**FRDM-KEA**

# QUICK START GUIDE (QSG)

**FRDM-KEAZ128**
**FRDM-KEAZ64**
**FRDM-KEAZN32**

## Ultra-Reliable MCUs for Industrial and Automotive Applications

**www.nxp.com/FRDM-KEA**

**NXP**

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# Contents

# Quick Start Package Overview

| Name | Type | Description |
| --- | --- | --- |
| Quick Start Guide | PDF | This document |
| Precompiled Examples | Folder | S-record images of example projects for use with the MSD Flash |
| SDK Evaluation Drivers | Folder | Headers and source code drivers, driver summary and testing |

Additional reference documents are available on www.nxp.com/FRDM-KEA

| Name | Description |
| --- | --- |
| FRDM-KEA Quick Start Package | Quick Start Guide and supporting files for getting started with the FRDM-KEA |
| FRDM-KEA User's Guide | This document— Overview and detailed information for the FRDM-KEA hardware |
| FRDM-KEA Pinouts | Spreadsheet of pin connections for all MCU pins. Includes pinout for the I/O headers, Arduino™ R3 compatibility chart, and OpenSDA MCU pinout. |
| FRDM-KEA Schematics | PDF and Gerber schematic files for the FRDM-KEA hardware |
| FRDM-KEA Design Package | Zip file containing all design source files for the FRDM-KEA hardware |
| OpenSDA User's Guide | Overview and instructions for use of the OpenSDA embedded debug circuit |

# Get to know the FRDM-KEAZ128



CAN Communication Bus

LIN Communication Bus

OpenSDA USB

Reset Button

OpenSDA MCU

External Power Supply (5-12V)

