NXP Semiconductors
Design Reference Manual

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Smart Plug Hardware Design Reference Manual

1. Introduction

This design reference manual describes a solution for a smart plug based on the MKM34Z64 microcontroller. This micro controller is part of the Kinetis-M microcontroller family. The smart plug reference design is intended for measurement of energies in single-phase, electronic power monitor, and wireless control. The solution can be extended to various areas, including lighting monitor, machine room power distribution, and so on. It can help the customer develop competitive products by providing design documents.

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2. Overview

The Smart Plug Solution is based on MKM14Z64 and implements measurement of grid voltage, current, frequency, active and reactive energies. With the WIFI chip, use UART and predefined command protocol to implement status display and function setting from the mobile application to the socket.

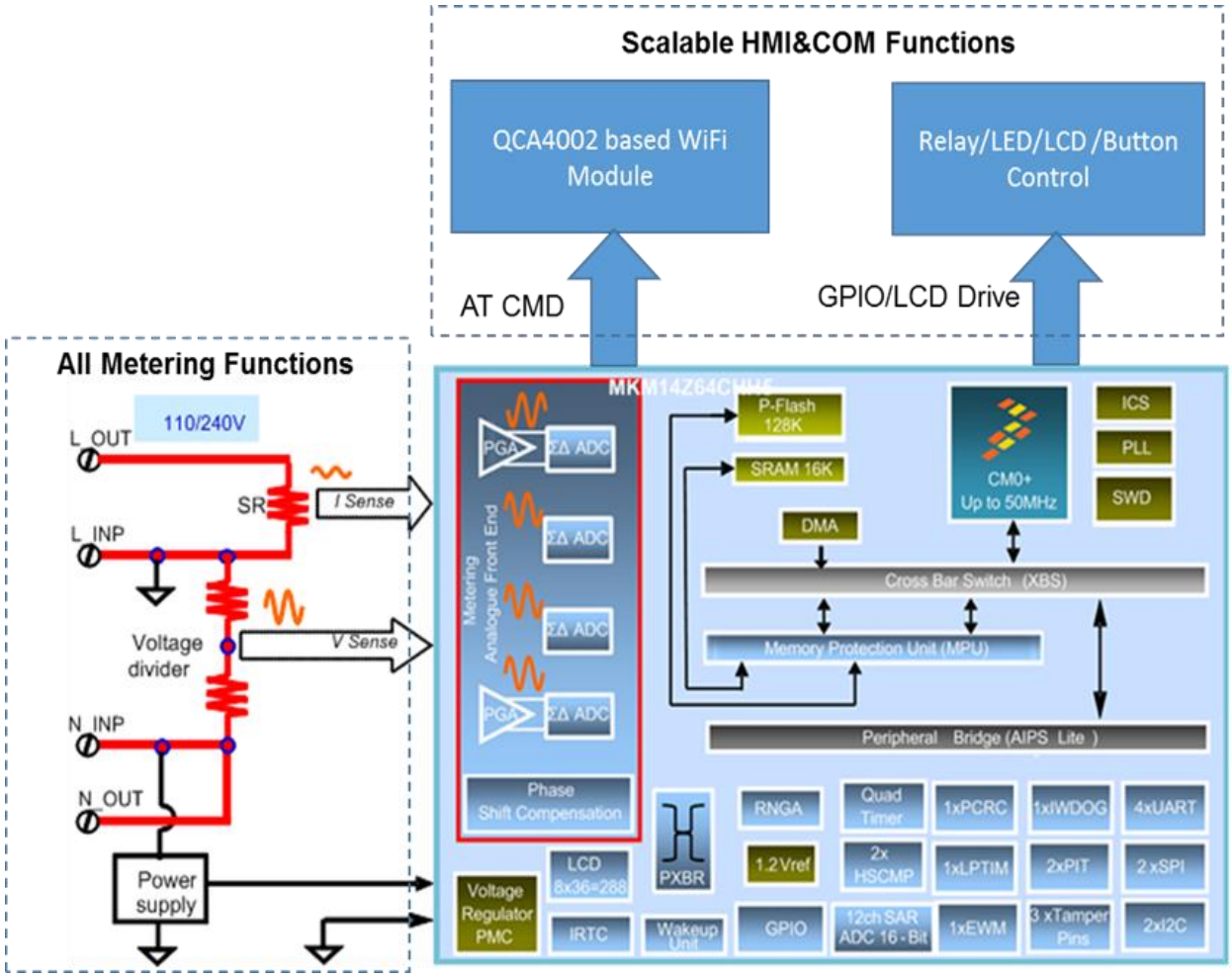

Figure 1. Smart Plug diagram

3. Hardware description

The Smart Plug is shown in the following figure. The hardware board is designed according to the existing mould. The maximum load is decided by different relay and width of power PCB.

