Freescale Semiconductor, Inc.
User's Guide

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Freedom FRDM-KV10Z Development Board User's Guide

1. Introduction

The Freedom development board is a set of software and hardware tools for evaluation and development. It is ideal for rapid prototyping of microcontroller-based applications. The Freedom KV10 hardware, FRDM-KV10Z, is a simple, yet sophisticated design featuring a Kinetis V series microcontroller, built on the ARM® Cortex®-M0+ core, and a perfect solution for BLDC and PMSM motor control applications.

FRDM-KV10Z can be used to evaluate the KV1x Kinetis V series devices. It is based on the MKV10Z32VLF7 microcontroller, running up to 75MHz with hardware square root and divide capability and featuring dual 16-bit analog-to-digital controllers (ADCs) sampling at up to 1.2 mega samples per second (MS/s) in 12-bit mode, multiple motor control timers, 32KB of flash and 8KB of RAM memories. It is supported by a comprehensive enablement suite from NXP and its third-party resources including reference designs, software libraries, and motor configuration tools. The FRDM-KV10Z hardware is form-factor compatible with the Arduino® R3 pin layout, providing a broad range of expansion board options. Board embeds a 6-axis digital sensor, combining accelerometer and magnetometer, an analog thermistor, a RGB LED and two user push-buttons. The FRDM-KV10Z platform includes the OpenSDAv2.1, the NXP open-source hardware for embedded serial and debug adapter, programmed with an open-source bootloader. This circuit offers several options for serial

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communication, flash programming, and run-control debugging. OpenSDAv2.1 is an mbed HDK-compatible debug interface preloaded with the open-source CMSIS-DAP Interface firmware (mbed interface) for rapid prototyping and product development.

2. FRDM-KV10Z Hardware Overview

The features of the FRDM-KV10Z hardware are as follows:

- MKV10Z32VLF7 MCU (75 MHz with hardware square root and divide, 32 KB flash and 8 KB RAM memory, dual 16-bit ADCs and motor control timers, 48 LQFP package)
- Dual-role USB interface with micro-B USB connector
- RGB LED
- FXOS8700CQ – Accelerometer and magnetometer
- Two user push buttons
- Flexible power supply option – OpenSDAv2.1 USB, and Arduino header and 5 V power input
- Easy access to MCU I/Os through Arduino R3-compatible and proprietary headers
- Programmable OpenSDAv2.1 debug circuit programmed with the CMSIS-DAP Interface application that provides:
    - Mass storage device (MSD) flash programming, over a driver free USB connection.
    - CMSIS-DAP debug interface providing run-control debugging for ARM® IDE toolchains.
    - Virtual serial port interface.

The following figure shows the block diagram of the FRDM-KV10Z design.