OpenSDA JTAG

J2 Header

System Basis Chip  MCZ33903

J3 Header

J1 Header

J4 Header

S9KEAZ128 MCU

J6 Header

J5 Header

User Buttons

Potentiometer

RGB LED
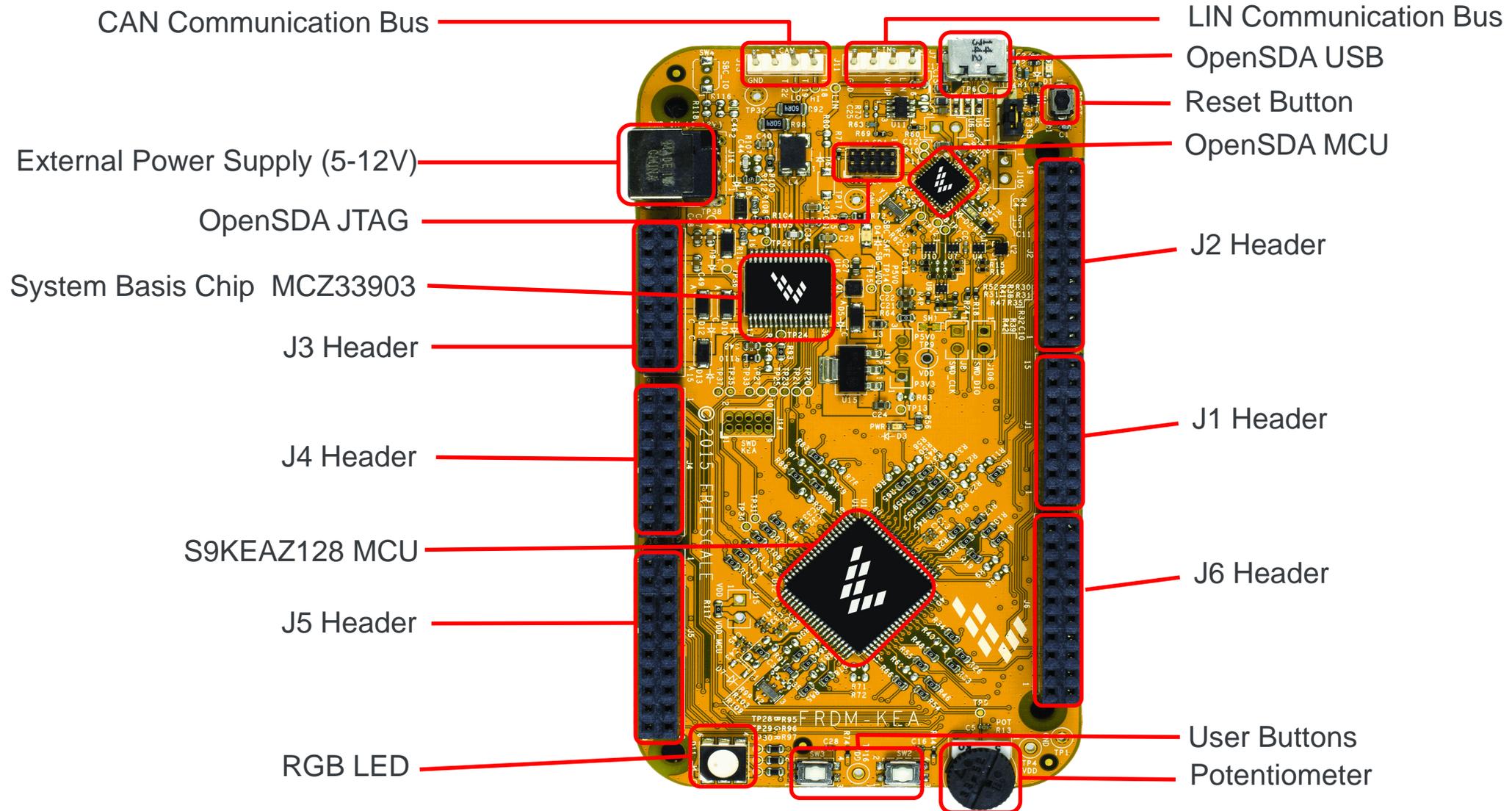
# FRDM-KEA Board : Features

- Supports **KEAZ128, KEAZ64 and KEAZN32 MCUs**
  - KEA is 5V, qualified to Automotive Grade 1 and -40 to +125 °C
- • Small form factor size supports up to 6" x 4"
- Platform supports scalability up to 176 pins
- • Arduino™ UNO footprint-compatible with expansion "shield" support
- • Integrated open-standard serial and debug adapter (OpenSDA) with support for several industry-standard debug interfaces
- • Easy access to the MCU I/O header pins for prototyping
- • On-chip connectivity for CAN, LIN, UART/SCI and SPI
- • Potentiometer for precise voltage and analog measurement
- • RGB LED
- • Two push-button switches (SW2 and SW3)
- Flexible power supply options
  - microUSB or
  - external 12V power supply
- Similar hardware across ARM®, S12 and Power Architecture® architecture based MCUs
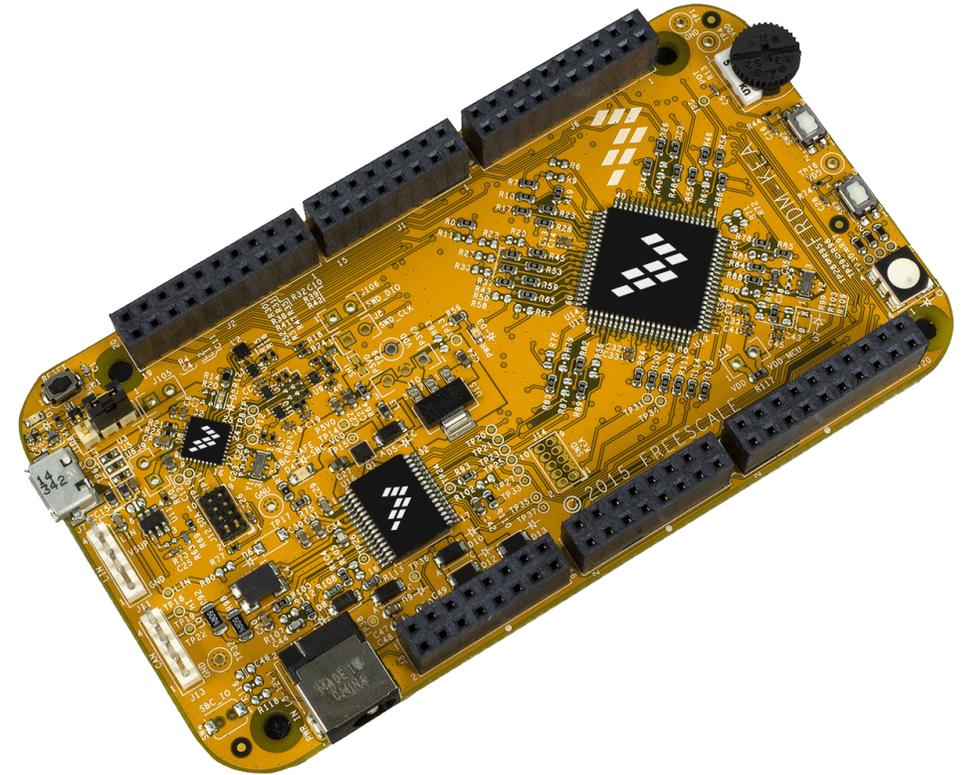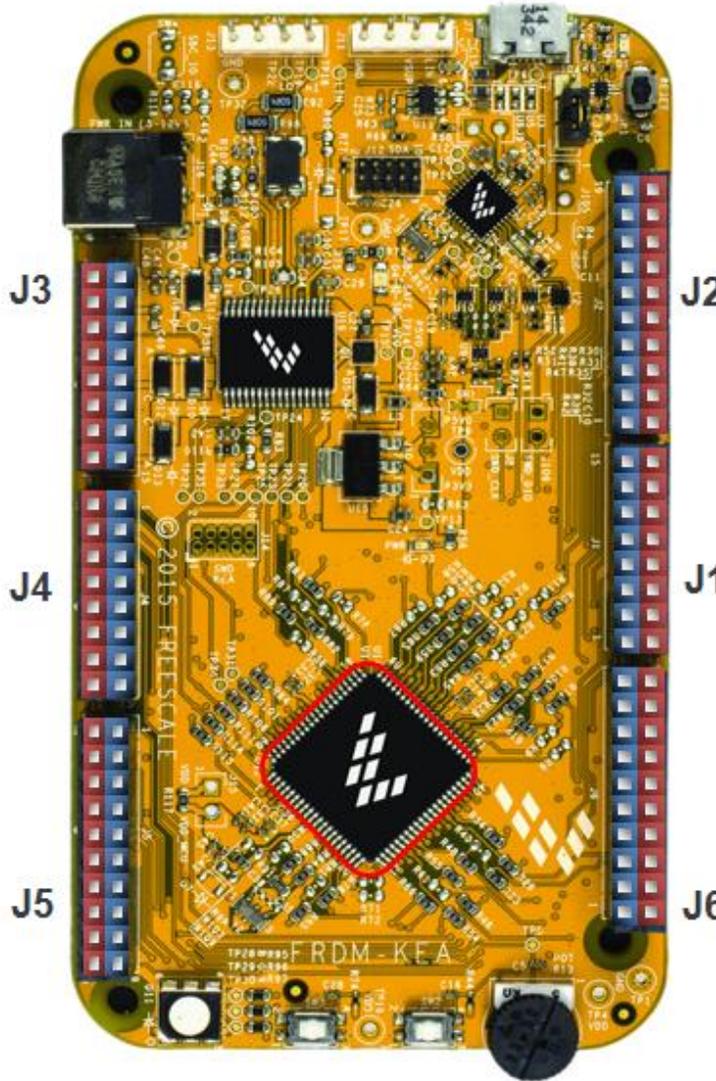


- **Includes:**
- Freescale Freedom board
- URL to online Quick Start Guide (QSG)
- Complimentary IDE Software
  - KDS and S32 Design Studio

# Header/Pinout Mapping for FRDM-KEAZ128

## J3

| PIN | PORT | FUNCTION | PIN | PORT | FUNCTION |
|---|---|---|---|---|---|
| J3-01 | | VIN | J3-02 | PTB6* | GPIO |
| J3-03 | | IOREF | J3-04 | PTB7* | GPIO |
| J3-05 | PTA5 | RESET_TGTMCU | J3-06 | PTE0 | GPIO |
| J3-07 | | P3V3 | J3-08 | PTE1 | GPIO |
| J3-09 | | 5V | J3-10 | PTE2 | GPIO |
| J3-11 | | GND | J3-12 | PTE3 | GPIO |
| J3-13 | | GND | J3-14 | PTE4 | GPIO |
| J3-15 | | VIN | J3-16 | PTE5 | GPIO |

## J2

| PIN | PORT | FUNCTION | PIN | PORT | FUNCTION |
|---|---|---|---|---|---|
| J2-19 | PTA3 | D15 | J2-20 | PTG3 | GPIO |
| J2-17 | PTA2 | D14 | J2-18 | PTG2 | GPIO |
| J2-15 | | A REF | J2-16 | PTG1 | GPIO |
| J2-13 | | GND | J2-14 | PTG0 | GPIO |
| J2-11 | PTB2 | D13 | J2-12 | PTF0 | GPIO |
| J2-09 | PTB4 | D12 | J2-10 | PTH1 | GPIO |
| J2-07 | PTB3 | D11 | J2-08 | PTC2 | GPIO |
| J2-05 | PTB5 | D10 | J2-06 | PTC3 | GPIO |
| J2-03 | PTH2 | D9 | J2-04 | PTB4 | GPIO |
| J2-01 | PTC5 | D8 | J2-02 | PTB5 | GPIO |

