Document: **Functional Description / Certification status**

Project: Continental Wireless charger

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VERSIONS LIST

Version	Date	Author	Comment, Description
V1	24.2.2016	Saïd Bouguern	Creation

RELATED DOCUMENTS

Document	Version	Date	Author	Comment, Description
sysdescrwpt-voli-part1-112				Qi standard

1 SYSTEM DESCRIPTION

Continental Wireless Power Charger is developed for automotive applications under the name WMI which includes:

- WPC: Wireless power charger
- NFC: Near field communication

The WMI module is shown in Fig. 1a and their implementation within a vehicle is depicted in Fig. 1b.

(a) (b)

Fig. 1 : (a) WMI module; (b) WMI automotive implementation.

1.1 WPC

WPC charger uses Qi standard of Wireless Power Consortium (WPC) according to sysdescrwpt-voli-part1-112 specification for enabling wireless charging from a base station unit to mobile device. The power transfer method is based on thigh coupling magnetic induction between coils.

1.2 System Overview

The structure of wireless power transmitter proposed in Fig. 2 shows an overview of the system with two kinds of distinguished devices: Base station and Mobile device where the base station is the Power Transmitter and Mobile device the Power Receiver.

Power transmitter comprises two main functional units, namely a power conversion unit and a Communications & Control unit for delivering, controlling and regulating the transferred power. Power receiver comprises a power pick up unit and a communications & control unit for achieving power requirements and charging the device battery.

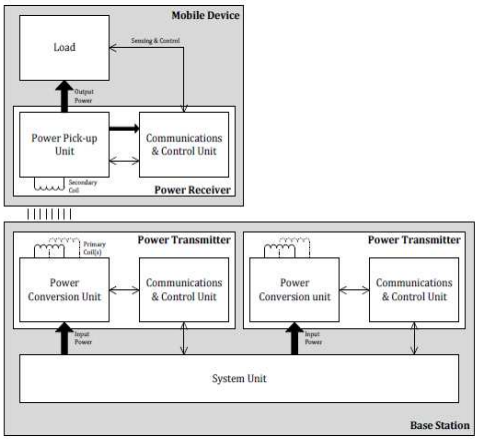


Fig. 2 : Wireless power transfer structure

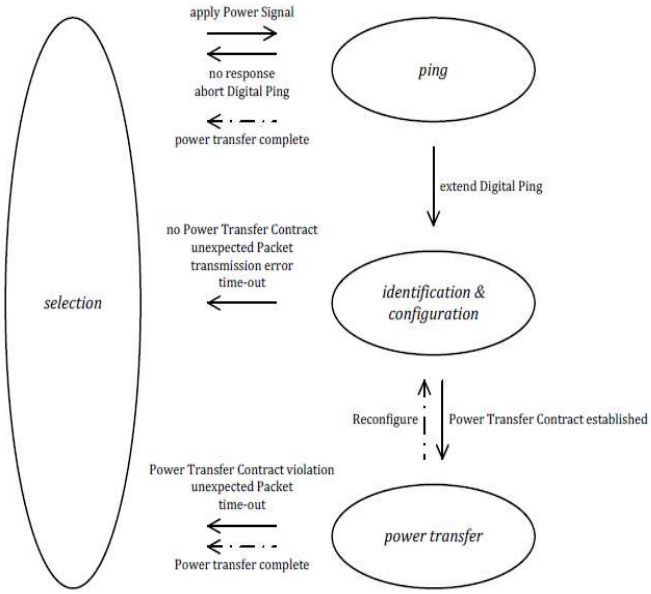
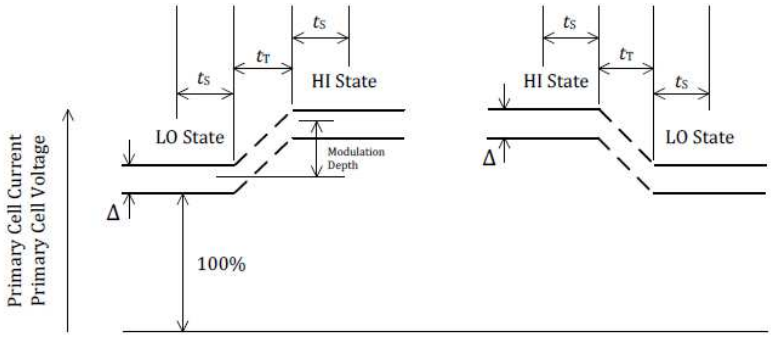


Fig.3 : Functional overview

1.3 Communication behavior

1.3.1 Load modulation

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.