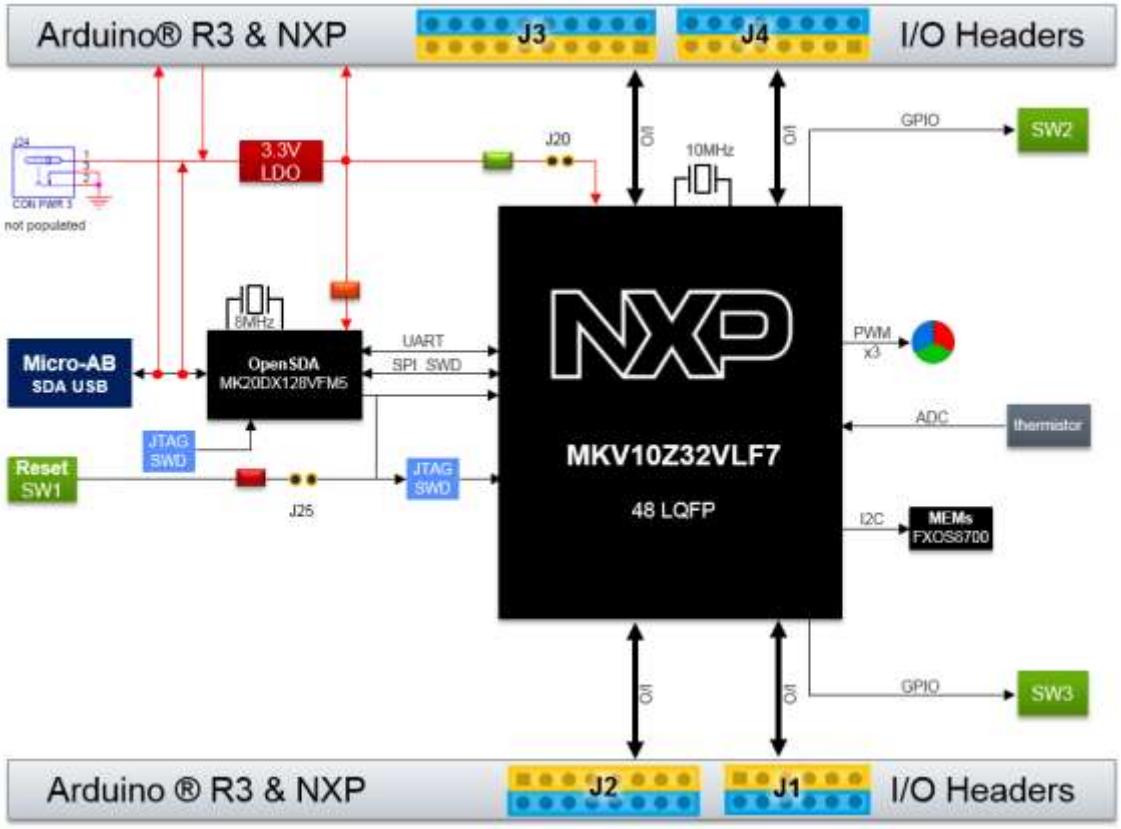

Figure 1. FRDM-KV10Z block diagram

The primary components and their placement on the hardware assembly are explained in the below figure.

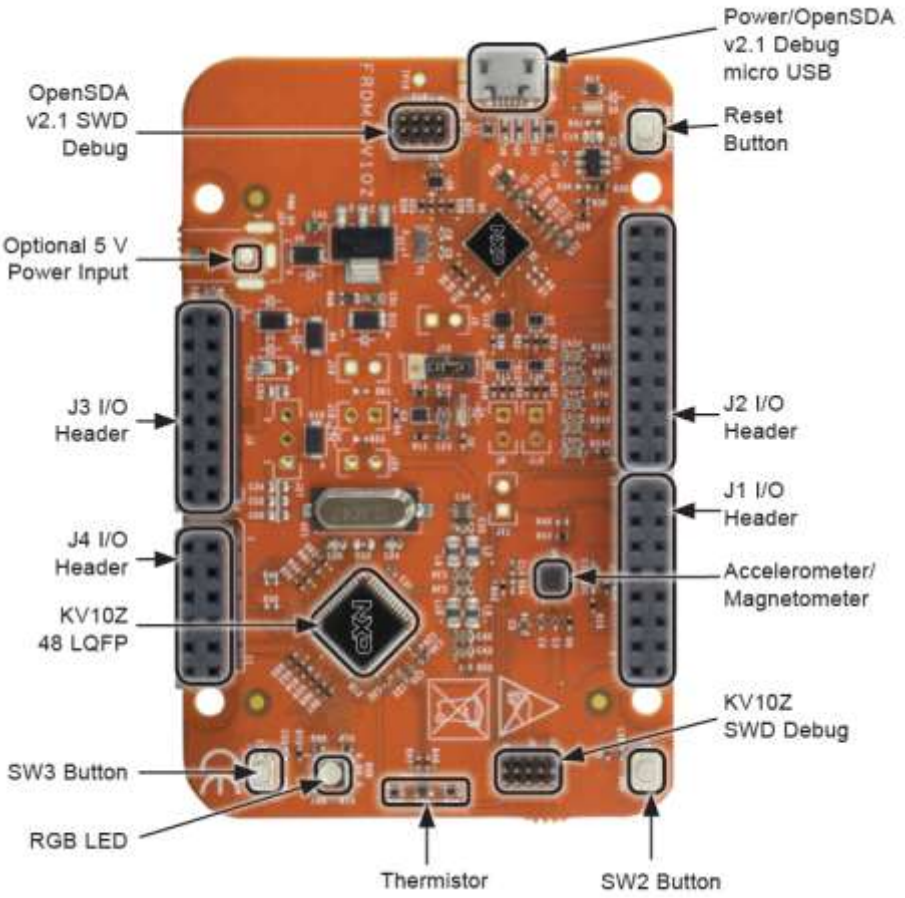

Figure 2. FRDM-KV10Z callout

3. FRDM-KV10Z Hardware Description

3.1. Power supply

There are multiple power supply options on the FRDM-KV10Z. It can be powered from either of the USB connectors, the V_{IN} pin on the J3 header, the DC Jack (not populated), or an off-board 1.71 V–3.6 V supply from the 3.3 V pin on the I/O header. The USB, DC jack, and V_{IN} supplies are regulated onboard using a 3.3 V DC-to-DC linear regulator to produce the main power supply. The voltage of the J20 header input is not regulated and will provide direct power-supply to the KV10Z microcontroller. The table below provides the operational details and requirements for the power supplies.

