Freescale Semiconductor
User's Guide

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FRDM-KL03Z User's Guide

1 Overview

The Freescale Freedom development platform is an evaluation and development tool ideal for rapid prototyping of microcontroller-based applications. The hardware design is form-factor compatible with popular third-party hardware designed to work with Arduino™ and Arduino-compatible boards.

The Freescale KL03Z freedom board (FRDM-KL03Z) is a simple, yet sophisticated design featuring a Kinetis L Series microcontroller KL03Z, a 3.3 V microcontroller built on the ARM® Cortex™-M0+ core.

The Kinetis L series is the most scalable portfolio of low-power, high-robustness, mixed signal 32-bit ARM Cortex-M0+ MCUs running up to 48 MHz in the industry. It supports power supply voltage range from 1.71 V to 3.6 V, ambient operating temperature ranges from –40C to 105C and includes up to 64 KB flash.

The FRDM-KL03Z includes the Freescale open standard embedded serial and debug adapter known as OpenSDA.

Contents

This circuit offers the user several options for serial communications, flash programming, and run-control debugging.

There are also many software development tool options available to the user. Choices include Kinetis Design Studio (KDS), IAR Embedded Workbench, Keil MDK featuring the µVision IDE, etc.

All of these features combine to give the user the freedoms needed to rapidly prototype many embedded designs: a powerful microcontroller built on a very low-power core and SoC platform, easy-access to I/O with a large ecosystem of compatible hardware, a flexible programming and debug interface, and a large ecosystem of software development environments. Freedom!

2 Reference documents

OpenSDA User's Guide	A guide for users of the OpenSDA embedded circuit
KL03 Sub-Family Reference Manual	A reference manual for KL03 sub-family devices
Arduino Overview	A guide to the Arduino platform
Arduino Uno	A guide to the Arduino Uno revision

3 Getting started

Refer to the FRDM-KL03Z *Quick Start Package* for step-by-step instructions for getting started with the freedom board. See the "Jump Start Your Design" section on http://www.freescale.com/FRDM-KL03Z for the Quick Start Package and software lab guides.

4 FRDM-KL03Z hardware overview

The FRDM-KL03Z hardware is a Freescale Freedom development platform microcontroller board assembled with the following features:

- Kinetis L Series KL03 family MCU MKL03Z32VFK4 in a 24 QFN package
- On-board serial and debug adapter (OpenSDA)
- I/O headers for easy access to MCU I/O pins
- Freescale inertial sensor MMA8451Q
- Capacitive touch slider
- Reset push button
- RGB LED
- Infrared communication
- Motor control header for simple BLDC motor control on APMOTOR56F8000E

Figure 1 shows a block diagram of the FRDM-KL03Z board.

