Wireless Charging Solutions
EUF-IND-T0590

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J U N E . 2 0 1 4
Market View

- 136 Members
- Complete supply chain
- Power scalability to 15W defined in Qi specs
- Resonance (via Power by Proxie & Fulton)
- Distances scalable up to 4cm
- Operating frequency 105 – 205kHz
- Currently supported by global telecom operators (Verizon, Orange, Docomo)
- Freescale contributing member

- Qualcomm & Samsung
- Magnetic Resonance @ 6.78MHz
- Distance of a few cm

- Inductive Charging
- Resonance (via Witricity)
- Incompatible with Qi
- Distance up to several cm
- Operating frequency 220 – 350kHz
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FSL Certified

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FSL Supported

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FSL Certified

FSL Supported
Freescale Value

Hardware
- Transmit controller ICs with high performance core & peripherals
- Power efficient control loop processing
- Digital demodulation and foreign object detection
- UART, SPI, I2C interfaces for external communication
- Ability to use additional memory & I/Os to add more features

Software
- Firmware library to perform wireless power core functions
- Programmable interface to adjust core function parameters
- Customize feature set and behavior
- Ability to add additional features outside of wireless core function

Reference Designs
- Production-ready reference designs for key markets
- Ready designs with minimal configuration and necessary tuning
- WCTGUI easy-to-use real-time tuning & debug tool
Hardware
Two ways how to create WCT application

**Standard**
- Separate WCT and Application MCU
- Limited configuration

**Premium**
- Charging and Application in one MCU
- Full control over charging process
Two ways how to create WCT application

**Standard**
- "Black box" solution
- Limited configuration

**Premium**
- Charging and Application in one MCU
- Full control over charging process
- Combine WCT and your SW in one MCU
Software
Freescale Wireless Charging Firmware Library

- Modify parameters on-the-fly using analysis tool (e.g. FSL’s FreeMASTER)
- Tune the system to optimize performance
- Add additional application code (via Freescale API)
- Create true differentiation by customizing your wireless charging product
Freescale Wireless Charging Firmware Library

- Pre-defined, encapsulated modules to perform charging core functions
- Configurable hardware layer to limit locked hardware resources
- Add additional application code
- Create true differentiation by customizing your wireless charging product

Freescale API

User Layer
- Parameter Calibration & Configuration
- Customer Code

APP Layer
- Power Control
- Monitor & Protection & Diagnostic
- Object Detection
- Low Power Mode
- FreeMASTER API

Middle Layer
- PID Control
- Coil Selection
- Rail Voltage Control
- Touch Sensor
- LED & Buzzer
- Qi Communication
- FOD

Processor Layer
- ADC
- Flash
- Timer
- PIT
- IC
- GPIO
- PIM
- JTAG
- UART

Freescale Wireless Charging Firmware Library
Main Wireless Charging Topologies

- WPC defines **Qi-Compliant** TX HW Topologies;
  - **A**-type: Litz-wire coils (single/multiple) on ferrite plate/sheet;
  - **B**-type: PCB type coils with ferrite sheet;
- Most frequently used: A1, A5, A6, A10, A11, A13, B4, B5;
- Main differentiation characteristics:
  - Coils topology
  - Power supply voltage (fix 5V, 12V, 19V), var 12V (automotive)
  - Power transfer control type:
    - Voltage control;
    - Frequency control;
    - Duty-cycle control / phase control;
# Main Wireless Charging Topologies