Table 1. **FRDM-KV10Z Power supply requirements**

Supply source	Valid range	OpenSDAv2.1 operational	Regulated onboard
OpenSDAv2.1 USB	5 V	Yes	Yes
VIN Pin	5 – 9 V	No	Yes
3.3 V Header (J20)	1.71 V – 3.6 V	No	No

DC Jack (not populated)	5 – 9 V	No	Yes

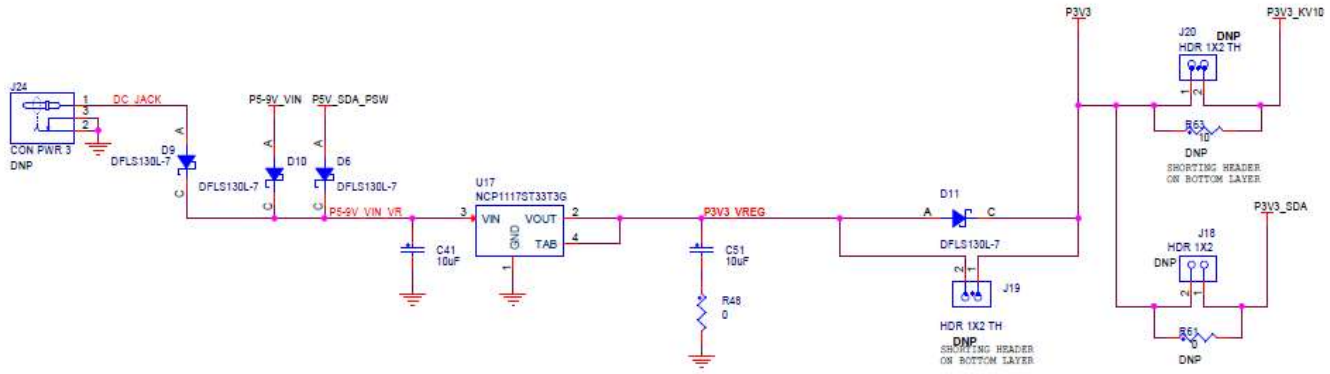

Figure 3. Power supply schematic

3.2. Serial and debug adapter (OpenSDAv2.1)

An on-board K20DX128VFM5-based OpenSDAv2.1 circuit provides a SWD debug interface to the MKV10Z32VLF7 target MCU. A standard USB A male to micro-B male cable (provided) can be used for debugging via the USB connector (J6).

The OpenSDAv2.1 interface also provides a USB to serial bridge. OpenSDAv2.1 comes preloaded with the ARM CMSIS-DAP Bootloader, an open-source mass storage device (MSD) bootloader and the CMSIS-DAP Interface application (alias mbed interface), which provides a MSD flash programming, a virtual serial port and a CMSIS-DAP debug protocol interfaces. More information about the OpenSDAv2.1 firmware available for the FRDM-KV10Z board can be found online at www.nxp.com/opensda.

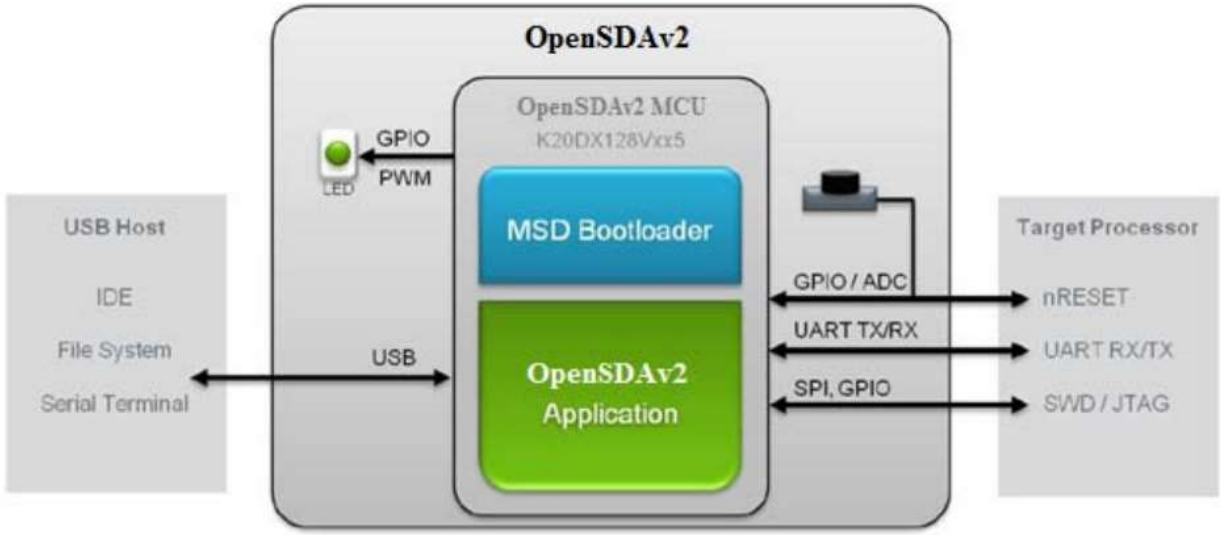

Figure 4. OpenSDA high-level block diagram

3.2.1. Debug interface

The embedded OpenSDAv2.1 circuitry has the ability to program an off-board MCU. The SPI and GPIO signals connected to the SWD port of the KV10Z MCU are brought out to a standard 10-pin (0.05") Cortex debug connector (J9). KV10Z pin SWD_CLK must be first isolated from the OpenSDAv2.1 MCU, by cutting the trace on the back side of the PCB, connecting J11-2 to J9-4, to avoid interferences with the off-board MCU.