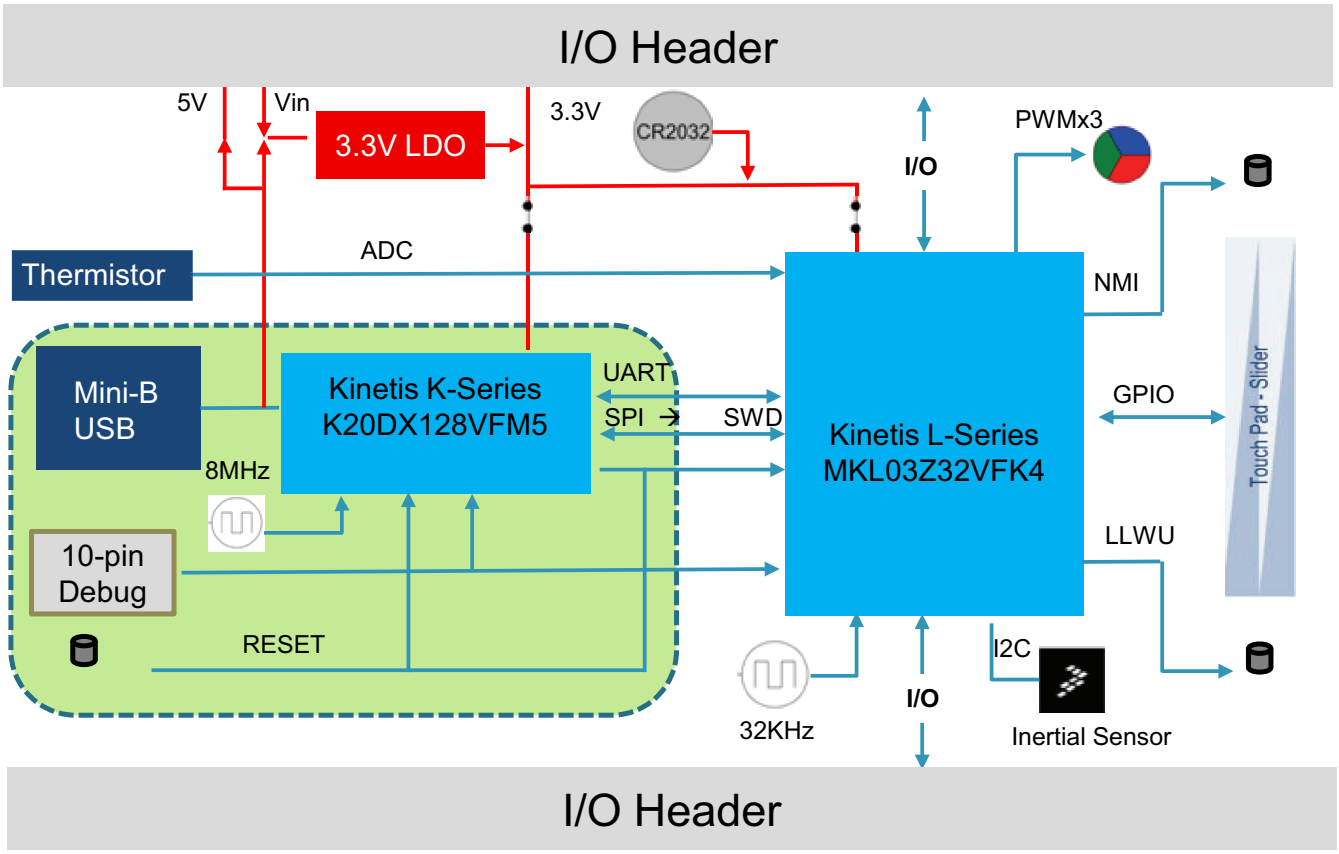

Figure 1. FRDM-KL03Z block diagram

The FRDM-KL03Z features two microcontrollers (MCUs): the target MCU and a serial and debug adapter (OpenSDA) MCU. The target MCU is a Kinetis L Series KL03 family device, the KL03Z32VFK4. The OpenSDA MCU is a Kinetis K Series K20 family device, the K20DX128VFM5.

Features of the KL03Z32VFK4 target MCU include:

- 32-bit ARM Cortex-M0+ core
  - Up to 48 MHz operation
  - Single-cycle fast I/O access port
- Memories
  - 32 KB flash
  - 2 KB SRAM
  - 8 KB ROM with build-in bootloader
  - 16-byte regfile
- System integration
  - Nine low-power modes to provide power optimization based on application requirements
  - COP Software watchdog
  - Low-leakage wakeup unit
  - SWD debug interface and Micro Trace Buffer