## J4

| PIN | PORT | FUNCTION | PIN | PORT | FUNCTION |
|---|---|---|---|---|---|
| J4-01 | PTC0 | ADC0 | J4-02 | PTF1 | GPIO |
| J4-03 | PTC1 | ADC1 | J4-04 | PTC4 | GPIO |
| J4-05 | PTF4 | ADC2 | J4-06 | PTC5 | GPIO |
| J4-07 | PTF5 | ADC3 | J4-08 | PTE6 | GPIO |
| J4-09 | PTF6 | ADC4 | J4-10 | PTH0 | GPIO |
| J4-11 | PTF7 | ADC5 | J4-12 | PTE7 | GPIO |
| J4-13 | PTA0 | ADC6 | J4-14 | PTH6 | GPIO |
| J4-15 | PTA1 | ADC7 | J4-16 | PTH7 | GPIO |

## J1

| PIN | PORT | FUNCTION | PIN | PORT | FUNCTION |
|---|---|---|---|---|---|
| J1-15 | PTG7 | D7 | J1-16 | PTA4 | GPIO |
| J1-13 | PTG6 | D6 | J1-14 | PTA1 | GPIO |
| J1-11 | PTG5 | D5 | J1-12 | PTD7 | GPIO |
| J1-09 | PTG4 | D4 | J1-10 | PTD6 | GPIO |
| J1-07 | PTH1 | D3 | J1-08 | PTD5 | GPIO |
| J1-05 | PTF0 | D2 | J1-06 | PTD4 | GPIO |
| J1-03 | PTB1 | D1 | J1-04 | PTD3 | GPIO |
| J1-01 | PTB0 | D0 | J1-02 | PTD2 | GPIO |

## J5

| PIN | PORT | FUNCTION | PIN | PORT | FUNCTION |
|---|---|---|---|---|---|
| J5-01 | PTC2 | ADC8 | J5-02 | PTF2 | GPIO |
| J5-03 | PTC3 | ADC9 | J5-04 | PTF3 | GPIO |
| J5-05 | PTB3 | ADC10 | J5-06 | PTI2 | GPIO |
| J5-07 | PTA6 | ADC11 | J5-08 | PTI3 | GPIO |
| J5-09 | PTA7 | ADC12 | J5-10 | | VDD |
| J5-11 | PTB0 | ADC13 | J5-12 | | GND |
| J5-13 | PTB1 | ADC14 | J5-14 | PTI4 | GPIO |
| J5-15 | PTB2 | ADC15 | J5-16 | PTI5 | GPIO |
| J5-17 | | NC | J5-18 | PTI6 | GPIO |
| J5-19 | | SBC_SAFE | J5-20 | PTH5 | GPIO |

## J6

| PIN | PORT | FUNCTION | PIN | PORT | FUNCTION |
|---|---|---|---|---|---|
| J6-19 | PTC7 | D14 | J6-20 | | NC |
| J6-17 | PTC6 | D15 | J6-18 | | NC |
| J6-15 | PTI1 | D16 | J6-16 | | NC |
| J6-13 | PTI0 | D17 | J6-14 | | NC |
| J6-11 | PTF3 | D18 | J6-12 | | GND |
| J6-09 | PTF2 | D19 | J6-10 | | VDD |
| J6-07 | PTH3 | D20 | J6-08 | PTH2 | GPIO |
| J6-05 | PTH4 | D21 | J6-06 | PTE7 | GPIO |
| J6-03 | PTD1 | GPIO | J6-04 | PTD3 | GPIO |
| J6-01 | PTD0 | GPIO | J6-02 | PTD2 | GPIO |