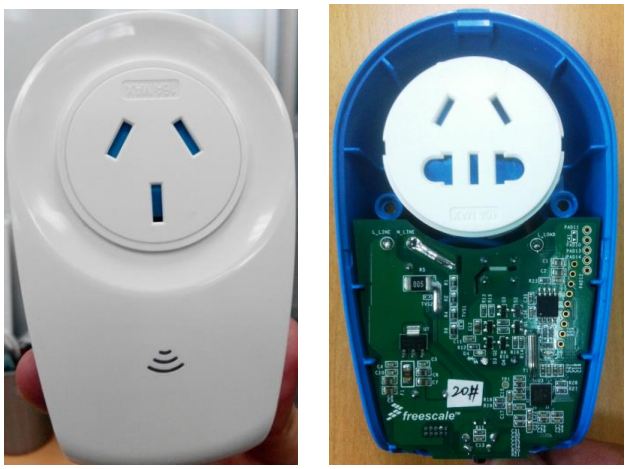

Figure 2. Board demonstration

4. Features

Smart Plug features:

- ARM® Cortex®-M0+ core, part number MKM14Z64CHH5, 44 LGA (5 mm × 5 mm) Packaging, 50 MHz system clock, 64 KB Flash, 16 KB SRAM
- 220 V input voltage, 10 A maximum current allowed
- Current sampling uses 25 ppm 5mΩ current sampler, 24 bit SD ADC
- Voltage sampling uses 25 ppm resistive voltage network, 24 bit SD ADC
- Grid frequency detected by on chip voltage
- Single 32.768 K Crystal Input for 5 ppm RTC
- Extensible external 64 Mb SPI Flash
- 3 channel light pulse for calibration
- UART to extend WIFI module

5. Hardware module

5.1 Power supply

The system accepts grid voltage input. The power module will then convert it to 5 V DC output and convert to 3.3 V DC by LDO. Finally, power is output to the MCU system and the WIFI module.

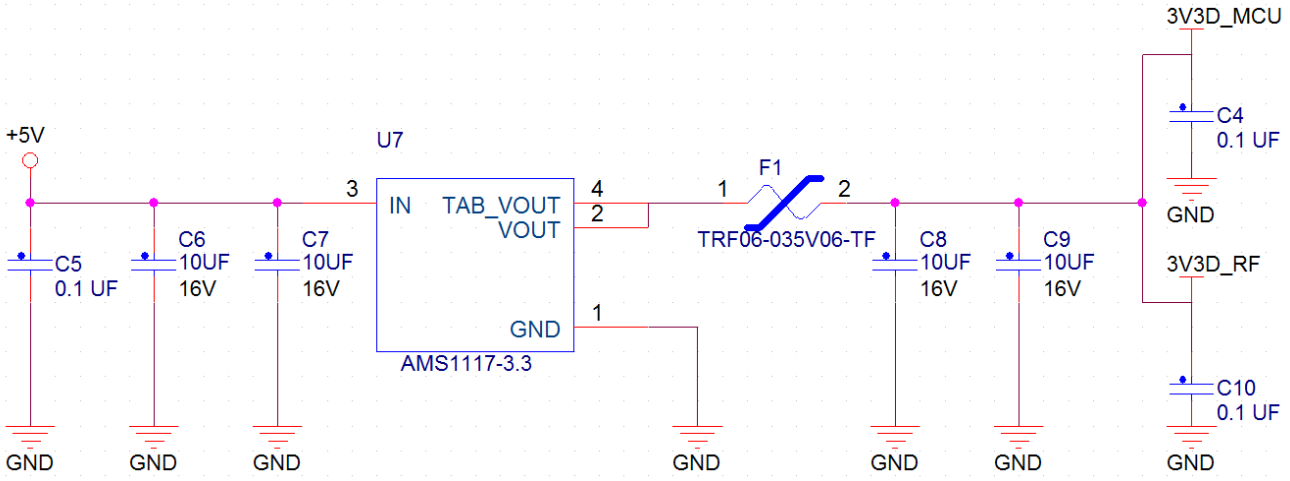

Figure 3. System power supply

5.2 System clock

KM14 uses an external Seiko +/-20 ppm 32.768 KHz crystal. The MCU will do frequency doubling by internal FLL. The system work clock is 48 MHz.