  - Bit manipulation engine (BME) for read-modify-write peripheral operations
- Clocks
  - 48 MHz high accuracy internal reference clock
  - 8/2 MHz low power internal reference clock
  - 32 kHz to 40 kHz crystal oscillator
  - 1 kHz LPO clock
- Analog peripherals
  - 12-bit SAR ADC with internal voltage reference, up to 7 channels
  - High-speed analog comparator containing a 6-bit DAC and programmable reference input
  - 1.2 V voltage reference (Vref)
- Communication peripherals
  - one 8-bit Serial Peripheral Interface (SPI)
  - one I2C module
  - one UART module
- Timers
  - two 2-channel Timer/PWM modules
  - one Low-Power Timer (LPTMR)
  - Real time clock (RTC)
  - System tick timer
  - One watchdog module
- Security
  - 80-bit unique identification number per chip
- Human-Machine Interfaces (HMI)
  - General purpose input/output up to 22
  - GPIO interrupt
  - external input pin for LLWU in LLS and VLLSx mode

5 FRDM-KL03Z hardware description

5.1 Power supply

The FRDM-KL03Z offers a design with multiple power supply options. It can be powered from the USB connector, the VIN pin on the I/O header, an off-board 1.71–3.6 V supply from the 3.3 V pin on the I/O header or 3.3 V from motor control header. The USB and VIN supplies are regulated on-board using a 3.3 V linear regulator to produce the main power supply. The other two sources are not regulated on-board. Figure 2 shows the schematic drawing for the power supply inputs and the on-board voltage regulator.

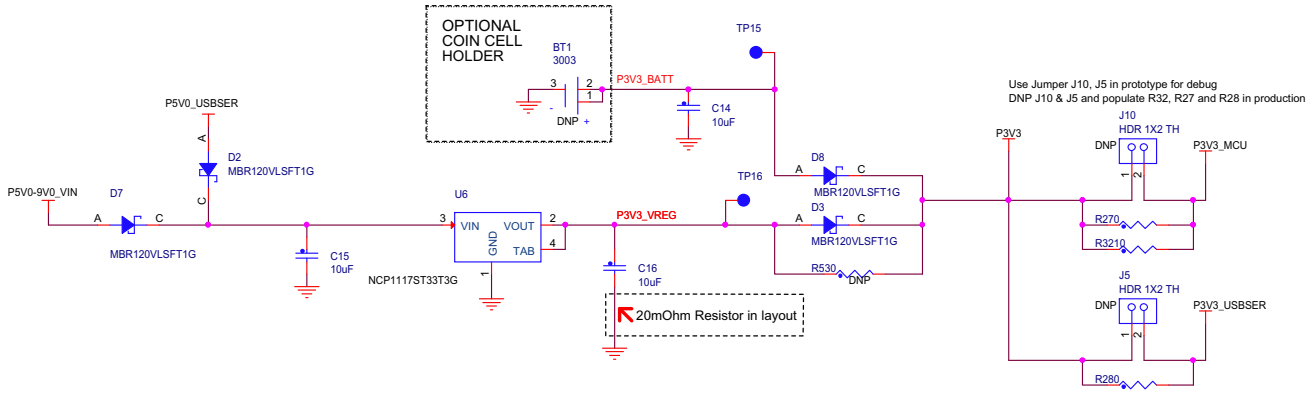

Figure 2. FRDM-KL03Z power supply

Table 1 provides the operational details and requirements for the power supplies.

Table 1. Power supply requirements

Supply Source	Valid Range	OpenSDA Operational?	Regulated on-board?
OpenSDA USB (J7)	5 V	Yes	Yes
P5V0–9V0_VIN Pin on I/O header	4.3–9 V	Yes	Yes
P3V3 Pin on I/O header	1.71–3.6 V	Yes	No

Note that the OpenSDA circuit is only operational when a USB cable is connected and supplying power to J9. However, the protection circuitry is in place to allow multiple sources to be powered at once.

Table 2. FRDM-KL03Z power supplies

Power supply name	Description
P5V0-9V0_VIN	Power supplied from the V_{IN} pin of the I/O headers (J3 pin 8).
P5V_USBSER	Power supplied from the OpenSDA USB connector (J9).
P3V3_VREG	Regulated 3.3 V supply. Sources power to the P3V3 supply rail through a back drive protection Schottky diode.
P3V3	Main supply rail for the FRDM-KL03Z. Can be sourced from P3V3_VREG.
P3V3_MCU	KL03Z MCU power supply. Header J10 provides a convenient means for KL03Z energy consumption measurements.
P3V3_USBSER	OpenSDA circuit power supply.