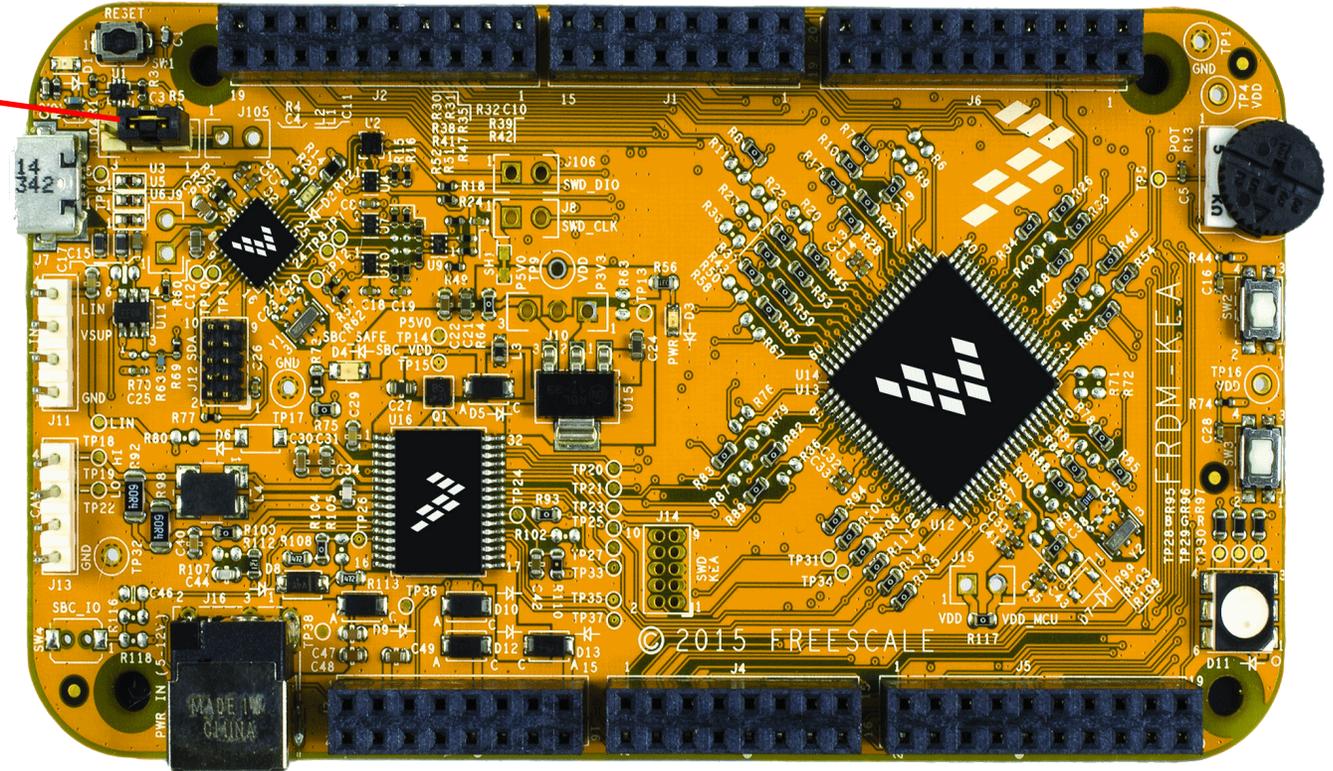**\* For pin multiplex options please review pinmap file**
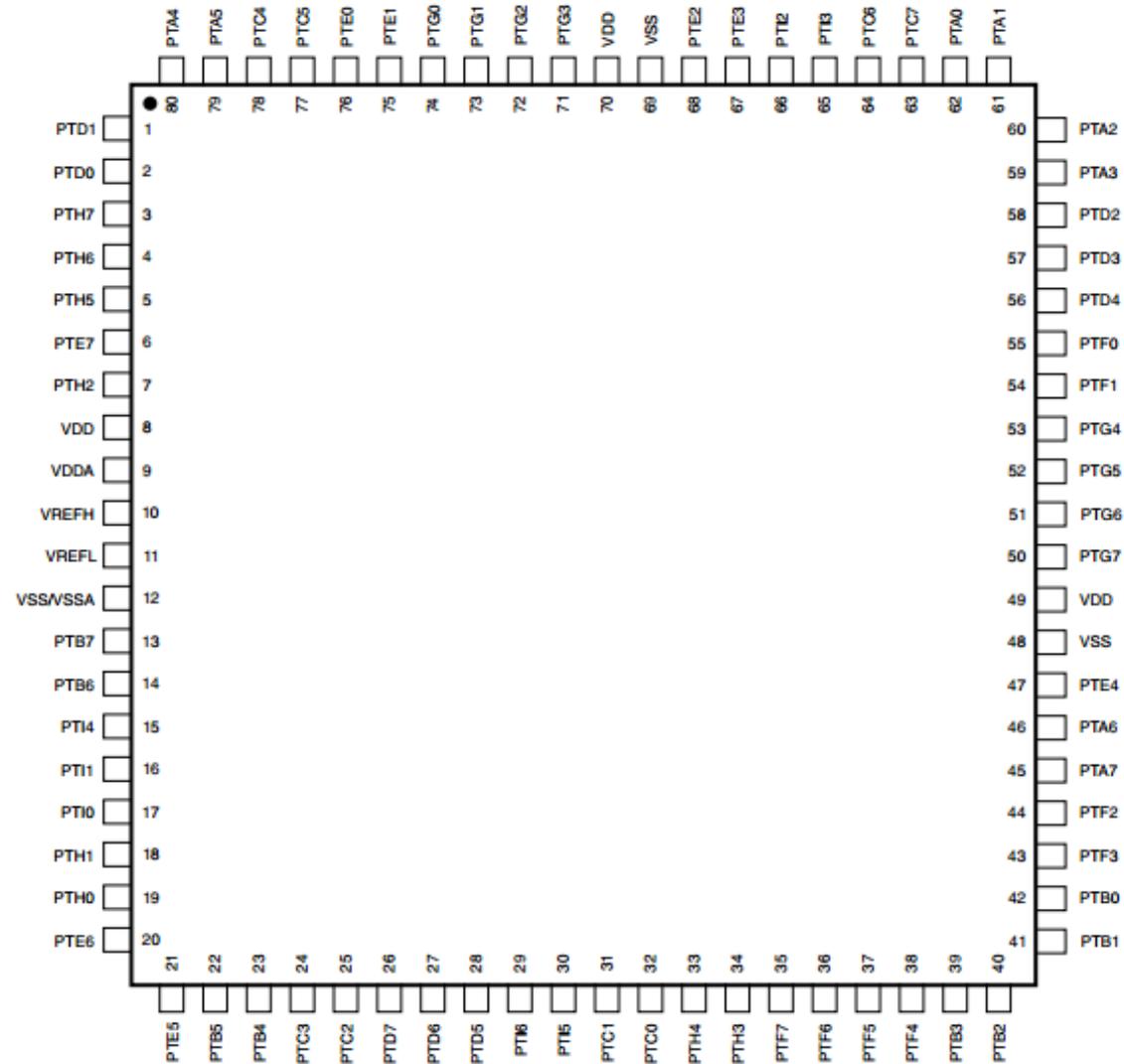
# FRDM-KEA: Jumper Settings

