Freescale Semiconductor, Inc.
Application Note

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Wireless Charging Receiver Using the Kinetis KL05Z32 MCU

Contents

1 Introduction

There are many low-power battery-powered devices in use. They must be charged periodically and one of the best options is using the wireless power transfer to charge the battery. Usually a Lithium-based battery is used. The battery voltage ranges from 3.0 V DC to 4.2 V DC or from 2.0 V DC to 3.6 V DC for the new LiFePO4 technology-based types.

This application note provides an example on how to build a wireless-charging receiver (WCHRX) and battery charger controlled by the Freescale Kinetis KL05Z32 MCU. It can be used as any of the low-cost MCUs, like the Freescale Kinetis Mini family, together with the dedicated Lithium battery charger from the MC3467x Freescale family, to form the whole battery charging application.

2 Main Requirements

The main requirements of the Wireless Charging Receiver (WCHRX) can be collected into several main points:

- High efficiency of the power transfer from the receiver's coil into the battery
- Fully controlled charging process
- Compliance with the Qi specifications for the wireless charging
- High flexibility – usable for a wide range of battery types
- Very simple application and high reliability

3 Block Schematic

Figure 1 shows the block schematic of the suggested application.

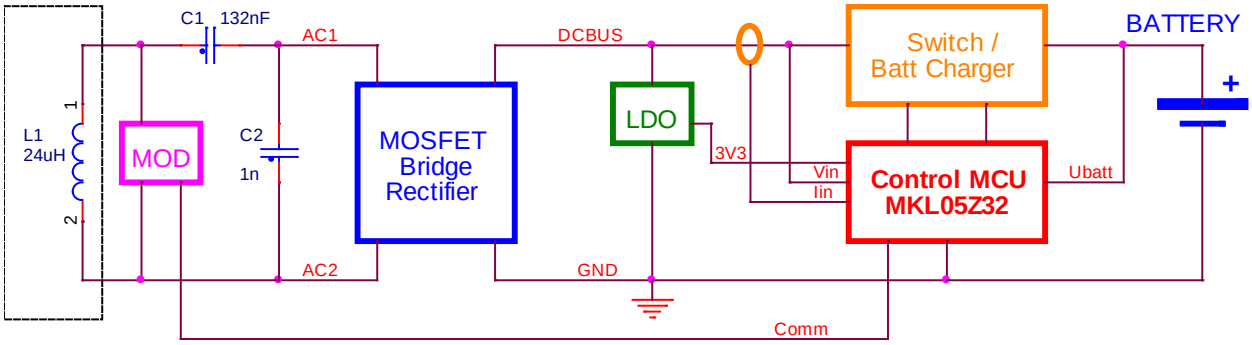

Figure 1 Block schematic of the Wireless Charging Receiver

The function of each block can be explained by the power flow description.

The power input from the high-frequency electromagnetic field is coil L1. Frequency used ranges from 100 kHz up to 200 kHz. This coil together with capacitors C1 and C2 forms the right shape of the regulation curve for the power transfer. If this coil is placed into near field (close to) of the active transmitting coil, the induced voltage between lines AC1 and AC2 is rectified by the MOSFET bridge rectifier. Usually, this bridge rectifier is completed from two N-MOSFETs and two Shottky diodes for greater simplicity. This option is usable for low-power applications – roughly up to 10 W. The main limitation is the voltage drop on the Shottky diodes, which together with higher rectified current lowers the overall efficiency and generates more heating power.

The rectified DCBUS voltage is directly used for the battery charging, if a simple controlled switch is used. This voltage can be used as the input voltage when the dedicated battery charger MC3467x family is used. In this case the battery charger is fully responsible for the battery charging process. It provides the charging status to the control MCU.

The LDO provides working supply voltage of 3.3 V DC for the control MCU. This LDO should have low quiescent current for better efficiency and low voltage drop at the output.

The control MCU has several functions. It must measure the input voltage and input current on the DCBUS line. If a simple switch is used, the battery voltage must also be measured for the accurate battery status recognition. If a dedicated battery charger is used, the MCU receives battery-charging status from the charger.

The control MCU uses serial communication channel and amplitude modulator to send the required message to the wireless power transmitter. The message sent contains information about regulation deviation as well as the actual received power value. The value of the received power is calculated from the measured input voltage and input current. This MCU functionality is part of the regulation loop of the whole wireless power transfer.

4 Control MCU Description

The Kinetis KL0x MCU belongs to low-power and low-cost family of controllers, but provides reachable options due to its internal peripheral modules. They can be used for the mentioned application and also for other features of the dedicated application. The internal blocks of the Kinetis KL0x MCU family are shown in Figure 2.

