identify and authenticate the receiver is shown below. *E.g.*, WPC 1.2.4 Standard, Introduction, page 9.



the electronics of an appropriate load to which it is connected. Conventional transformers use the same effect to achieve inductive power transfer between a primary and a secondary coil that are strongly coupled by means of a magnetic core.

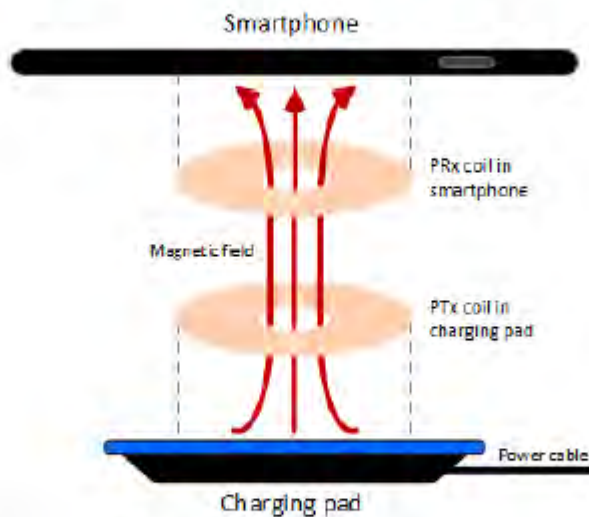
Although a Qi-based system is similar to a conventional transformer in the sense that power is transferred from a first coil to a second coil, it is also very different because of the much lower magnetic coupling between those coils. A conventional transformer has a magnetic coupling coefficient close to one, whereas a Qi-based system typically has a magnetic coupling coefficient in the range of 0.5 or below.

In the Qi-based system illustrated in Figure 4, power is transferred from the PTx contained in the Qi charging pad to a PRx contained in the Qi smartphone. Before charging begins, the PRx and PTx communicate with each other to establish that the mobile device is indeed capable of being charged, whether it needs to be charged, how much power is required, etc. In short, the communication ensures an appropriate power transfer from the power transmitter to the power receiver. The communication channel can also be used to trigger location based services by providing an SSID, a Bluetooth link, or a unique ID.

When charging begins, the power transmitter runs an alternating electrical current through its coil(s), which generates an alternating magnetic field in accordance with Faraday's law. This magnetic field is in turn picked up by the coil inside the power receiver and transformed by a power converter back into an alternating electrical current that can be used to charge the battery.

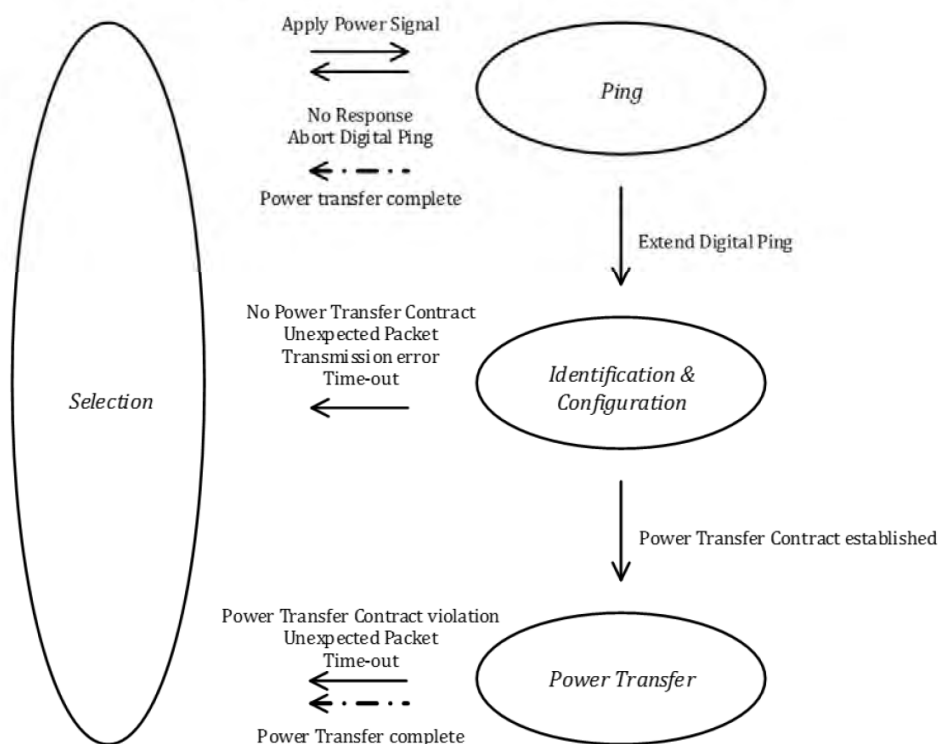
A critical feature of the magnetic field is that it can transfer through any non-metallic, non-ferrous materials, such as plastics, glass, water, wood, and air. In other words, wires and connectors are not needed between the power transmitter and power receiver.

Figure 6. Qi wireless power transfer using magnetic induction



The 440 Claim 3 Accused Products do so per the WPC Standard. For example, see WPC 1.2.4 Standard, Parts 1 and 2, Interface Definition at 45-50, of which Figure 16 is illustrated below to provide a general pictographic overview of those pages, in the Baseline Power Profile (BPP) and described in more detail in claim 1.