NOTE

J10 and J5 are not populated by default on the production version. The two pins of these headers are shorted together by 0 Ω resistor R27 and R28 on the PCB. To measure the energy consumption of either the KL03Z or the OpenSDA MCU, the 0 Ω resistor between these pins must first be cut. A current probe or a shunt resistor and voltage meter can then be applied to measure the energy consumption on these rails. When the MCU current measurement is done with no further need, this 0 Ω resistor can be soldered on again.

5.2 Serial and Debug Adapter (OpenSDA)

OpenSDA is an open-standard serial and debug adapter. It bridges serial and debug communications between a USB host and an embedded target processor as shown in Figure 3. The hardware circuit is based on a Freescale Kinetis K20 family microcontroller (MCU) with 128 KB of embedded flash and an integrated USB controller. OpenSDA features a mass storage device (MSD) bootloader, which provides a quick and easy mechanism for loading different OpenSDA applications such as flash programmers, run-control debug interfaces, serial-to-USB converters, and more. Two or more OpenSDA applications can run simultaneously. For example, run-control debug application and serial-to-USB converter run in parallel to provide a virtual COM communication interface while allowing code debugging via OpenSDA with just a single USB connection. These two applications are provided in a single code package.

Refer to the *OpenSDA User's Guide* for more details.

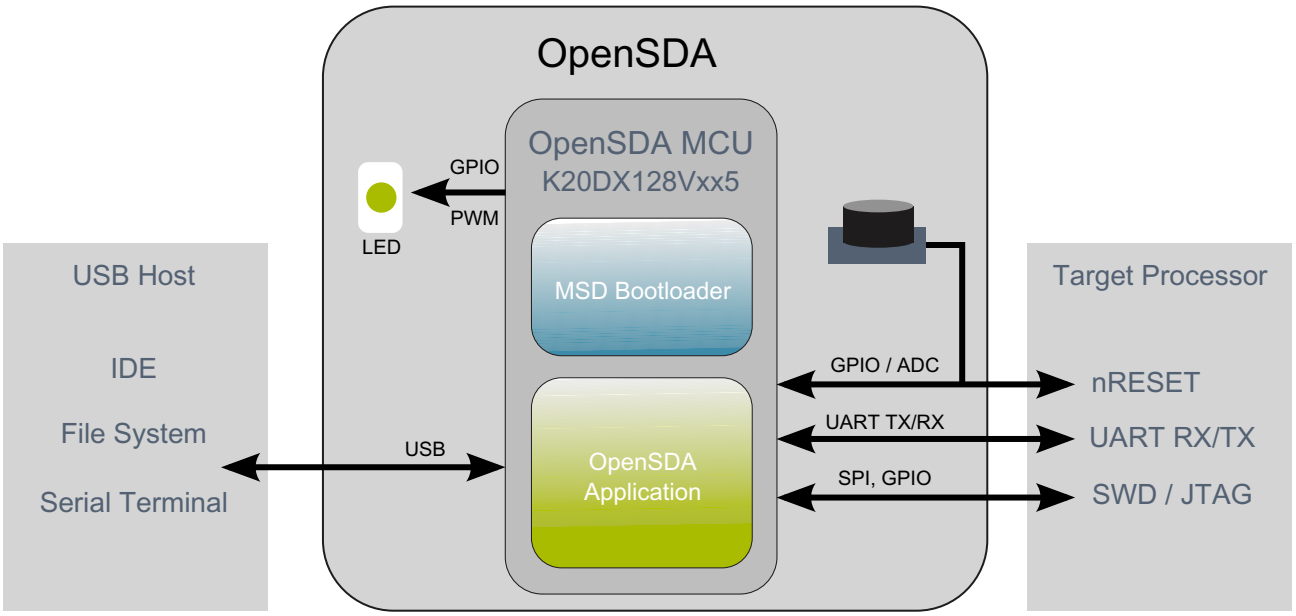

Figure 3. OpenSDA block diagram

OpenSDA is managed by a Kinetis K20 MCU built on the ARM® Cortex-M4 core. The OpenSDA circuit includes a status LED (D1) and a RESET push button (SW1). The push button asserts the Reset signal to the KL03Z target MCU. It can also be used to place the OpenSDA circuit into Bootloader mode by holding