Parameter	Symbol	Value	Unit
Maximum transition time	t_T	100	μs
Minimum stable time	t_S	150	μs
Current amplitude variation	Δ	8	mA
Voltage amplitude variation	Δ	110	mV

Fig. 4 : Amplitude modulation

1.3.2 Messages

Charging is divided into 3 different phases

- **Analog ping phase**
  - No message

- **Digital ping phase**

Power Receiver modulates the carrier wave emitted by Power Transmitter in order to identify itself.
In this operational mode, the WMI module transmits a short time carrier signal with a specific pattern in order to detect a mobile device Qi compliant onto its surface. When a mobile device is placed on the base station, the identification and the collection of configuration information is done without changing the operating point of the base station. Based on the configuration information received from the mobile device, the base station creates a power transfer contract containing the maximum power that the mobile device intends to provide at its output. The Fig. 5 depicts the time pattern of the operational mode 1. The pattern is composed of short carrier bursts during 30ms spaced of 200ms between them and followed by three long carrier burst of 90ms spaced of 10ms. This pattern is repeated until that a mobile device is detected and identified.

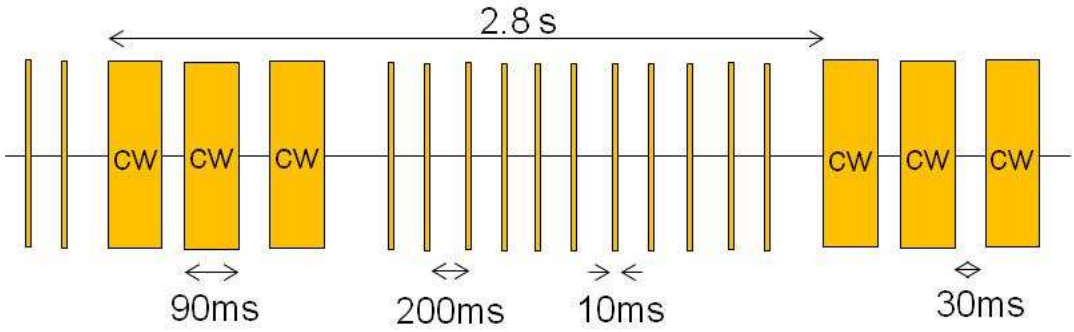


Fig.5: Schematic of time pattern of Digital ping phase

- Configuration packet

- **Power transfer phase**

After passing through the digital ping phase, the power transfer starts. In this operational mode, the base station sends the carrier at a given level defined in the power contract in the digital ping phase. The base station controls the power transfer to the mobile device, in response to control data that it receives from the latter. The power transfer is done until the mobile device decides to stop the charge. Figure 6 shows the pattern of the power transfer phase.

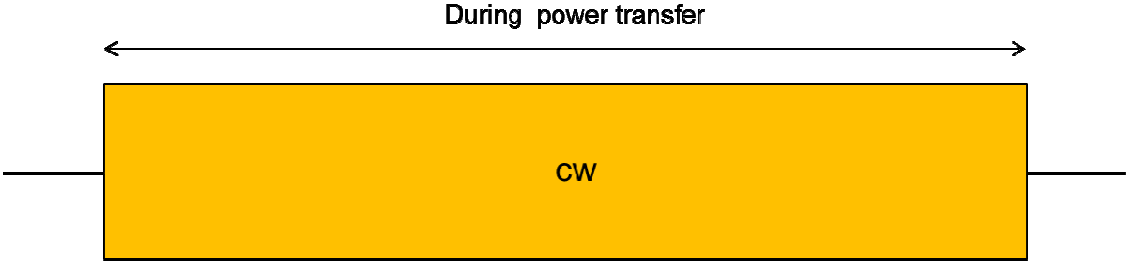


Fig. 6: Schematic of pattern power transfer phase

Power receiver modulates the carrier wave emitted by Power Transmitter in order to adjust power transfer.

- Control Error Packet.
  - Power adjustment
- Received Power Packet.
  - Power at load, useful to diagnosis power transfer (e.g. foreign object is heating by consuming part of the transferred power)
- Charge Status Packet.
  - Useful for visual feedback of the charging status of the battery.
- End Power Transfer Packet.
  - In case of power transfer complete or power transfer issue as a consequence Power Transmitter will stop is carrier wave emission.