<table>
<thead>
<tr>
<th>type</th>
<th>A1</th>
<th>A5 (similar to A1)</th>
<th>A6</th>
<th>A10</th>
<th>A11</th>
<th>A13</th>
<th>B4</th>
<th>B5</th>
</tr>
</thead>
<tbody>
<tr>
<td>description</td>
<td>single coil with magnet</td>
<td>single bifilar coil with magnet</td>
<td>three coils / overlapping</td>
<td>single coil</td>
<td>single coil</td>
<td>three coils / overlapping</td>
<td>n-layer PCB + n-layer wire wound coils;</td>
<td>n-layer PCB + n-layer wire wound coils;</td>
</tr>
<tr>
<td>TX topology</td>
<td>half bridge, series capacitor;</td>
<td>full bridge, series capacitor;</td>
<td>half bridge, series capacitor;</td>
<td>half bridge, series capacitor;</td>
<td>full bridge, series + parallel capacitor;</td>
<td>for the each coil: full bridge, series + parallel C &amp; L;</td>
<td>full bridge, series capacitor, multiplexer with max 2 coils together;</td>
<td>phase controlled full bridge, series + parallel C &amp; L + multiplexer;</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>19V ±1V</td>
<td>5V; 5%</td>
<td>12V</td>
<td>19V ±1%</td>
<td>5V; 5%</td>
<td>1 - 12V</td>
<td>12V ±5%</td>
<td>12V ±5%</td>
</tr>
<tr>
<td>control</td>
<td>frequency</td>
<td>frequency</td>
<td>frequency</td>
<td>frequency</td>
<td>frequency</td>
<td>voltage</td>
<td>phase / duty-cycle</td>
<td>phase / duty-cycle</td>
</tr>
<tr>
<td>Oper. Frequency</td>
<td>110 - 205 kHz;</td>
<td>110 - 205 kHz;</td>
<td>115 - 205 kHz;</td>
<td>110 - 205 kHz;</td>
<td>105 - 115kHz;</td>
<td>105 - 113kHz;</td>
<td>96+2kHz</td>
<td></td>
</tr>
<tr>
<td>Inductance</td>
<td>24uH;</td>
<td>6.3uH;</td>
<td>11.5uH / 12.5uH;</td>
<td>24uH;</td>
<td>6.3uH;</td>
<td>11.5/12.5uH; + 2 x 1uH series L;</td>
<td>N x 8.8uH, N x 9.1uH; N x 9.5uH; Lm=3.8uH;</td>
<td>N x 8.8uH, N x 9.1uH, N x 9.5uH; Lm=3.8uH;</td>
</tr>
<tr>
<td>series capacitance</td>
<td>100nF;</td>
<td>400nF;</td>
<td>147nF / 136nF;</td>
<td>100nF;</td>
<td>400nF;</td>
<td>Cs1 + Cs2 = 200nF; Cp = 400nF;</td>
<td>Cm=300nF;</td>
<td>Cm1 = 356nF, Cm23 = 82nF;</td>
</tr>
</tbody>
</table>
Reference Design Enablement

- Schematics, Bill-of-Materials, Gerbers
- Transmitter firmware
- Receiver firmware
- Customizable Software for adding features
- Industry know-how to help enable Wireless Power Consortium’s Qi product certification
- Available to customers under NDA
A11 Transmitter

Key Features:
- Freescale high performance low power (<5W) wireless transmitter compatible with Qi specs
- 5V DC input voltage
- Guided positioning with single primary coil (A11 type coil)
- Single-stage full-bridge inverter with frequency and duty cycle control
- Low standby power with TSI
- Basic FOD function (Foreign Object Detection)
Typical Usage for A11 Design

• 5W mobile phone charger

• Trends: from after-market to build-in feature
  – Wireless charging function integrated inside the phone
  – Simple wireless charger shipped with the smartphone
Phone Adoption Drives an Accessory Market

Audio Speakers with wireless charging

Bluetooth headset with wireless charging

Wireless mouse with wireless charging

Alarm clock with wireless charging
Automotive A13 Transmitter

Key Features:
- Freescale automotive low power wireless transmitter compatible with Qi specs
- 6 -16V DC input voltage support
- Free positioning with three primary coils (A13 type coil)
- Two-stage power stage (BUCK + full-bridge) with rail voltage control
- Low standby power with TSI (ver. 2)
- Coil temperature sensing (ver. 2)
- Key FOB avoidance (ver. 2)
- Basic FOD function (ver. 3)
- CAN support (ver. 3)
- NFC co-existence (ver. 3)
- Digital demodulation algorithm (ver. 3)
Typical Usage of A13 Design