down the RESET push button while plugging the USB cable into USB connector J9. Once the OpenSDA enters Bootloader mode, other OpenSDA applications such as a debug application can be programmed.

SPI and GPIO signals provide an interface to the SWD debug port of the KL03Z. Additionally, signal connections are available to implement a UART serial channel. The OpenSDA circuit receives power when the USB connector J9 is plugged into a USB host.

5.2.1 Debugging interface

Signals with SPI and GPIO capability are used to connect directly to the SWD of the KL03Z. These signals are also brought out to a standard 10-pin (0.05”) Cortex Debug connector (J7) as shown in Figure 4. It is possible to isolate the KL03Z MCU from the OpenSDA circuit and use J7 to connect to an off-board MCU. To accomplish this, cut the trace between pin1 and pin2 of J6 on the bottom layer. This will disconnect the SWD_CLK pin to the KL03Z so that it will not interfere with the communications to an off-board MCU connected to J7.

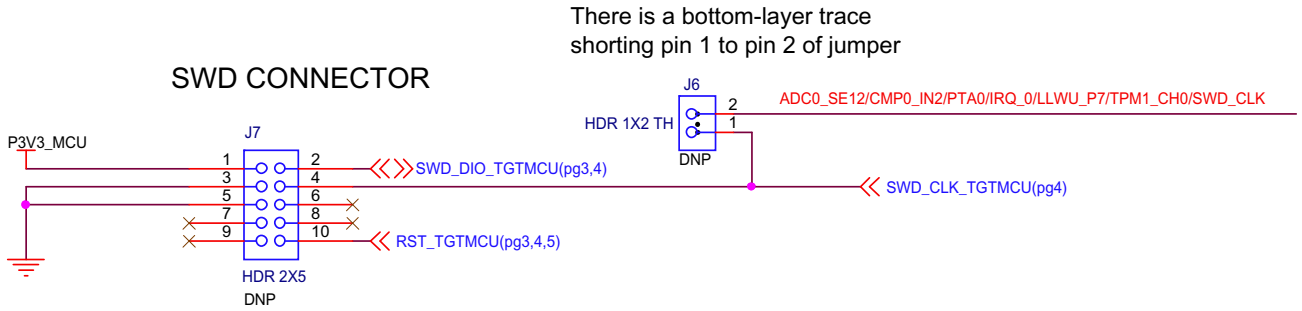

Figure 4. SWD debug connector to KL03Z

5.2.2 Virtual serial port

A serial port connection is available between the OpenSDA MCU and LPUART0 pin PTB1(TXD) and PTB2 (RXD) of KL03Z. Several of the default OpenSDA applications provided by Freescale, including the MSD Flash Programmer and the P&E Debug Application, provide a USB Communications Device Class (CDC) interface that bridges serial communications between the USB host and this serial interface on the KL03Z.

PTB2 is a multiplex pin with VREF_CAP and LPUART0, furthermore PTB2 is configured to manage the LPUART0_RX function under ROM Bootloader mode. There is one 0.1 µF capacitor C35 on the PTB2 pin for VREF stability. We recommend using a maximum baud rate of 38400 bps. If the baud rate increases, C35 should be removed.

5.3 Clock source

The Kinetis KL03 microcontrollers feature an on-chip oscillator compatible with low ranges of input crystal or resonator frequencies: 32 KHz to 40 KHz (low frequency mode).