1.4 Wireless Power Charger Description

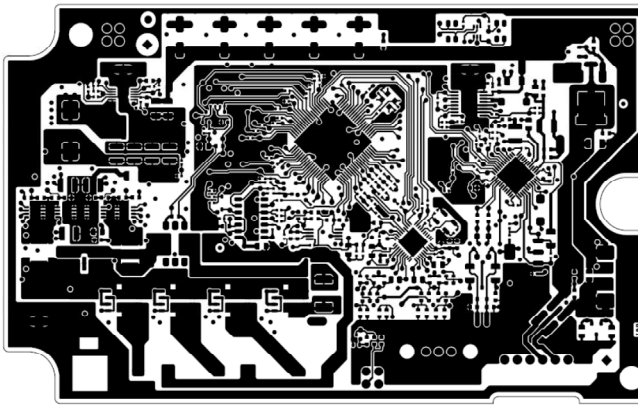
1.4.1 External view.

A manufactured product view is shown in Fig. 7.

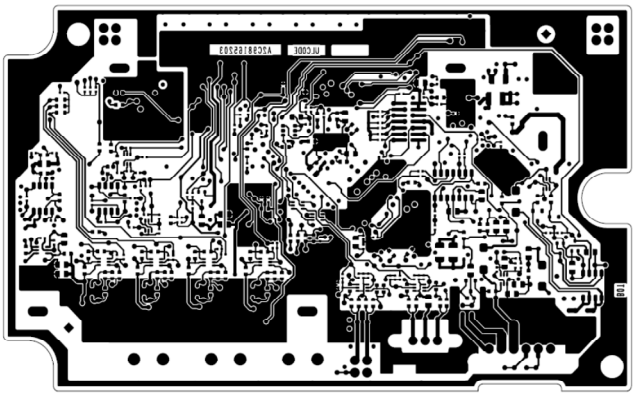
Top view

Side view

Fig. 7 : Manufactured WMI



PCB Top view



PCB Bottom view

Fig. 8 : PCB

1.4.2 Power Transmitter coil detail

Design is based on Qi standard specified A13 transmitter. Coil assembly is based on 3 litz coil fitted on piece of ferrite in order to increase Q factor and limit magnetic field leakage.

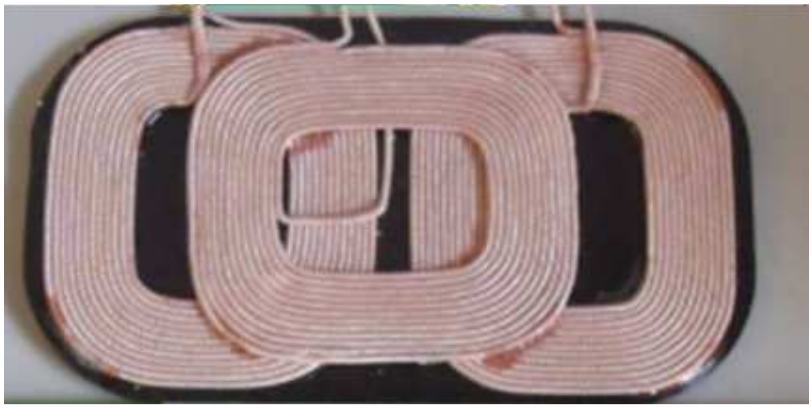


Fig.9 : Power trasmitter coil

1.4.2.1 Coil geometry

Item	Parameter	Symbol	Value
Primary Coil	Outer Length	d_{ol}	53.2±0.5 mm
	Inner Length	d_{il}	27.5±0.5 mm
	Outer Width	d_{ow}	45.2±0.5 mm
	Inner Width	d_{iw}	19.5±0.5 mm
	Thickness	d_c	1.5±0.5 mm
	Number of Turns per Layer	N	12
	Number of Layers	-	1
	Displacement between Odd Coils	d_{oo}	49.2±4
	Displacement between Odd and Even Coil	d_{oe}	24.6±2
	Feeding Line Length	d_{fl}	31±2 mm
	Soldering Length	d_{di}	7±2 mm

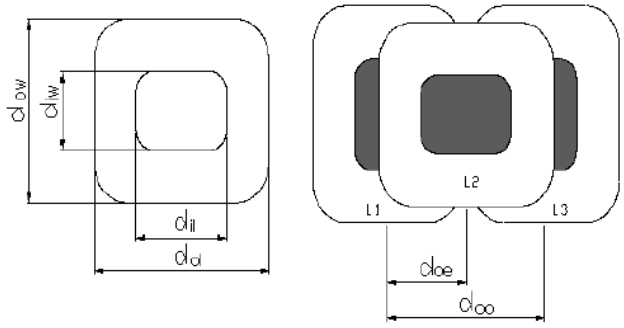


Fig.10: Power transmitter coil geometry

1.4.2.2 Electrical parameter

L= 12.5µH
Q = 80
SRF = 15MHz

1.4.3 WPC parameters

Bellow in table 1, the technical parameters of the WMI WPC charger are specified:

Parameters	Values
Carrier frequency	108.7 kHz
Frequency shift	+-2 KHz
Supply voltage	12V lead acid vehicle battery
Voltage supply range	8V < Vbat < 16V
Operating temperature range	-20°C < Temp* < 40°C
Max current	3.2A rms (in the coil)
Max power	5W

Table 1: Power transmitter technical parameters.