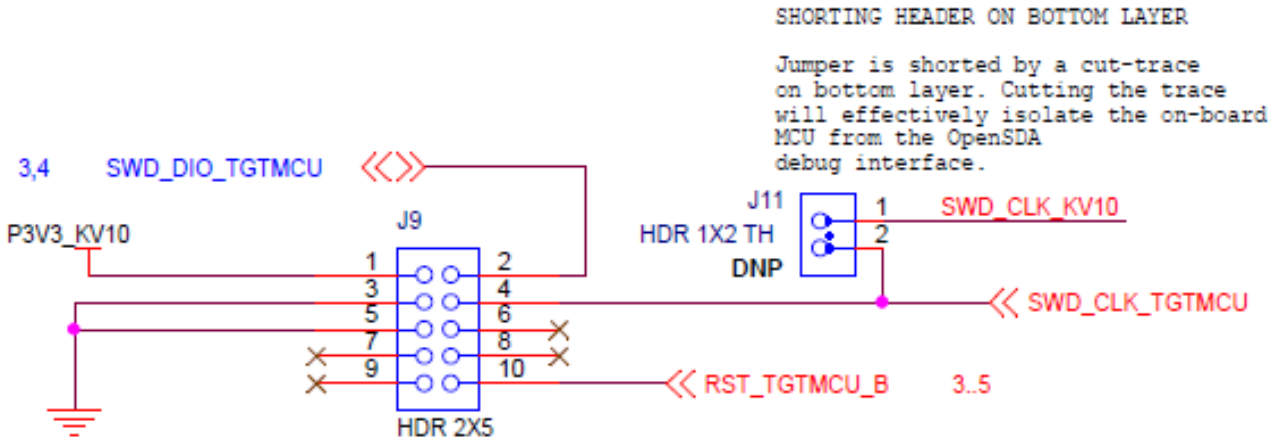

Figure 5. SWD debug connector

J9 is populated by default. A mating cable, such as a Samtec FFSD IDC cable, can then be used to connect the OpenSDAv2.1 of the FRDM-KV10Z to an off-board SWD connector.

3.2.2. Virtual serial port

A serial port connection is available between the OpenSDAv2.1 MCU and pins PTB16 and PTB17 of the KV10Z MCU.

4. Microcontroller

The FRDM-KV10Z features the MKV10Z32VLF7 MCU. The KV10Z MCU family is a highly scalable member of the Kinetis V series and provides a high-performance, cost-competitive motor control solution. Built on the ARM® Cortex®-M0+ core running at 75 MHz, with hardware square root and divide capabilities, this is implemented in the 48-pin LQFP package. The following table describes some of the features of the MKV10Z32VLF7 MCU.

Table 2. **Features of MKV10Z32VLF7**

Feature	Description
Performance	• 75 MHz ARM Cortex-M0+ core withhardware and divide hardblock • Dual 16-bit ADCs sampling at up to 1.2 MS/s in 12-bit mode. • 10 channels of highly flexible motor control timers (PWMs) across 4

	independent time bases.
Memories and memory interfaces	• 32 KB of flash and 8 KB of RAM embedded memory.
System peripherals	• Flexible low-power modes, multiple wake-up sources. • 4-channel DMA controller. • Independent external and software watchdog monitor.
Clocks	• 32 to 40 kHz or 3 to 32 MHz crystal oscillator. • Multipurpose clock generator with FLL.
Security and integrity modules	• Hardware CRC module. • 80-bit unique identification (ID) number per chip. • Flash access control to protect proprietary software.
Analog modules	• Two 16-bit SAR ADCs (1.2 MS/s in 12-bit mode). • One 12-bit DAC. • Two analog comparators (CMP) with a 6-bit DAC •
Timers	• One 8-ch motor-control/general purpose/PWM timers. • Two 2-ch motor-control/general purpose timers with quadrature decoder functionality. • Periodic interrupt timers. • 16-bit low-power timer. • Programmable delay block.
Communication interfaces	• One SPI module. • Two UART module~~s.~~ • One I2C: Support for up to 1 Mbit/s operation •

5. Clock source

A 10 MHz external crystal is used for the external clock source of the KV10Z MCU.

