Challenges in Mass Market Application of Wireless Power Transfer

Menno Treffers - July 2017
Wireless Power: A large market

- Phones:
  - 1000 million in 2020
  - 2000 million in 2025
- Chargers:
  - 500 million in 2021

[Graph showing wireless power market growth from 2014 to 2026]

Qi in all wireless charging phones

- All phones with integrated wireless charging support Qi
All home chargers support Qi

- Current market size: 60-80 M units/year
- Potential market > 500M units/year
- 400+ charger products available today
- All home chargers are Qi compatible


Source other data: The Wireless Power Consortium
All in-car chargers support Qi

Adopted by nearly all global auto manufacturers
What did we learn?
Wireless power is easy

• Power level
  – A kilowatt? It is possible

• Transfer distance
  – A kilometer? It is possible

https://www.youtube.com/watch?v=7O44WM1Q9H8
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Making a competitive product is hard

Engineering a prototype into a mass market product is incredibly hard
What makes it hard?

- Safety
- Efficiency
- Interference with other electronics
- Cost
- Compatibility
EMF regulations limit the exposure of human body to electro-magnetic fields

Tradeoff: tightly coupled configurations have lower emissions
Safety – high temperatures

- Wireless chargers must not make phones, coins, or banking cards hot
  - Even at 5W the temperature of a coin can easily increase above melting point of plastics
- Products must be tested to verify that they are safe
- The Qi logo is licensed only for products that have passed testing by one of our independent test labs

Example of a product that failed one of the Qi tests on “Foreign Object Detection”. July 2017
Efficiency

- High efficiency improves safety
  - Less heat
  - Lower EM emissions

- Responsible use of energy needed
  - Better than 70% for 5 W receivers
  - Better than 90% for 1 kW receivers

- Tradeoffs
  - Cost - A wireless charger can be as efficient as a wired charger\(^{(1)}\)
  - Transfer distance – tightly coupled configurations are more efficient

Measuring Efficiency

- Misleading numbers:
  - Coil to coil efficiency (ignoring losses in DC to RF and RF to DC conversion)
  - RF to DC efficiency within the receiver (ignoring losses in Tx and during transfer)

- Efficiency should be measured
  - DC out / DC in
  - With a realistic load
  - Averaged over the complete charging surface

- A simple check: look at the rating of the power supply of the Tx
• In-vehicle is one of the toughest environments
  – Preventing interference with contactless car keys and vehicle electronics

• RFID/NFC cards must not be damaged

• Tradeoffs
  – Lower frequency is easier
  – Fixed frequency is easier
Cost

- Mass market products need low-cost solutions
- Increasing volume reduces the cost of components
  - Positive feedback cycle
- BoM of Qi charger is now less than US$10. Qi receiver less than US$2.

Example of a correlation between cost and mass market adoption
Compatibility

- What is the value of a charger that cannot charge your mobile phone?
- What is the point of adding wireless charging to a phone if you cannot charge in your car or at home?
The network effect forces standardization

The benefit of wireless charging increases with the number of compatible chargers and phones

When the installed base increases beyond 100 M units:

- Selling incompatible chargers becomes difficult
- Selling incompatible phones becomes difficult
Conclusion
Mass market products must be:

- Safe
- Efficient
- Non-interfering
- Low cost
- Compatible

Wireless power market surges as usage leaps forward
The start of a mass market

Sales of products that use the standard in million units (log scale)
Years after finalizing the first specification

Sources:
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