Freescale Semiconductor
Application Note

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Low-Power Wireless Charging Using the Freescale WCT1001A Controller

by: Arendarik Stanislav

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1 Introduction

There are many battery-powered devices, which need to be periodically charged. For example mobile phones, tablets, battery-powered hand tools and others. These tools are usually powered or charged by a dedicated cord from a USB port or from a dedicated wall adapter. Wirelessly transferred power simplifies the powering or charging of these devices and brings a new level of convenience to the everyday lives of our customers. Dedicated controllers are required for wireless charging application control. Freescale provides the WCT1001A controller.

This application note describes an example of how a universal wireless low-power charger can be designed. This example shows how to easily build a wireless charging transmitter. It is possible to modify this example in accordance with specific customer requirements.

2 Typical Requirements

- Supply voltage in the automotive range from 9 V to 16 V DC with short voltage drop to 6 V level
- Delivered power of up to 5 W
- Free positioning system

- Touch sensing interface to detect an object placed on the charging surface
- Controller Area Network (CAN) and Near Field Communication (NFC) interfaces

3 Block Schematic

The block schematic of the application is shown in the figure below.

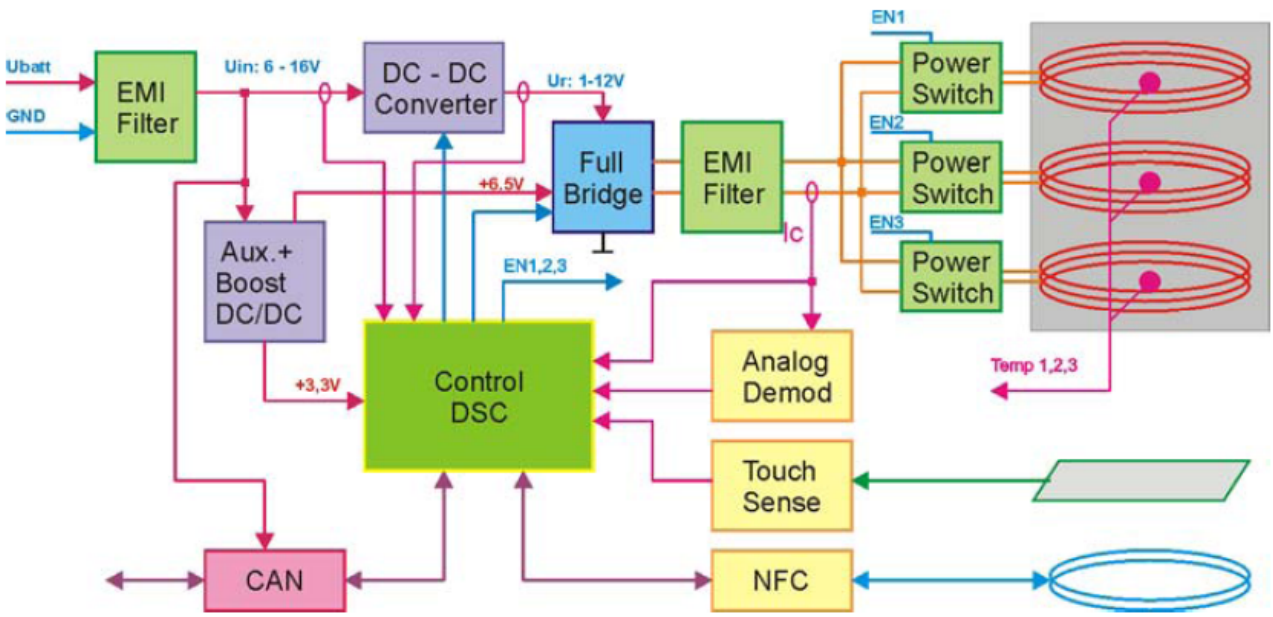

Figure 1. Block schematic

This low-power application is intended for the automotive sector. For this reason there are added features implemented, such as the CAN, touch-sensing, and NFC (Near Field Communication) interfaces. The whole design is based on the A13 coils topology in accordance to the Qi specification. It provides the free positioning of the device being charged.

The heart of the whole application is the Freescale's dedicated wireless charging controller type WCT1001A. This device provides the full set of peripherals required for the control of this application. The WCT1001A controller is described in the following section.

The associated circuitry comprises the input EMI filter and the auxiliary DC-DC buck converter included in the CAN device MC33908, which provides the on-board power supply +3.3 V for the controller and +6.5 V for the MOSFETs drivers. The full-bridge stage is powered from the variable DC voltage and provides the power to the electromagnetic field generated by the coil. Only one coil is energized at a time. The selection of which coil is energized is maintained by the power multiplexer.

The communication between the receiver and transmitter sides is maintained by the amplitude modulation of the high frequency current flowing through the power coil. The modulation is done on the receiver side. The demodulation circuit implemented on the transmitter side demodulates the signal and provides the data sent by the receiver to the control unit. This communication loop maintains the regulation of the delivered power by the transmitter. When the battery in the device on the receiver side is fully charged, the charging process is ended.

The touch-sense circuit periodically senses the charging surface as to whether any object is placed on the charging surface. The information about the placed object is sent to the controller. The controller takes action to recognize if an object placed is a Qi wireless charging compatible device or not. If yes, it starts to provide the power for charging, and if not, the power transfer will not start.

The NFC block comprises the NFC communication transceiver working in the 13.56 MHz frequency band. This block provides the communication channel to mobile phones equipped with the NFC interface. A message communicated through the NFC interface is then sent through the CAN interface to the central unit of the car for further processing.

4 WCT1001A Wireless Charging Controller Description

A very simplified block schematic of the WCT1001A peripherals used and the main blocks needed for this application is shown in the following figure.