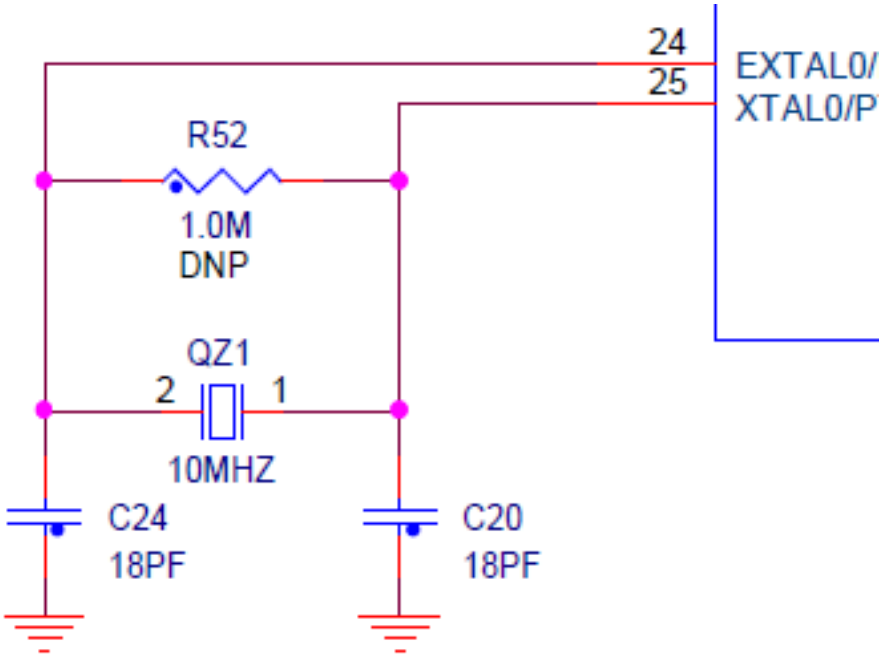

Figure 6. Clock source

6. Accelerometer and magnetometer

An FXOS8700CQ, 6-axis accelerometer and magnetometer sensor is interfaced through an I2C bus and two GPIO signals, as shown in the following table. By default, the I2C address is 0x1D (SA0 pull-up and SA1 pull-down).

Table 3. **Accelerometer and magnetometer signals connections**

FXOS8700CQ	KV10Z Connection
SCL	CMP0_IN0/PTC6/LLWU_P10/SPI0_SOUT/PDB0_EXTRG/UART0_RX/I2C0_SCL
SDA	CMP0_IN1/PTC7/SPI0_SIN/UART0_TX/I2C0_SDA
INT1	ADC1_SE2/ADC1_DP2/PTB3/UART0_CTS_b/I2C0_SDA/FTM0_FLT0
INT2	ADC0_SE10/ADC1_SE10/ADC1_DM2/PTB2/I2C0_SCL/FTM0_FLT1/UART0_RTS_b/FTM0_FLT3