Figure 16. Power transfer phases—Baseline Power Profile



13. The system of claim 3, further comprising a data storage component for storage of data, for subsequent transmission of data to or from the mobile device.

The 440 Claim 3 Accused Products, which are smartphones or chargers that comprise data storage and wireless communication capability with the mobile device (e.g. the SmartThings Station) infringe this claim.

Samsung Galaxy smartphones

Samsung smartphones, including at least the S20 and S22 Ultra running Android 6.0 (Marshmallow) or later are able to transfer photos, videos, and other files via Nearby Share with other mobile devices supporting Nearby Share (e.g., smartphones and/or tablets running Android 6.0 or newer).

<https://www.cnet.com/tech/mobile/googles-version-of-iphone-airdrop-is-rolling-out-to-android-phones-now-heres-how-to-use-the-new-feature/>

Send or receive with Nearby Share

With Nearby Share turned on and set up, you can use it to send documents, photos, videos or links to people who are in the same room as you.

If you're sending a file, ask your friend to unlock their phone and leave the display turned on. If you're on the receiving end, you'll need to have your phone unlocked and the screen on.

<https://www.samsung.com/levant/smartphones/galaxy-s22-ultra/specs/>

Galaxy S22 Ultra

REVIEWS

Specifications

Support

COMPARE

BUY NOW

Highlights

Showroom

Models

Accessories

Specifications

Design

[Galaxy S22 Ultra](#) | [Galaxy S22](#) | [Galaxy S22+](#)

Colors



Burgundy

Green

Phantom Black

Phantom White

Memory

RAM_Size (GB)

12

ROM Size (GB)

256

Available Memory (GB) *

218.5

Similarly, utilizing Samsung's Quick Share feature, Samsung Galaxy smartphones, including but not limited to the S20 and S22 Ultra running Android 10 or alter can transfer files between devices.

<https://www.samsung.com/global/galaxy/what-is/quick-share/>

What is Quick Share on Galaxy?

Quick Share is a new sharing service for sending photos, videos, and files with your friends and family. When you've captured a masterpiece, you want to share it quickly with the people who are there in the moment with you, right? You can instantly send to multiple people at a time via Quick Share on Galaxy S20, S20+, and S20 Ultra. File sharing has never been so easy on a Galaxy.

Getting set up is easy — this method of picture and video sharing is so simple, all you have to do is find the photo, video, or file that you want to send and tap the Share button. Select the icons of the nearby contacts you want to send to. Those people have to tap Accept on their phones to receive and complete the process. And that's it! Quickly and easily send files to a group of people all at once.

Discover more about Galaxy.

*Quick Share is available on previous Galaxy series when upgraded to Android 10.

Samsung SmartThings Station

In addition to wireless charging capabilities, the Samsung SmartThings Station comprises a data (non-wireless charging related) storage component and connects wirelessly to the mobile phone, earbud case and other devices being charged or nearby and exchanges data with the mobile device being charged. Some of the pre-programmable actions and activated subsequent to initiation of charging of a phone by transmission of data to or from a phone to a storage component in the SmartThings Station are shown below. Such a smart charger brings new functionalities and possibilities to home and electronic life integration.

Charge to activate the night

Go to sleep easy. When wireless charging is detected, SmartThings Station will make your room comfortable to get you ready for a restful night. Simply set your phone down on the charger and know that your doors are locked, lights out, temperature set and more.[®]



Your home. In the palm of your hands.

Invite intelligence into your home. Beyond charging your device, SmartThings Station is designed to make your day and night run smoothly with smart features, automated experiences and convenient control of your home.¹

¹Products sold separately.



Powerful charger. Intelligent control hub.

It's the whole package. Available in Black or White, SmartThings Station's clean design makes it seamless in any room. It's also packed with convenience and performance, including Direct Air Cooling, a USB-C port, Smart Button, Reset Key, and more.



27. A system capable of inductive powering or charging by a universal base unit for charging of different mobile devices and/or batteries of different charging characteristics associated therewith, comprising:

a battery, wherein one or both of a device and the battery have particular charging characteristics associated therewith;

a receiver and a receiver coil, for one of inductively powering the device or charging the battery in the device, wherein the receiver is one of attached to or incorporated into the battery or the device, and wherein the receiver coil has generally planar shape so that a magnetic field received in a direction substantially perpendicular to the plane of the receiver coil is used to inductively generate a current in the receiver coil;

an identification component associated with the device or battery, which is configured to provide wireless identification of the receiver to the universal base unit;

a means for avoiding overcharging one or both of the mobile device and battery inductively; and a regulator, coupled to the output of the receiver or to the battery, that regulates an output voltage or output current provided by the receiver, to the device or battery, to be within a range of parameters for the device or the battery;

wherein different devices and batteries can have different charging characteristics associated therewith; and

wherein the receiver communicates with the base unit to detect, identify and authenticate the receiver with the base unit, as provided by the identification component; determine and then activate one or more primary coils of the base unit which are aligned with the receiver coil; verify the continued presence of the receiver near the base unit; and communicate information describing the characteristics of the device or the battery, for use by the base unit to provide power transfer to the receiver and to the device and the battery according to their particular charging characteristics.

The 440 Claim 27 Accused Products include at least those accused under Claim 1. The Claim 27 Accused Products are structured and function as described with respect to claim 1 and infringe claim 27 in the same manner as shown with above respect to claim 1.