1.5 NFC

NFC reader used NFC (Near Field Communication) technology to enable the communication between phones and cards with the vehicle, having user functions like:

· BT pairing
· Personalization
· Android beam
· …

All above functions are implemented at vehicle level only (transparent for the NFC Reader). The NFC reader behaves like a gateway between NFC and CAN. For making the above user function available for vehicle, the NFC reader has the following functions supported:

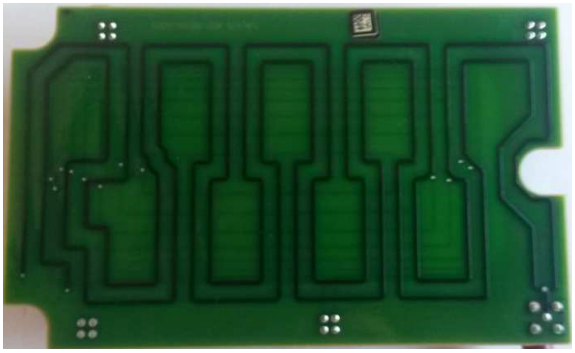
· Pear-to-Pear – in this move the Reader works in bi-directional way allowing any or both NFC parties to emit and/or modulate the field.

· Card emulation – in this mode the NFC reader emulates a tag/card. In this mode the NFC reader does not emit field but only modulates the field emitted by an external device (e.g. a phone).

· Read/Write - In this mode the NFC reader reads and writes information on a NFC tag/card. In this mode the NFC reader emits the field needed by the tag/card.

1.5.1 NFC antennas

The NFC reader has two antennas. The firestone is implemented in the WMI module. The second one is an external NFC antenna connected by a cable to the WMI module. Fig. 11 shows the internal (shown by transparency in the middle of the board) and external NFC antennas.



(a)

(b)

Fig. 11: (a) Internal NFC antenna by transparency and (b) external NFC antenna.

1.5.2 NFC Parameters

Bellow in table 2, the technical parameters of the WMI NFC reader:

Parameters	Values
Carrier frequency	13.56 MHz
Modulation type	Amplitude Shift Keying (ASK)
Data rate max.	848 kbps
Supply voltage	12V lead acid vehicle battery
Voltage supply range	8V < Vbat < 16V
Operating temperature range	-20°C < Temp < 40°C

Table 2: WMI NFC technical parameters.

2 Regulation status

USA/CANADA : Complies with section 5.2 of KDB 680106 D01 RF Exposure Wireless Charging Apps v02.

Requirement 1: Respected with regard of load modulation behavior describe in §1.3 of this document.
Requirement 2: Respected according to 47 CFR Part 18. In fact, at 108.7kHz is only charging and limited communication.
Requirement 3: Respected, client device placed directly on the charger.
Requirement 4: Product excluded from submitting RF exposure evaluation

- ⇨ Power transfer frequency = 108.7kHz (<1MHz)
- ⇨ Output power = 5W.
- ⇨ Power transfer only allowed between individual pairs of coil.
- ⇨ Client is in direct contact with Power Transmitter.
- ⇨ Coupling surface area is 24cm^2 (only one coil active at a time)

Reserved ID:

FCC ID:KR5DWMI2015A
IC:7812D-DWMI2015A

EUROPE: Complies with:

Health and Safety: IEC 60950-1: 2005 (2nd Edition)+A1:2009+A2:2013 and
EN 60950-1: 2006+ A11:2009+ A1:2010+ A2:2013+ AC:2011+ A12: 2011

Electromagnetic compatibility: ETSI EN 301 489-1 V1.9.2
ETSI EN 301 489-3 V1.6.1

Efficient use of Spectrum
ETSI EN 300 330-1 V1.8.1

CE DoC : Allows certification in following countries (Country/certificate number)

OMAN : *TRA/TA-R/3069/16*
Barhain : *DLM 0000000932*
Saudi Arabia : *TA 05022016-05022017-14153*
United Arab Emirat : *ER44340*
Custom Union (Russian federation/Belarus/Kazakhstan) : *RU C-DE.MJI66.B.00093*

CHINA: Complies with:

General Micro-power (short range) radio transmission equipment Type A equipment.
CMIIT ID 2 0I6DI02T5

JAPAN: Complies with: Japan Extremely Weak Power Equipment

No certificate required, fulfill radio emission levels.