There is only one jumper: J104
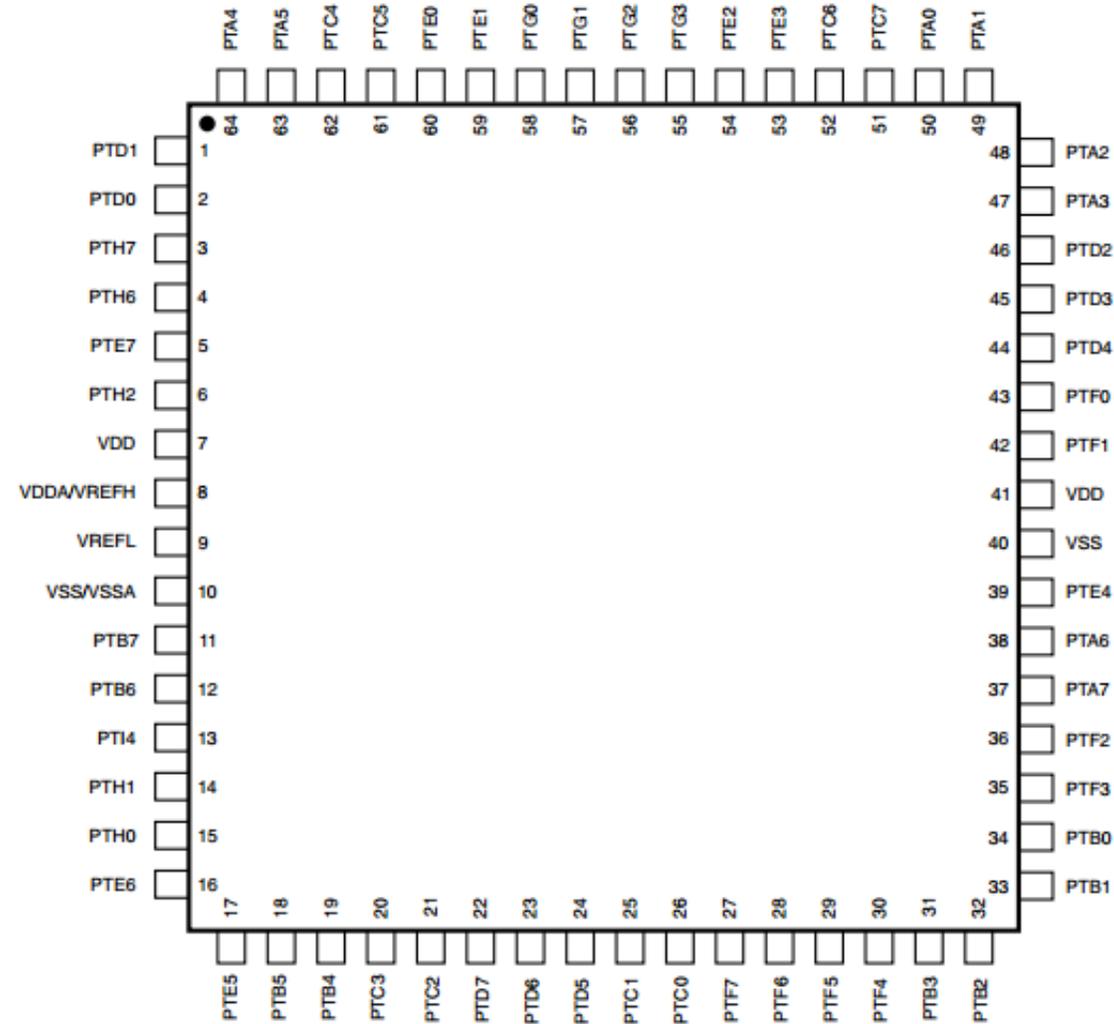It is to select Reset source:

1-2: **Default**
2-3: **Reset** signal direct to the MCU
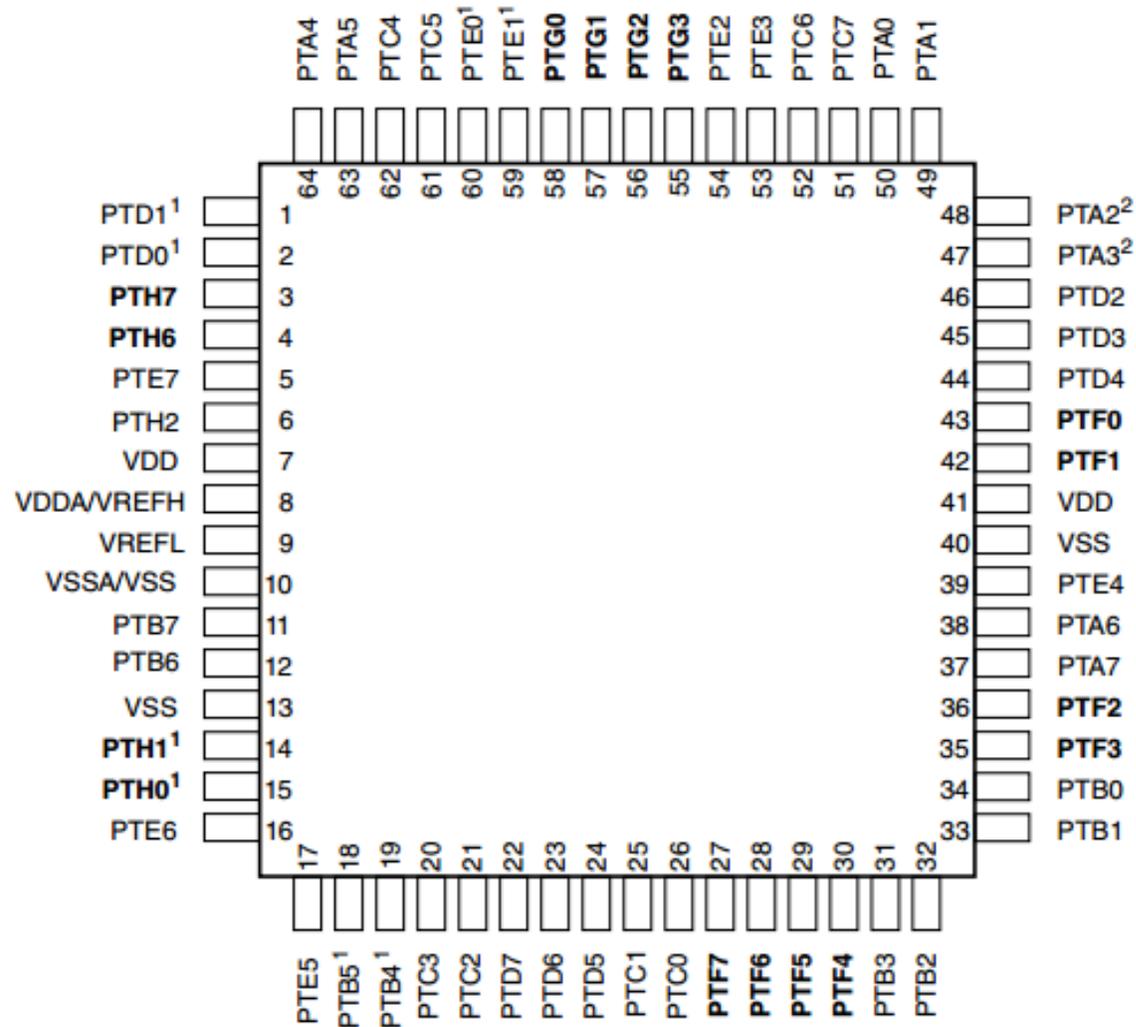when OpenSDA is not powered