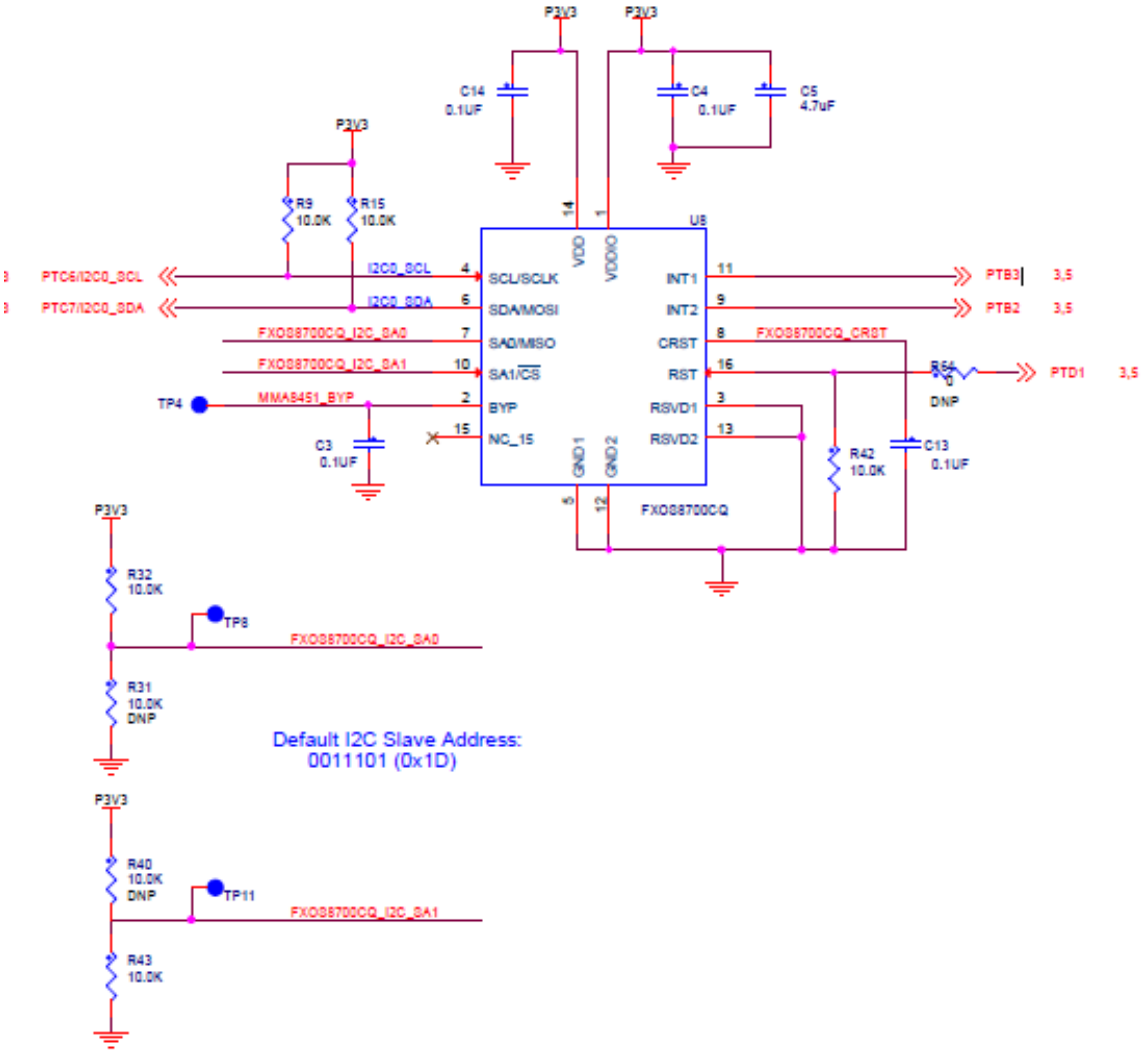

Figure 7. Accelerometer and magnetometer

7. Thermistor

There is a thermistor RT1 provided on the board that can be used as single-ended or differential analog inputs to the KV10Z MCU.

In addition to the thermistor, there is a resistor between the thermistor and 3.3 V system power supply and another resistor between the thermistor and ground. The thermistor is a 10 K ohm part, but the associated divider chain uses different resistors. This makes the voltage across the thermistor larger or smaller, and provides the ability to try the different gain settings on the analog channels. The thermistor circuit is designed to provide useable differential inputs over the temperature range of 90˚ C to -20˚ C.

In addition to the thermistor voltage divider chain, the thermistor has a 0.1 uF capacitor in parallel.

Each analog input to the KV10Z has a 100-ohm series resistor and a 2200 pF capacitor as a low-pass filter. This helps protect the KV10Z from electrostatic discharge, and lowers the impedance of the analog signal so that it can be sampled with less noise.

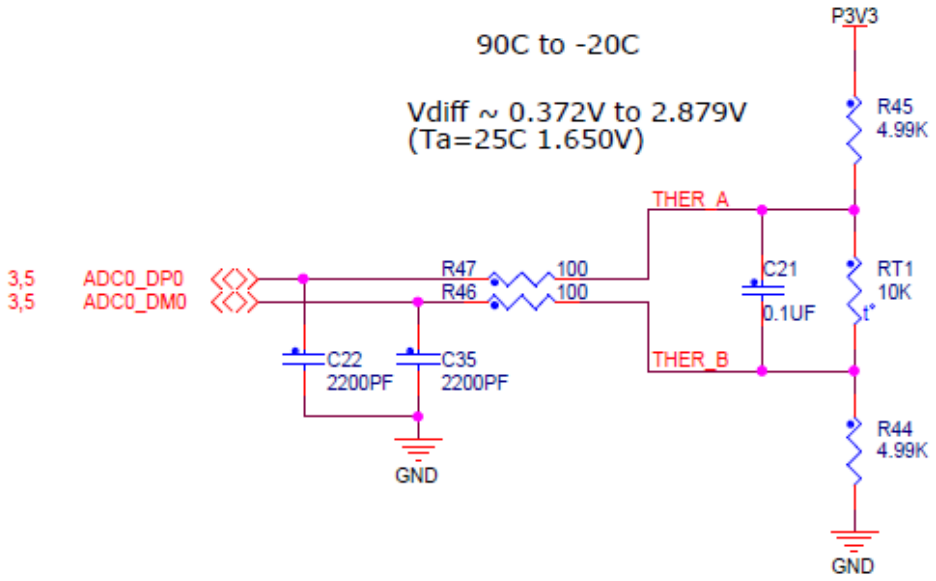

Figure 8. Thermistor

8. RGB LED

RGB LED is connected through GPIO, and signal connections are shown in the following table.

Table 4. **LED Signal connection**

RGB LED	KV10Z
RED	ADC1_SE6/PTD6/LLWU_P15/SPI0_PCS3/UART0_RX/FTM0_CH0/FTM1_CH0/FTM0_FLT0
BLUE	PTE25/FTM0_CH1/I2C0_SDA/EWM_IN
GREEN	CMP1_IN5/CMP0_IN5/PTE29/FTM0_CH2/FTM_CLKIN0

