Document Number: AN4937
Rev. 0, 04/2014

Low-Power Wireless Charging Receiver using the Freescale MC9S08QB8 MCU

Contents

1. Introduction 1
2. Typical Requirements 1
3. Block Schematic 2
4. Control Unit (MCU) Description 2
5. Software 3
6. Conclusion 3
7. References 3

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 living.

This application note provides an example of how to build a wireless charging receiver—battery charger, with the Freescale very low-power MC9S08QB8 microcontroller. It is possible to adapt this example for voltage source instead of a battery charger.

2 Typical Requirements

- Very low internal power loss of the charger
- Full responsibility of the charging process
- Support the Qi specification for wireless charging
- Usable for a wide range of battery types

3 Block Schematic

The block schematic of the application is shown in Figure 1.

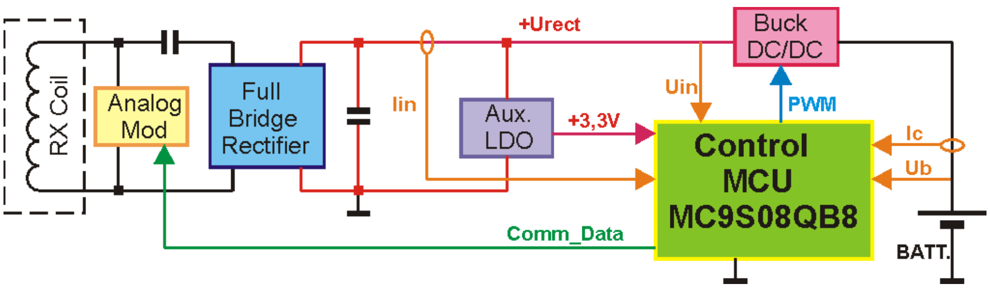

Figure 1. Block Schematic

This low-power application is intended for the consumer sector. A very low-power MCU is used for the control of this application to maintain the highest possible efficiency of the power transfer.

The foundation of the entire application is the Freescale very low-power microcontroller, MC9S08QB8. This device provides the full set of the peripherals required for the control of this application. The Kinetis, KL05 sub-family of devices can also be used in this application with comparable power consumption parameters. The descriptions in this document use the MC9S08QB8 MCU as the product sample.

The associated circuitry comprises the input power coil with tuning capacitor, the bridge rectifier (diode/MOSFETs/combined), which provides the rectified power supply +Urect, a low-power LDO for internal usage, the DC-DC buck converter for the battery charging, and the control MCU.

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 maintained by the analog modulation block. The demodulation circuit implemented on the transmitter side demodulates the signal and provides the data sent by the receiver control unit. This communication loop maintains the regulation of the power delivered by the transmitter. When the battery on the receiver side is fully charged, the control MCU completes the charging process and sends the request for terminating the power transfer.

4 Control Unit (MCU) Description

A very simplified block diagram of the MC9S08QB8 MCU used in this application is shown in Figure 2. Only the main blocks required for this application are illustrated.

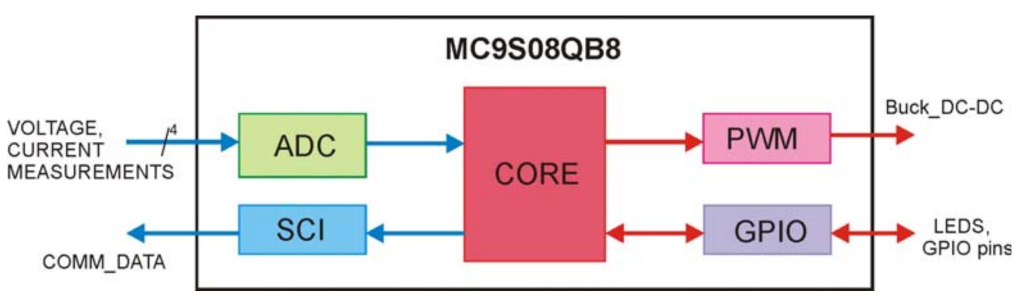

Figure 2. Simplified block diagram

The analog inputs of the ADC modules are used for the measurements of the rectified input voltage, input current, charging current, and the battery voltage. The measured values are used for the control of the charging process and calculation of the actual delivered power. The information about the delivered power is sent to the transmitter side. This information is used for the detection of any foreign object (FO) placed on the charging surface together with the device to be charged. When a power loss in the FO reaches a set limit, the power transfer can be limited or interrupted depending on the application settings.

The PWM module provides the control signal to the DC-DC buck converter. The charged battery has very low internal DC resistance, so the buck converter must be used instead of a simple switch. The battery connection to the rectified voltage level can cause an overcurrent event on the transmitter side and the power deliverance can be interrupted. The buck converter also provides the best option to manage the charging process of the battery used.

The GPIO pins are used to signal the LEDs' charging state or can be used for other customer features.

The serial link is used as the analog modulator interface which returns to the transceiver all data that is required by whichever communication protocol is used.

5 Software

Software control of the microcontroller requires the following:

- Manage the required Qi communication protocol for the wireless power transfer
- Control the battery charging process by the buck converter control
- Provide the signals of the charging process by the LEDs

6 Conclusion

Wireless power transfer is a dynamically evolving process and can be used in many application areas. The use of a very low-power MCU simplifies the design process of the battery charger and improves the efficiency of the entire application.

7 References

1. *MC9S08QB8 Series Data Sheet* (Document number: MC9S08QB8)
2. *KL05 Sub-Family Data Sheet* (Document number: KL05P48M48SF1)
3. The Freescale *Wireless Charger for Industrial Battery Packs* web page is available at www.freescale.com.

These documents and a current list of all documentation, is available at www.freescale.com.

8 Revision history

Revision 0 is the initial release of this document.

How to Reach Us:

Home Page:
freescale.com

Web Support:
freescale.com/support

Document Number: AN4937
Rev. 0
04/2014