The KL03Z on the FRDM-KL03Z is clocked from a 32,768 Hz crystal.

5.4 Serial port

The serial port interface signals used with OpenSDA are UART0 pin PTB1 (TXD) and PTB2 (RXD). These signals are also connected to I/O header J1.

5.5 Reset

The RESET signal on the KL03Z is connected externally to a push button, SW1. The reset button can be used to force an external reset event in the target MCU. The reset button can also be used to force the OpenSDA circuit into bootloader mode when plugging the USB cable to J9. Please refer to Section 5.2, "Serial and Debug Adapter (OpenSDA)" for more details.

5.6 Debug

The sole debug interface on all Kinetis L Series devices is a Serial Wire Debug (SWD) port. The primary controller of this interface on the FRDM-KL03Z is the onboard OpenSDA circuit. However, a 2×5-pin (0.05") Cortex Debug connector, J7, provides access to the SWD signals for the KL03Z MCU. Table 3 shows SWD connector signal descriptions for KL03Z.

Table 3. ARM JTAG/SWD mini connector description

Pin	Function	Connection to KL03Z
1	VTref	P3V3_MCU
2	SWDIO/TMS	PTA2
3	GND	GND
4	SWDCLK/TCK	PTA0
5	GND	GND
6	SWO/TDO	NC
7	NC	NC
8	TDI	NC
9	NC	NC
10	RESET	PTA1

5.7 Capacitive touch slider

Two GPIO pins functioning as Touch Sense Input (TSI) signals are connected to capacitive electrodes configured as a touch slider, as shown in Figure 5.

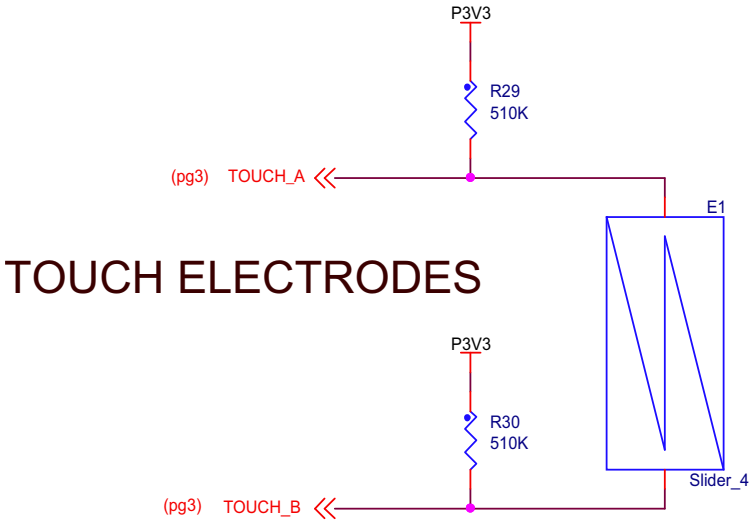

Figure 5. Touch slider connection

5.8 3-axis accelerometer

A Freescale MMA8451Q low-power, three-axis accelerometer is interfaced through an I^2C bus and two GPIO signals as shown in Table 4. By default, the I^2C address is 0x1D (SA0 pulled high).