- Phone charger in central tunnel
- More position flexibility for charged device
- 5W output
30W Transmitter + Receiver

Key Features:
- Freescale medium power (30W) wireless transmitter compatible with Qi specs (low power version)
- **18-22V DC** input voltage support
- Guided positioning with single primary coils
- Single-stage power stage (half-bridge) with frequency and duty cycle control
- 4 independent channels in one base station with one DSC silicon
Typical Usage for 30W Demo

• Industrial battery pack charger

• Tablet charger
Main Board PCB target size:
38 mm x 14 mm

Daughter Board PCB target size:
42 mm x 42 mm (1.65” x 1.65”)

Freescale Technology
## Wireless Charging Support Options – General Structure

### Typical Issues
- Evaluation of processor & software
  - Demo board
  - Familiarization
  - Features
  - Code size
  - Performance Report
  - Installation
  - HW Set up
  - Demos / examples

- Proof of Concept
  - Demo board
  - Documentation
  - API Features
  - Code size
  - Calibration
  - Charging efficiency

- Preliminary application development
  - Demo/ Custom boards
  - Possible bugs
  - HW structure
  - App architecture
  - WCT Lib. Feature use
  - Configuration

- Final application development
  - Custom boards
  - Integration with 3rd party SW
  - Adding customer features

- Integration and product validation
  - Custom boards
  - Timing issues
  - Performance tuning

### Forums and Freescale Support
- Standard Support and Services $3K (20hrs over 6 months)
  - Starter Services
    - Driver development support
    - SW/HW Architecture design support
    - Implementation guidance
    - Training/Consulting
  - Technical Support
    - Remote-support of customer boards
    - 48 hrs response time
    - 2 hrs live remote debug
    - Senior level developers
    - Debug customer code
    - Communication- email, phone or live remote debug

- Premium Support - $12K (100hrs over 12 months)
  - Starter Services
    - Driver development support
    - SW/HW Architecture design support
    - Implementation guidance
    - Training/Consulting
  - Technical Support
    - Hands-on support of customer-provided boards
    - 24hrs response time
    - 10 hrs live remote debug
    - Assistance with your system level diagnosis
    - Senior level developers
    - Debug customer code
    - Communication - email, phone or live remote debug
Solution Support

• Wireless charging firmware
  - Core modules contained in library are owned by Freescale- **NO LIBRARY SOURCE CODE** is provided to customer
  - Bug fixes to core modules are provided free of charge
  - Bug fixes will become available upon approved release
  - Customer is responsible for checking for updates
  - Feature enhancements, as defined by Freescale, to the core modules are provided free-of-charge

• Additional functions or capabilities
  - Some additional features may be demonstrated on certain reference platforms (i.e. CAN, SPI)
  - Non-core functions are provided as demonstrator code-only
  - System level changes made, such as magnetic or BOM substitutions are responsibility of customer unless specified by Freescale
  - Support for certain applications, such as NFC, are provided by third-party partners where appropriate
  - Deviations from the base platform or solution provided by Freescale are the customer’s responsibility, and support cannot be guaranteed
More Information

• For more information about Freescale’s wireless charging solutions, visit www.freescale.com/wirelesscharging

• For information on Freescale’s 5W single-coil wireless charging reference design, visit: www.freescale.com/5w1coiltx

• Link to FreeMASTER Installation package (37.4MB), User Manual is in “Help” of the installed software
  • https://cache.freescale.com/secured/microcontrollers/software/app_software/application_development_framework/FMASTERSW.exe?fileExt=.exe&__gda__=1399300568_1b003f47a204269d1e8261f99df83409