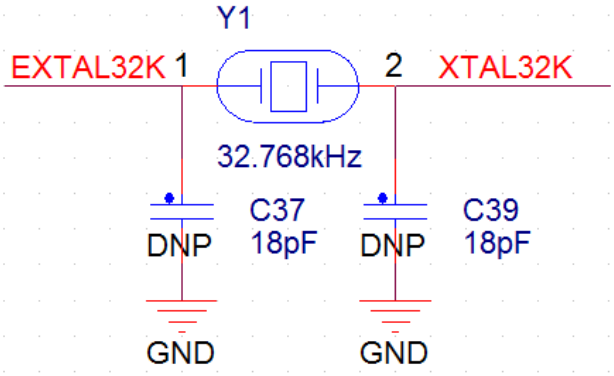

Figure 4. System clock

5.3 Debug interface

KM14 uses SWD as a debug interface and the customer can use Jlink or Multilink for development and debugging.

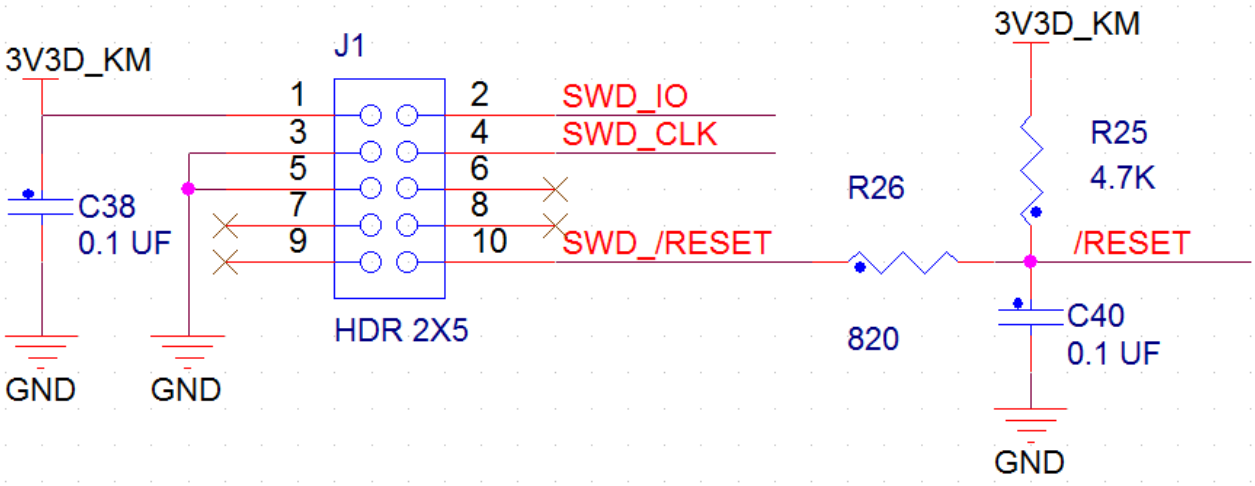

Figure 5. Debug Interface

5.4 Voltage sampling

Voltage sampling uses the AFE 24-bit ΣΔ ADC module. Signals of grid voltage will go through the voltage division resistor first and then enter into the ADC module.