# Package Level Pinout Diagram – KEAZ128 (80 LQFP)

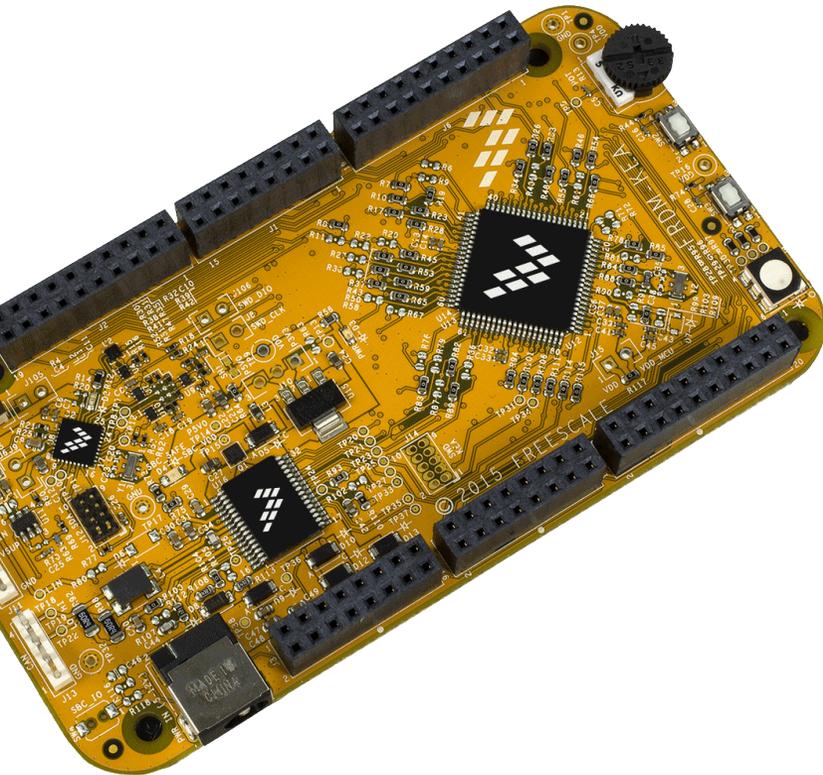# Package Level Pinout Diagram – KEAZ64 (64 LQFP)

# Package Level Pinout Diagram – KEAZN32 (64 LQFP)

# Step-by-Step Setup Instructions for S32 Design Studio IDE

In this quick start guide, you will learn how to setup the **FRDM-KEA** board with pre-loaded code example

**1**

**Install Software and Tools**

**Install S32 Design Studio for ARM MCUs V1.x** at
S32 Design Studio for ARM v2.0 for Windows
Download the **Software Installation Guide for S32DS** which provides step by step installation instructions

**2**

**Power up FRDM-KEA Board**

**Follow step by step power and setup procedures on slides 12-14**

**3**

**Run the Pre-loaded Code Examples**

Run the pre-loaded 2-in-1 code example project which utilizes the **FRDM-KEA** potentiometer and the RGB LED.
**Follow slides 15-16 to switch between code example #1 and #2**
*_To get back to Code example #1 press SW3 button_
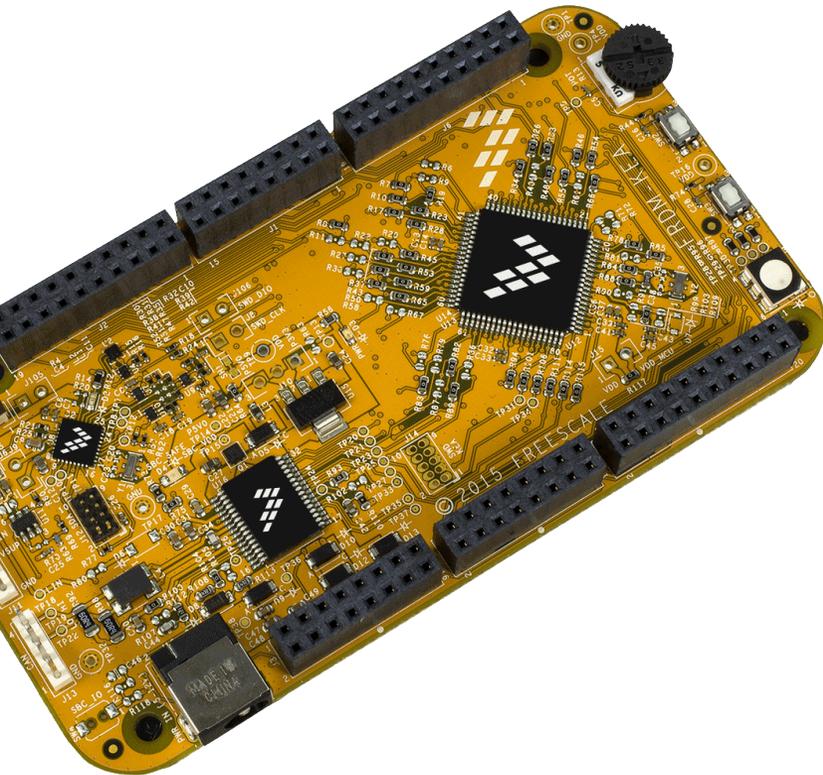
**4**

**Learn More About the KEA**

**Install FreeMaster - free serial real-time GUI monitor tool**
follow slides 32-46 from the Software Installation Guide

Read the release notes and documentation on www.freescale.com/KEA

# Step-by-Step Setup Instructions for Kinetis Design Studio (KDS)

In this quick start guide, you will learn how to setup the **FRDM-KEAZ128** board with pre-loaded code example

**1**

**Install Software and Tools**

Install Kinetis Design Studio Integrated Development Environment (IDE)
www.nxp.com/kds

**2**

**Connect the USB Cable**

**Follow step by step power and setup procedures on slides 12-14**

**3**

**Using the Pre-loaded Code Example Project**

Run the pre-loaded 2-in-1 code example project which utilizes the **FRDM-KEA** potentiometer and the RGB LED.
**Follow slides 15-16 to switch between code example #1 and #2**
*  To get back to Code example #1 press SW3 button*

**4**

**Learn More About the KEA**

**Install FreeMaster - free serial real-time GUI monitor tool**
follow slides 32-46 from the Software Installation Guide

Read the release notes and documentation on www.nxp.com/KEA

# Step 1: Power up the Board – FRDM-KEA Power Supplies

- The FRDM-KEA evaluation board powers from a USB or external 12V power supply

- Connect the USB cable to a PC using supplied USB cable or plug it into a socket (12V power supply sold separately)
  - External power port is J16
  - Only use one power supply, not both