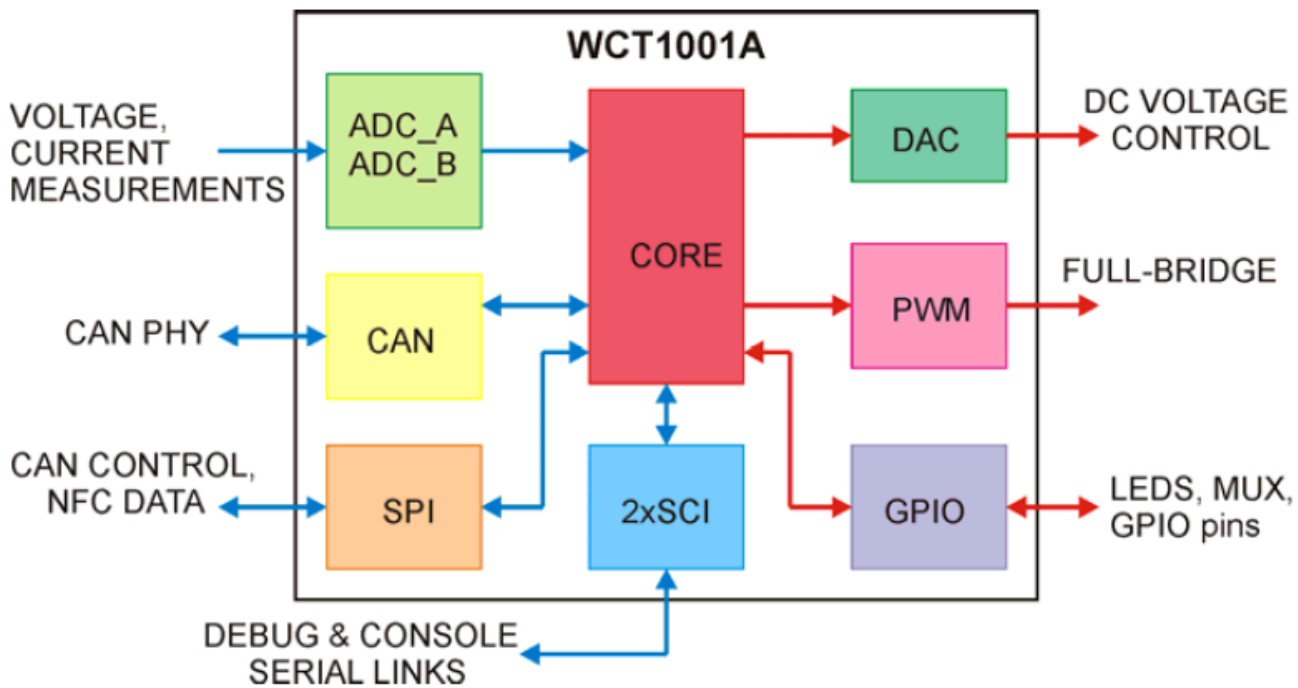

Figure 2. Simplified block diagram

The analog inputs of the ADC modules are used for the measurements of the input voltage, supply voltage, and current of the full-bridge and the coil current. The measured values are used for the calculation of the actual delivered power and for the detection of any foreign object (FO) placed on the charging surface together with the device to be charged. Where a power loss in the FO reaches a set limit, the power transfer can be limited or interrupted. This depends on the application settings.

The PWM module provides the control signal to the power full-bridge. The carrier frequency for the A13 design is defined in the range from 105k Hz to 115 kHz. The amount of power transferred is controlled by the DAC output. This DAC provides the analog control voltage for the power buck DC-DC converter control.

The GPIO pins are used for the power multiplexer control, LEDs signalization of the charging state, selection of the CAN, and NFC device for SPI communication and as the interface from the touch-sensing circuit.

The internal CAN module comprises the full CAN interface including the physical layer. The NFC circuit is a fully featured universal transceiver. Both devices are controlled by the SPI bus interface. The SPI bus also serves for the data transfer from/ to the NFC circuit.

The serial links are used for the debug interface – the FreeMASTER (FM) tool, and for the console interface. The FM tool is used for setting the parameters, which include the calibration, the user behavior settings, and all detailed parameters of the application settings. This tool provides the option to save all the set parameters to the FLASH memory.

The console interface is used to provide real-time information about the power transfer. The type and number of the messages displayed can be set by the debug interface too.

5 Software

The control software is based on the licensed wireless charging library. This library provides all the functions needed to build a wireless charging application. The free user code part can call all the functions from the library and manage the final behavior of the wireless charger application. The user can use the rest of the free peripherals for their own tasks. The wireless charging library is used as the binary input to the CodeWarior programming tool. This library is locked to the WCTxxxx controllers and meets all the required Qi specifications.

6 Conclusion

Wireless power transfer is a dynamically evolving process and can be used in many application areas. The use of the WCT1001A controller together with the binary library considerably simplifies the whole design process and provides fully tested functions for a reliable application.

7 References

- Wireless charging web page: http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=RDWIRELESSBATTERY

How to Reach Us:

Home Page:
www.freescale.com

Web Support:
http://www.freescale.com/support

USA/Europe or Locations Not Listed:
Freescale Semiconductor
Technical Information Center, EL516
2100 East Elliot Road
Tempe, Arizona 85284
+1-800-521-6274 or +1-480-768-2130
www.freescale.com/support

Europe, Middle East, and Africa:
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
www.freescale.com/support

Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor China Ltd.
Exchange Building 23F
No. 118 Jianguo Road
Chaoyang District
Beijing 100022
China
+86 10 5879 8000
support.asia@freescale.com

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