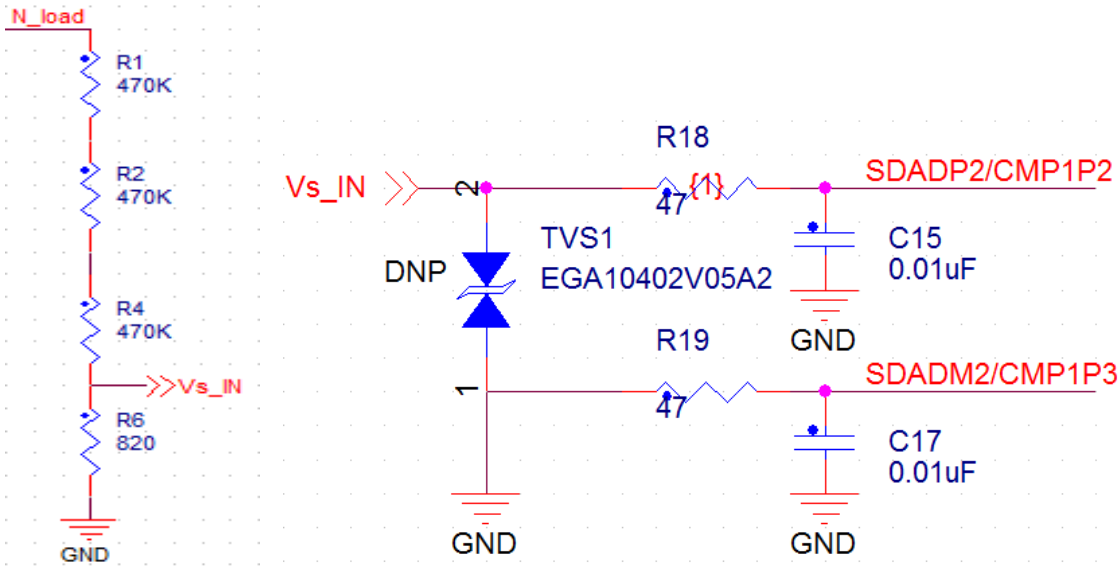

Figure 6. Voltage sampling

5.5 Current sampling

Current sampling uses AFE 24-bit ΣΔ ADC module. The load current goes through the sampling resistor and enters into the ADC module.

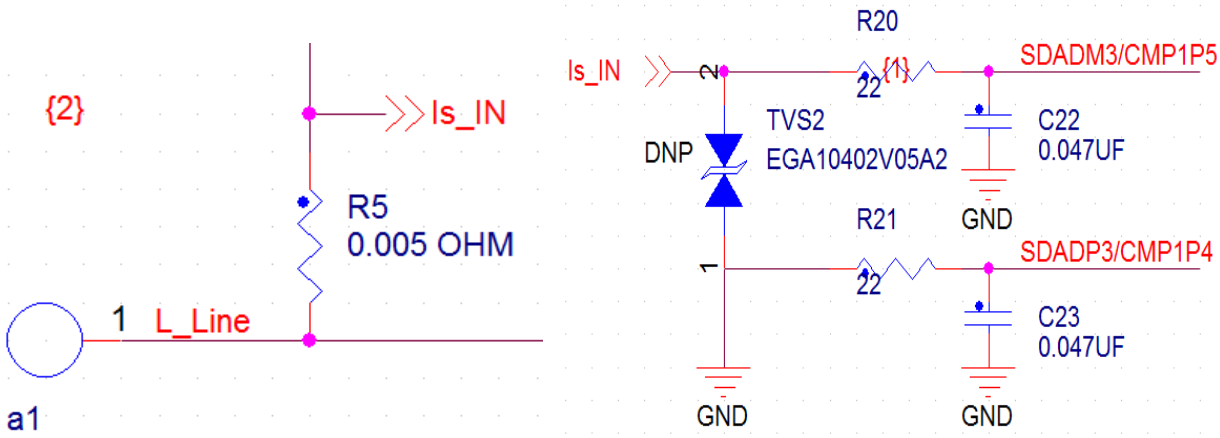

Figure 7. Current sampling

5.6 Grid frequency detection

The grid frequency is detected by the analog comparator in KM. The two inputs of the comparator are connected to L and the output signal of the AC divided voltage.

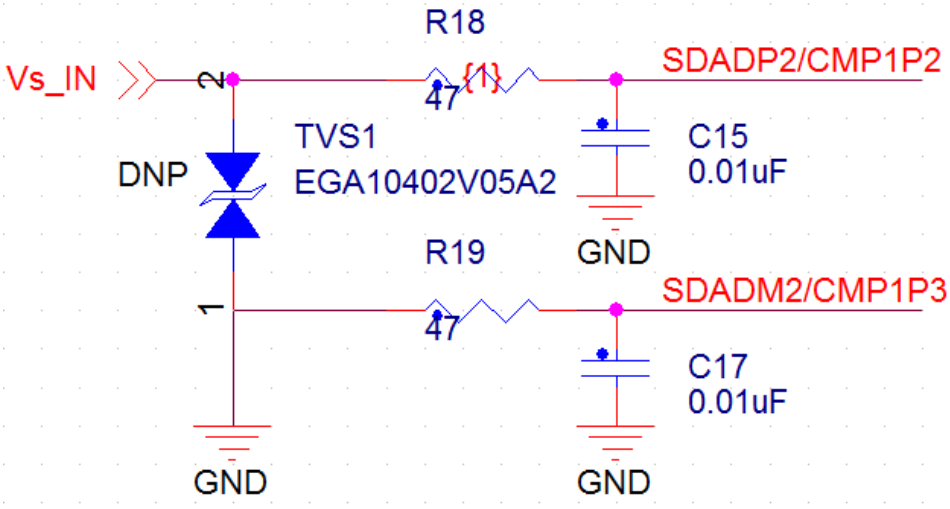

Figure 8. Grid frequency detection

5.7 External NVM

The system has an extensible extended 64 Mb SPI Flash. The actual capacity can be decided by customer application.