- Connect other end of USB cable (microUSB) to mini-B port on FRDM-KEA at J7

- Allow the PC to automatically configure the USB drivers if needed

- Debug is done using OpenSDA through J7

J7

J16
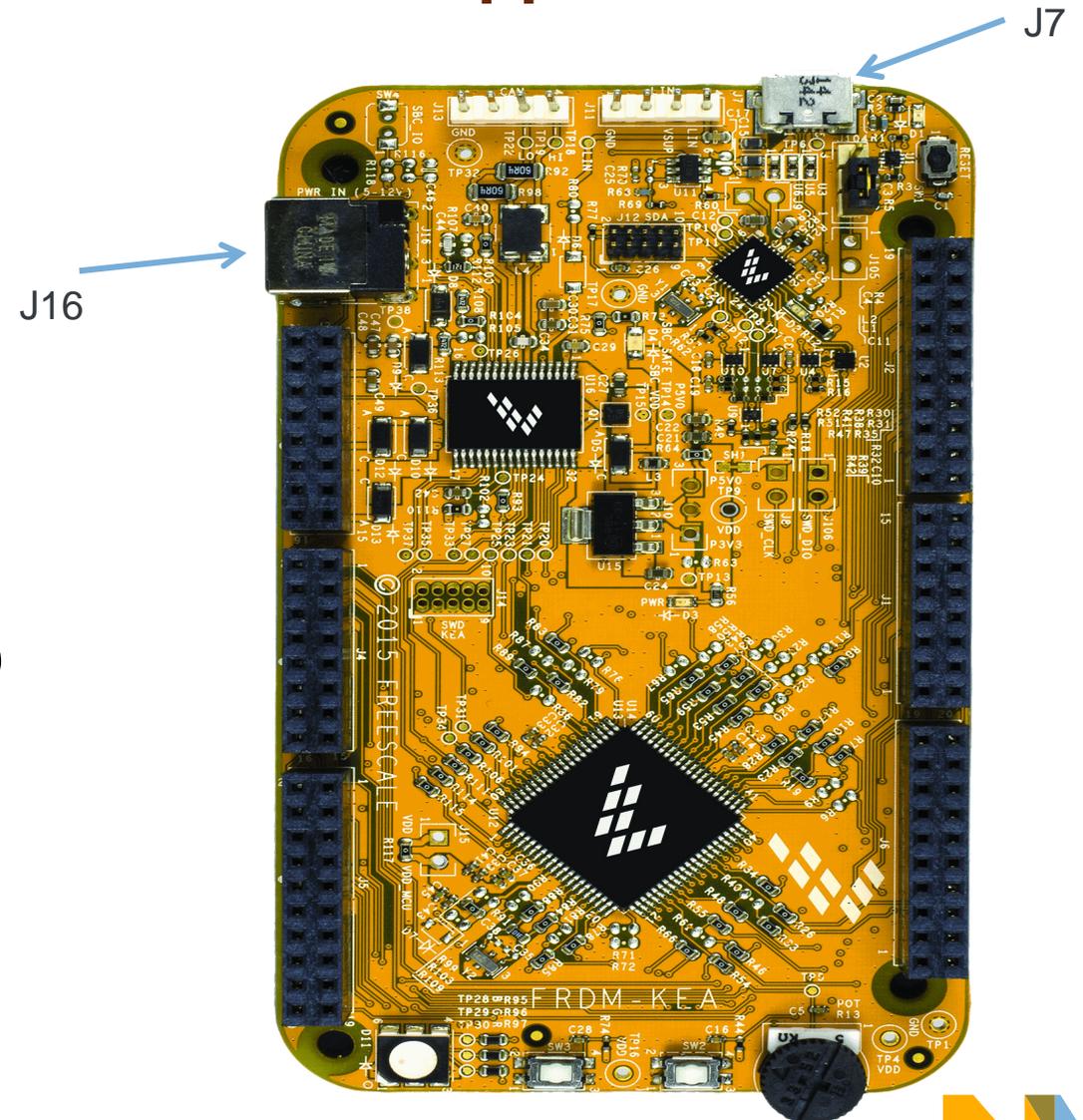
# Step 1: Power up the Board – Is it powered on correctly?

- When powered through USB, LEDs D2 and D3 should light green

- FRDM-KEA boards ship with a 2-in-1 demo code example pre-installed

- When you power the board, it will default to the Blinking LED demo

- The RGB LED D11 will blink

- If you see this initially when powered, the correct firmware is running
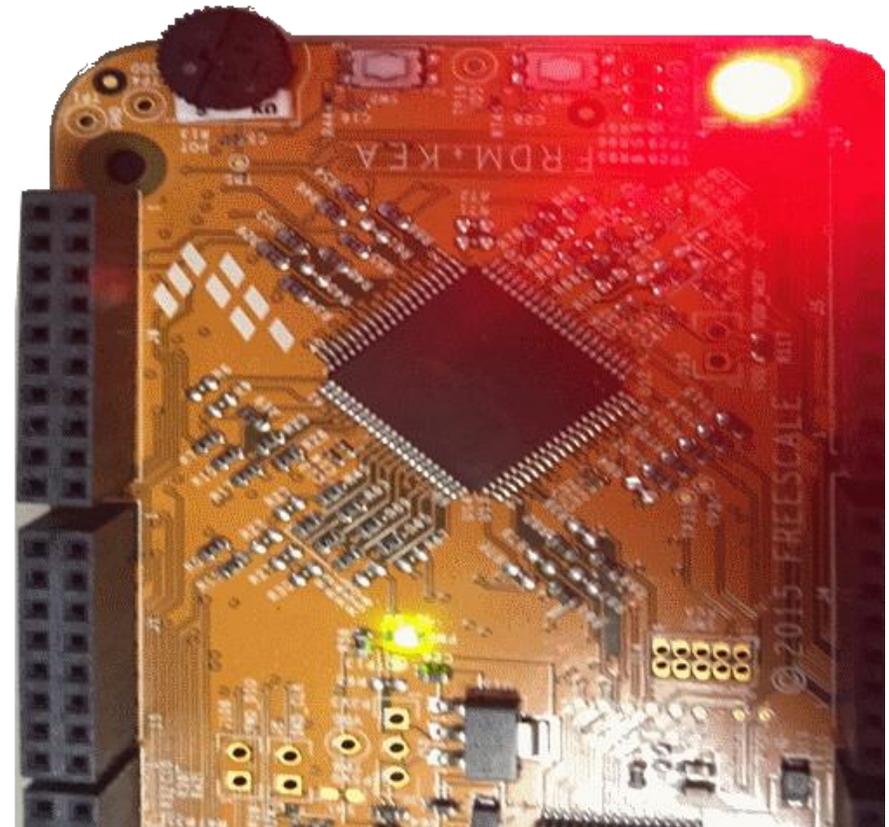
# Step 1: Power up the Board – Is it powered on correctly?