Table 4. Accelerometer signal connections

MMA8451Q	KL03Z
SCL	PTB3
SDA	PTB4
INT1	—
INT2	PTA12

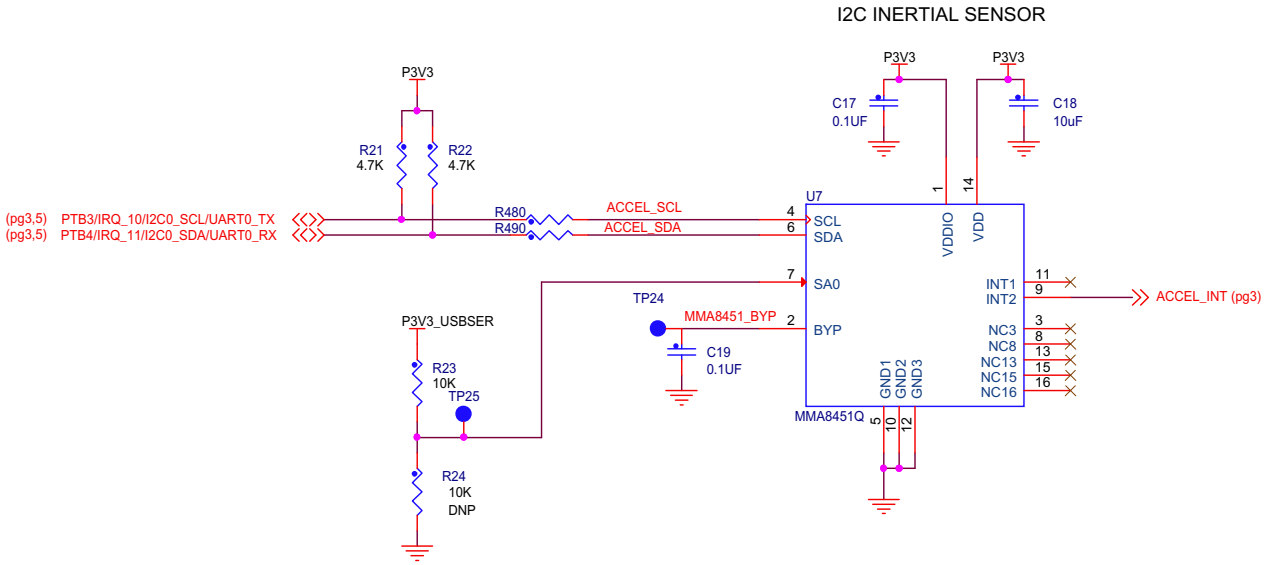

Figure 6. Accelerometer connection

5.9 RGB LED

Three PWM-capable KL03Z signals are connected to a red-green-blue LED. The signal connections are shown in Table 5.

Table 5. RGB LED signal connections

RGB LED	KL03Z
Red cathode	PTB10/TPM0_CH1/SPI0_SS_b
Green cathode	PTB11/TPM0_CH0/SPI0_MISO
Blue cathode	PTB13/CLKOUT32K/TPM1_CH1/RTC_CLKOUT

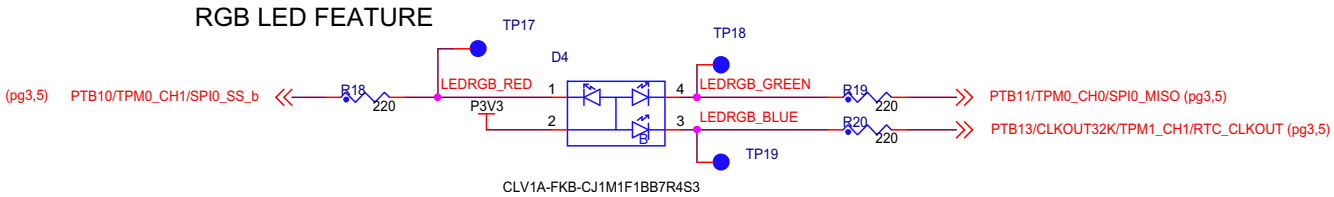

Figure 7. RGB LED connection

5.10 Input/output headers

The MKL03Z32VFK4 microcontroller is packaged in a 24-pin QFN. Some pins are utilized in on-board circuitry, but many are directly connected to one of four I/O headers (J1, J2, J3, and J4).