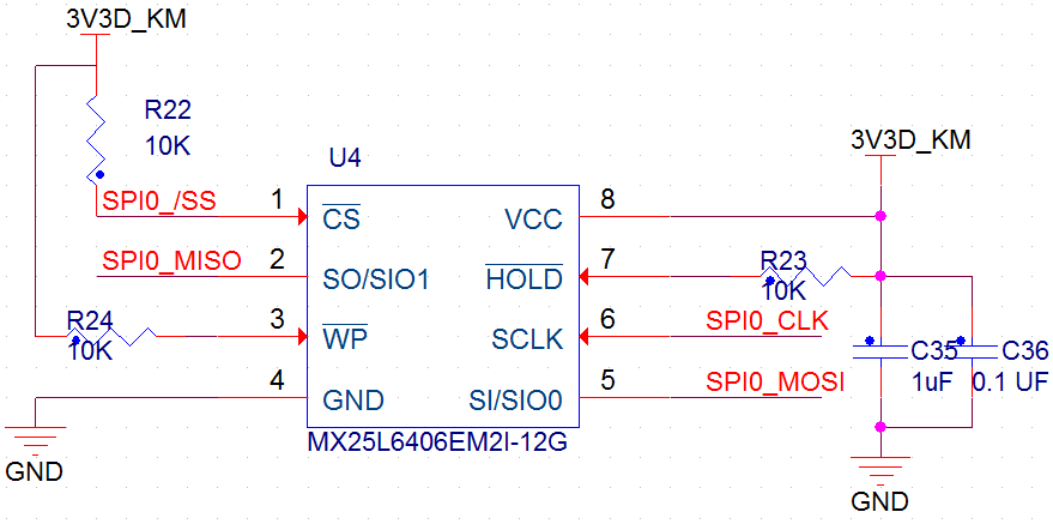

Figure 9. External NVM

5.8 Light pulse

The system has 3-channel light pulse for precision calibration, second pulse, and status indicator.

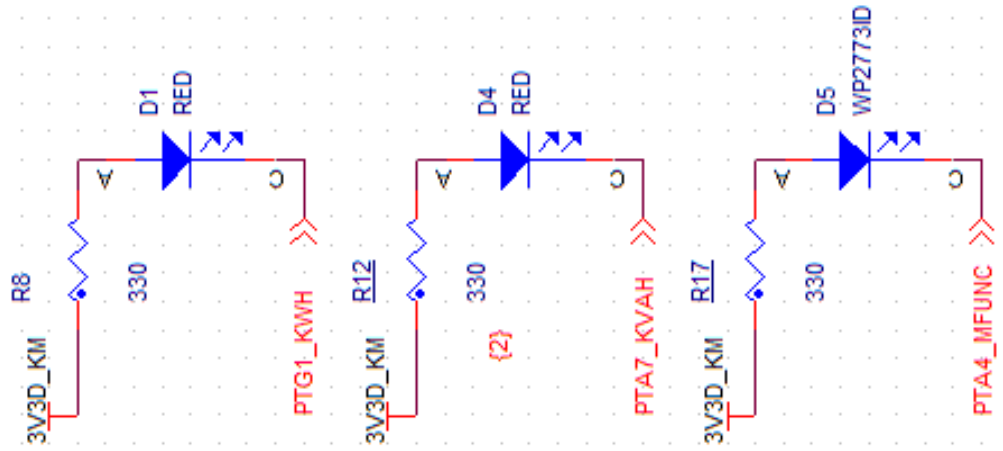

Figure 10. Light pulse

5.9 Communication interface

The system uses UART as an interface to communicate with the Wi-Fi module and also provides the required power, interrupt, and control signal.