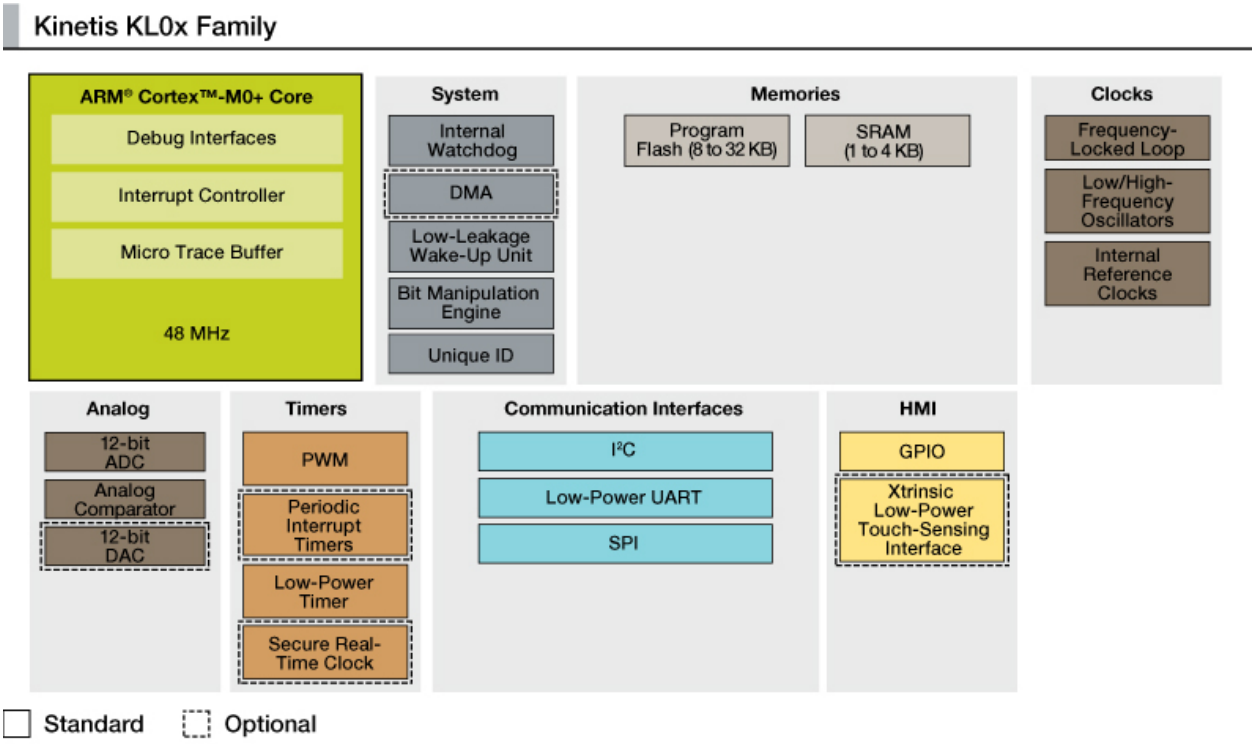

Figure 2 Internal blocks of the Kinetis KL0x family

The main features of this MCU family are:

- Supply voltage ranging from 1.71 V DC to 3.6 V DC.

- Working temperature ranging from -40°C to +105°C.
- 32-bit ARM core Cortex M0+.
- Rich set of the system and power management features.
- Running on 48 MHz bus clock with rich set of the internal and external clock sources.
- Up to 32 KB FLASH with 64 byte cache memory.
- Up to 4 KB of the RAM.
- 12-bit ADC, 12-bit DAC and high speed analog comparator.
- One six-channel and one two-channel timer module.
- Real time clock and programmable interrupt timer.
- Rich set of communication interfaces – SPI, I^2C and low power UART – all with DMA access.

The ADC and Timer modules are used together with GPIO input/output pins for this battery charger application.

5 Software

The software application for the control MCU depends on the final application. Mandatory functions include:

- Input power measurement (Vin and Iin)
- Input power calculation
- Communication to the wireless power transmitter

These functions form the main regulation loop and the power transfer can be processed. Other functions, like the switch control, battery voltage measurement, receiving the status information from the battery charger, and possible LED indicators control are added functions. Their usage depends on the final application.

The main points are:

- Making required measurements – input voltage and current.
- Managing the communication based on the Qi specifications.
- Controlling the power switch or accepting the status signals from the dedicated charger.
- Managing all signalization requirements for the application.

6 Conclusion

Wireless power transfer used for battery charging becomes a more and more popular feature for many new applications. It can be simply implemented/added into any application, even if controlled by low-power and low-cost MCUs like the Kinetis KL0x family.

7 References

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