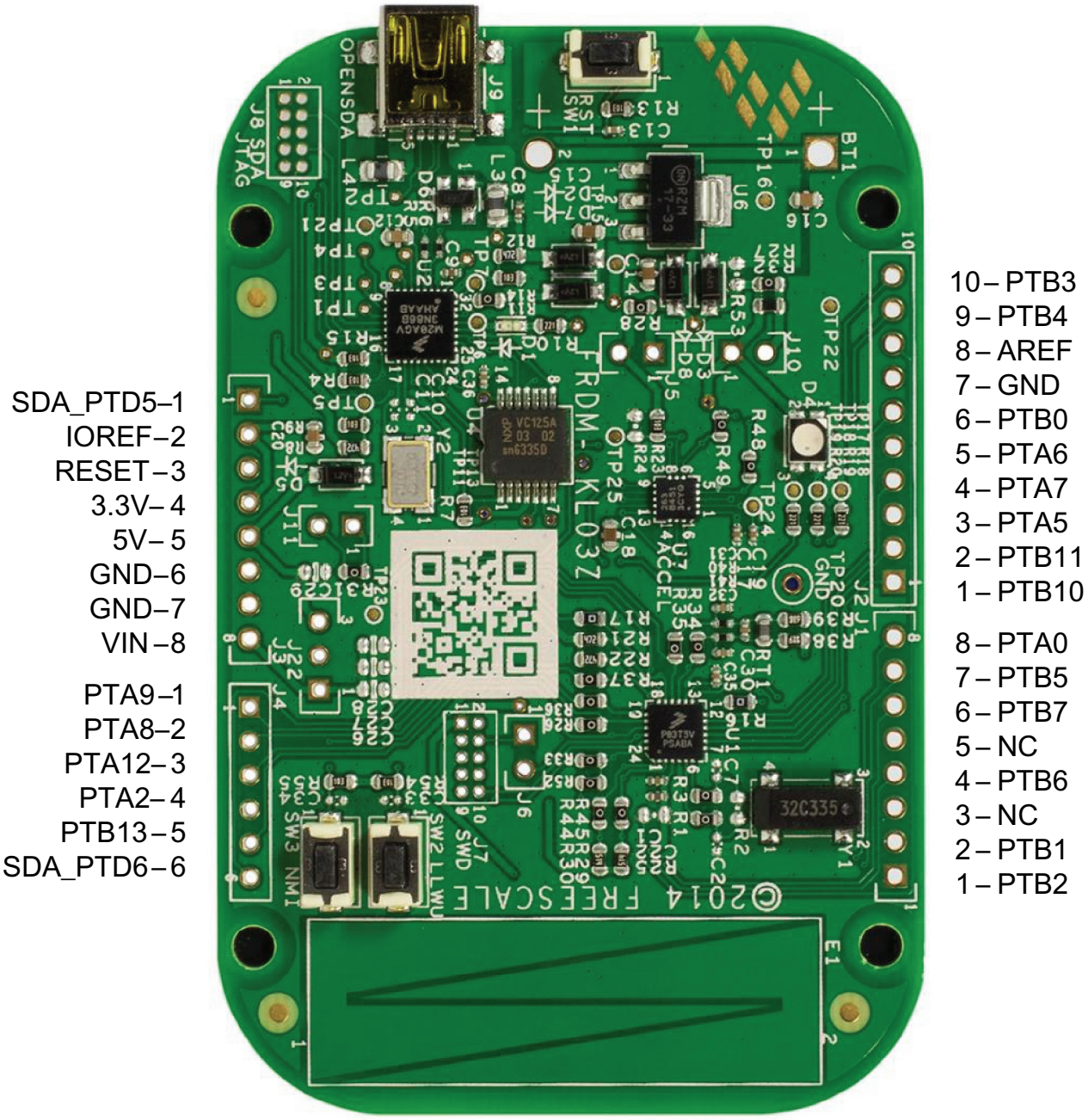

Figure 8. I/O headers

5.11 Arduino compatibility

The I/O headers on the FRDM-KL03Z are arranged to allow compatibility with peripheral boards (known as shields) that connect to Arduino and Arduino-compatible microcontroller boards. The pins on the

headers share the same mechanical spacing and placement as the I/O headers on the Arduino Uno Revision 3 board design. See Figure 8 for compatible signals.

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