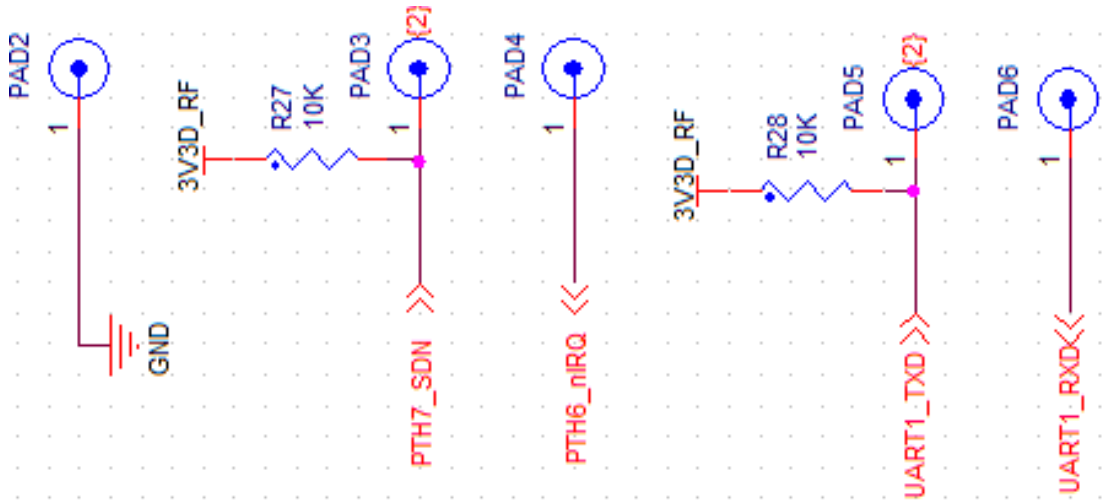

Figure 11. Communication interface

5.10 Communication module

The communication module of this reference design uses the Qualcomm QCA4002 and the K22F MCU, with AllJoyn, and the customer can also select their own communication module as per their design.

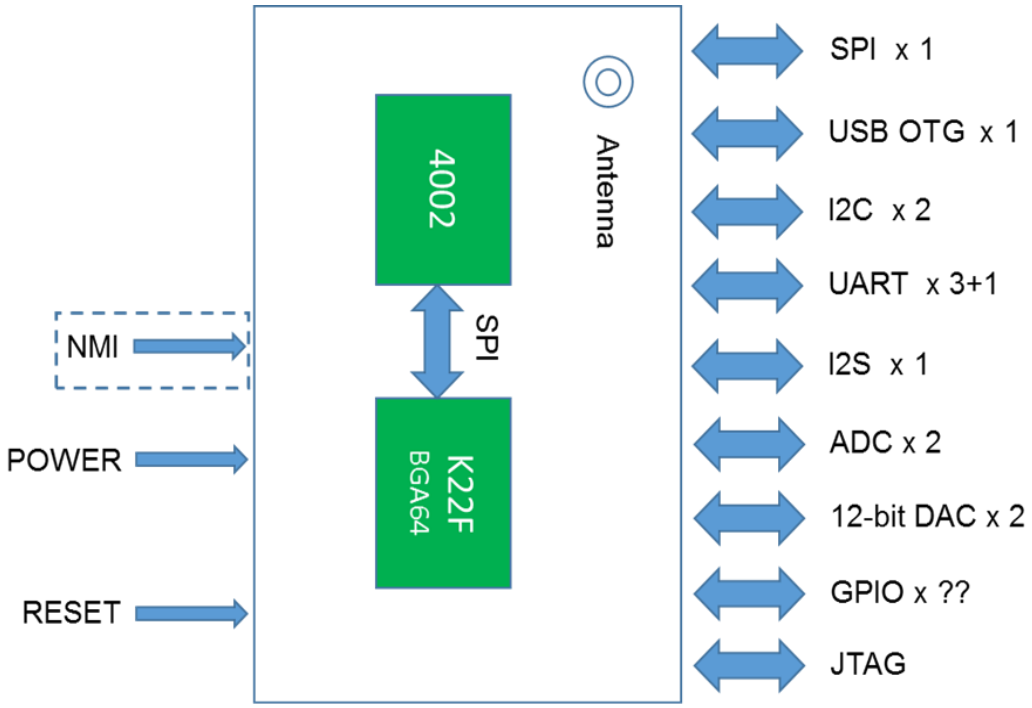

Figure 12. Communication module

6 Revision history

Table 1. Revision history

Revision number	Date	Substantive changes
0	03/2017	Initial release

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