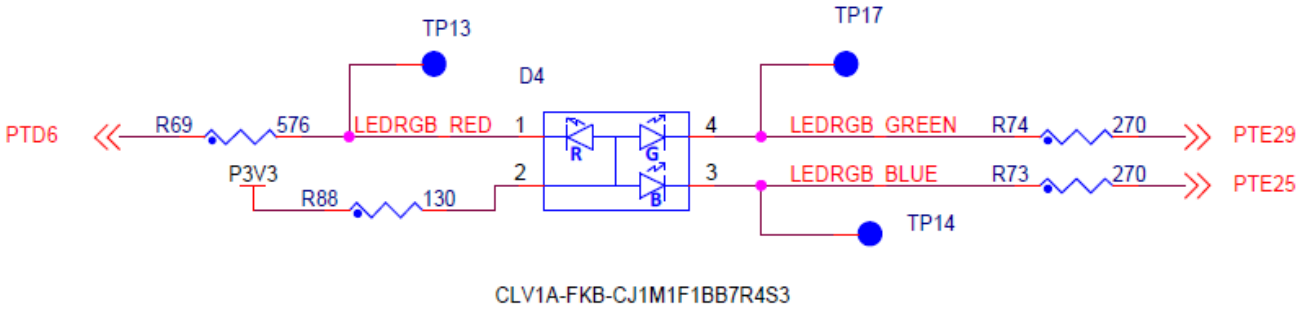

Figure 9. RGB LED

9. Serial Port

The primary serial port interface signals are PTB16 UART0_RX and PTB17 UART0_TX. These signals are connected to the OpenSDAv2.1 circuit.

10. Reset

The reset signal on the K20 is connected externally to a push button, SW1, and also to the OpenSDAv2.1 circuit. The reset button can be used to force an external reset event on the target MCU. The reset button can also be used to force the OpenSDAv2.1 circuit into bootloader mode. For more details, see Section 3.2, "Serial and debug adapter (OpenSDAv2.1)".

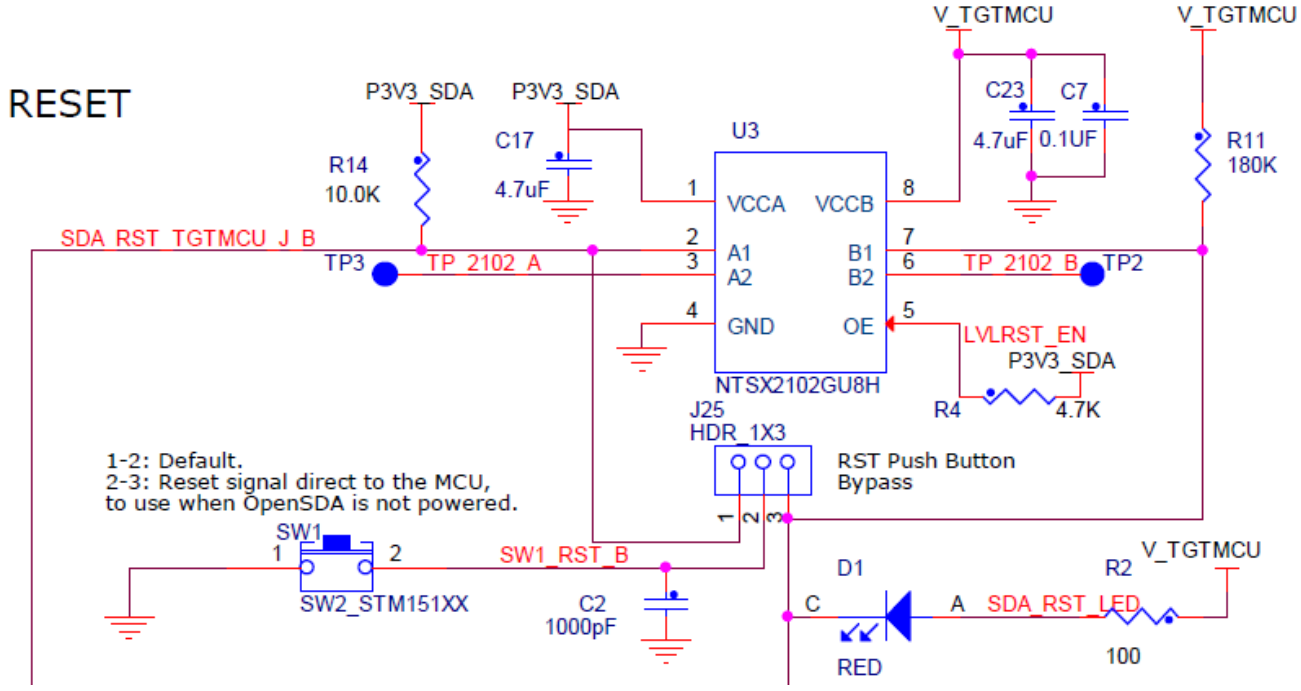

Figure 10. Reset circuit

11. Push Button Switches

Two push buttons, SW2 and SW3, are available on the FRDM-KV10Z board, where SW2 is connected to PTA4, and SW3 is connected to PTB0. Besides the general purpose input/output functions, SW2 and SW3 can be a low-power wake up signal. Also, only SW3 can be a non-maskable interrupt. (?)

Table 5. **Push button GPIO function**

Switch	GPIO Function
SW2	PTA4/LLWU_P3/FTM0_CH1/FTM0_FLT3/NMI_b
SW3	ADC0_SE8/ADC1_SE8/PTB0/LLWU_P5/I2C0_SCL/FTM1_CH0/FTM1_QD_PHA/UART0_RX

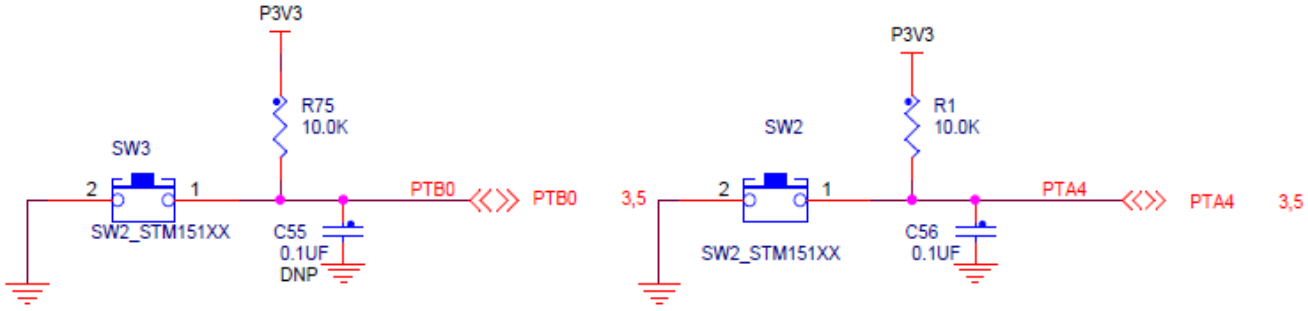

Figure 11. Push button switches

12. Input/output connectors

The MKV10Z32VLF7 microcontroller is packaged in a 48-pin LQFP. Some pins are utilized in onboard circuitry, but some are directly connected to one of the four I/O headers.

The pins on the KV10Z microcontroller are named for their general purpose input/output port pin function. For example, the first pin on Port A is referred as PTA1. The name assigned to the I/O connector pin is same as of the KV10Z pin connected to it, if applicable.

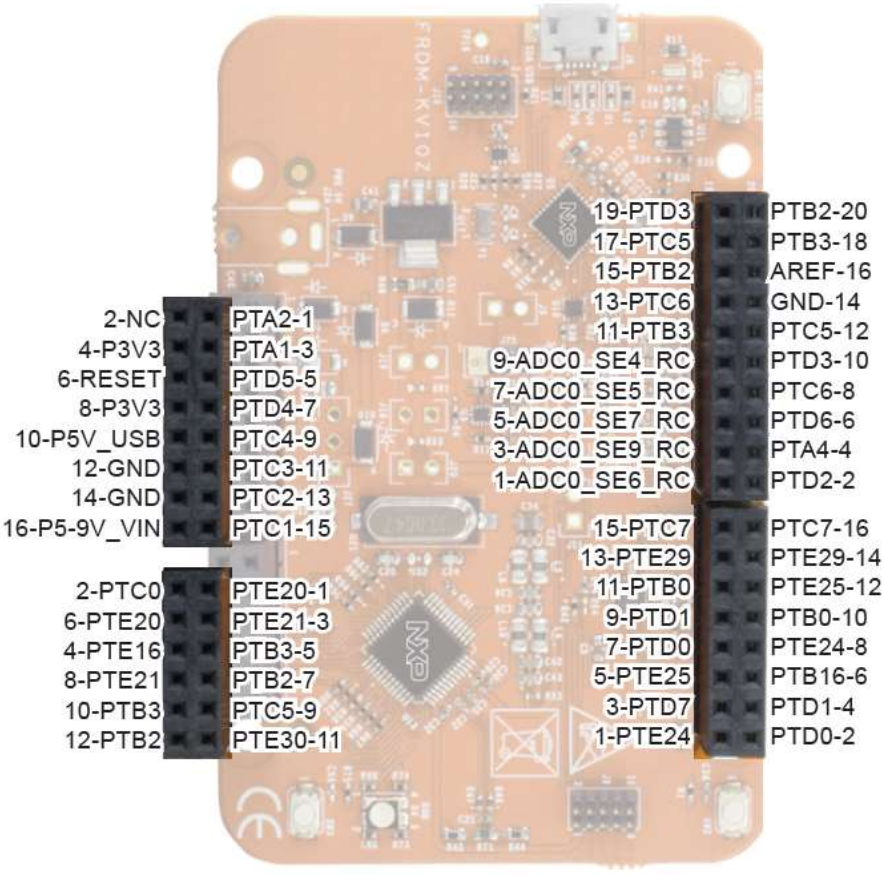

Figure 12. FRDM-KV10Z I/O header pinout

13. Arduino Compatibility

The I/O headers on the FRDM-KV10Z board are arranged to enable compatibility with peripheral boards (known as shields) that connect to Arduino and Arduino-compatible microcontroller boards. The outer rows of pins (even numbered pins) on the headers, share the same mechanical spacing and placement with the I/O headers on the Arduino Revision 3 (R3) standard.

14. References

The following references are available on www.nxp.com:

- FRDMKV10ZQSG, FRDM-KV10Z Quick Start Guide
- FRDM-KV10Z Pinouts
- FRDM-KV10Z Schematic
- FRDM-KV10 Design Package

15. Revision History

Table 6. **Revision history**

Revision number	Date	Substantive changes
0	02/2016	Initial release

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