- Switch between code example projects using push buttons SW2 and SW3

- The buttons are located on the edge of the board opposite the microUSB port.
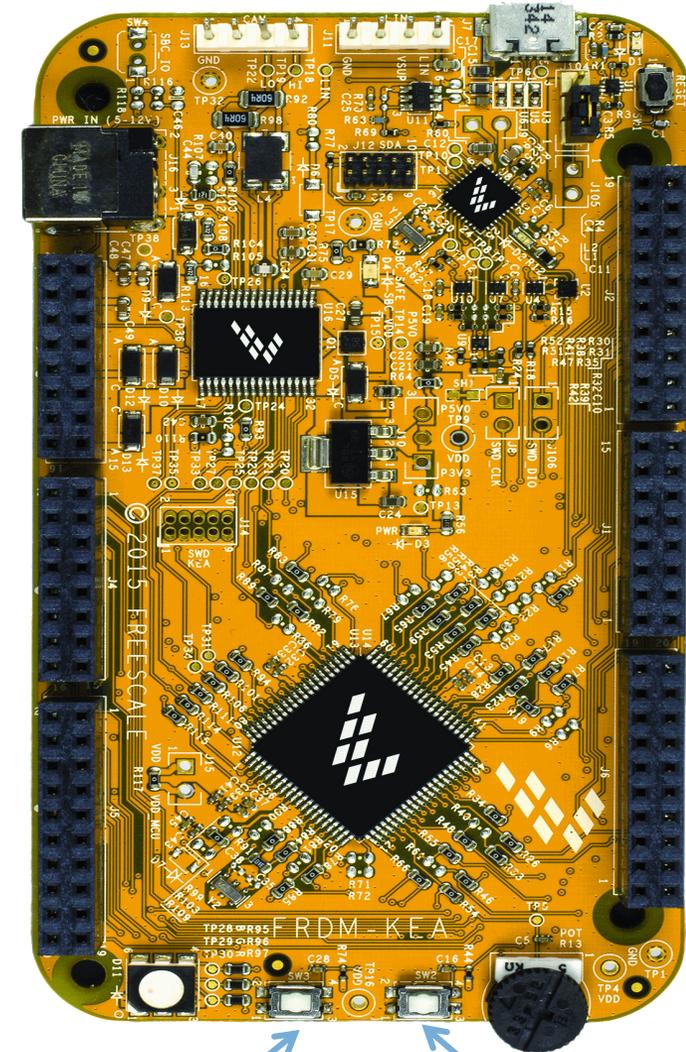


SW3

SW2

# Step 3: Running Code Example #1 (Blinking LED Demo)

**Code Example #1 allows D11 (RGB LED) to illuminate in response to turning R13 (Potentiometer). The LED color will change as the potentiometer position is adjusted**

- The Blinking LED Demo uses ADC and FTM

- FTM interrupts toggles the RGB LED D11 at a frequency controlled by the value of the ADC

- ADC controls the blink period and LED selection (red, green, or blue)

- Dialing the potentiometer R13 will cause D11 to change frequency or color depending on the resistance



D11

R13
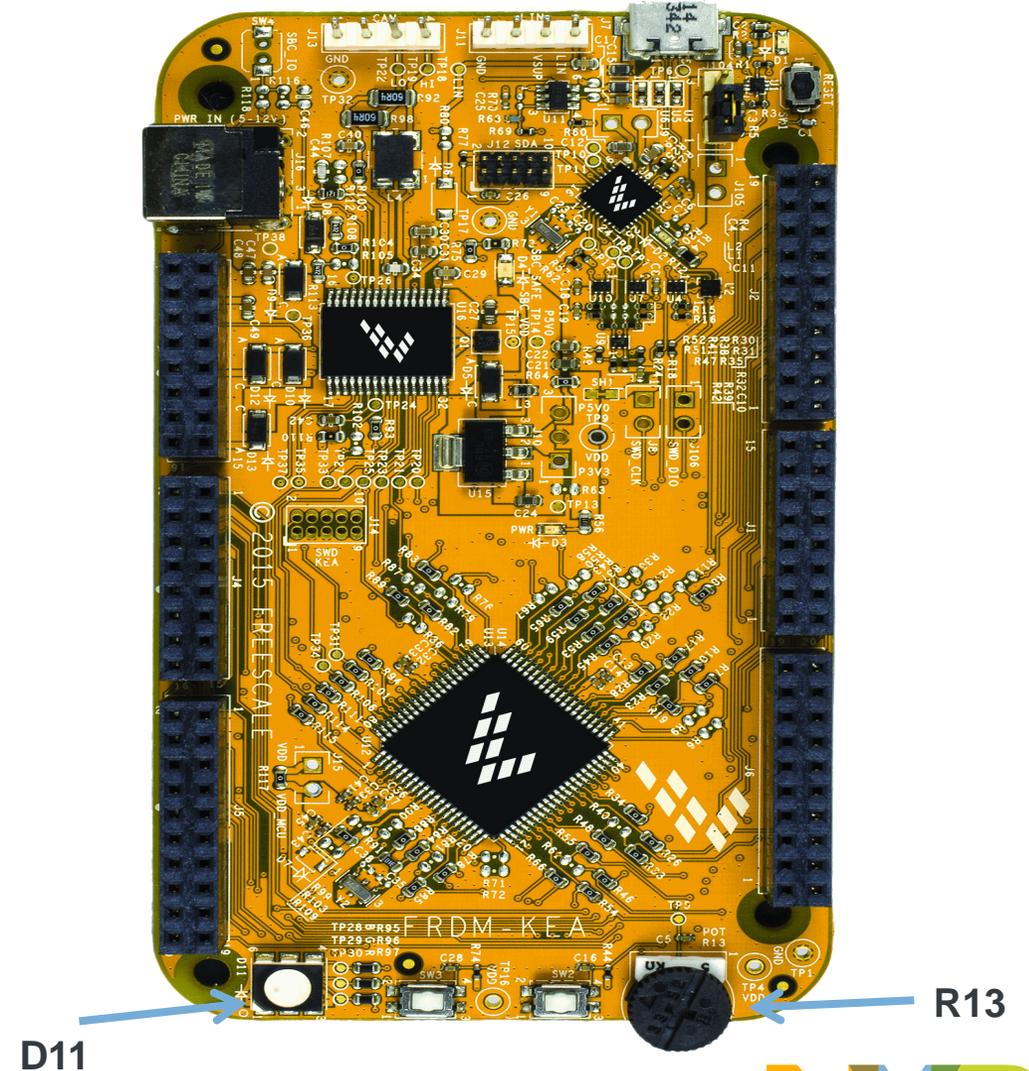
# Step 3: Running Code Example #2 (Dimming LED Demo)

**Code Example #2 modulates the brightness of LED as you turn the potentiometer**

- Press SW2

- All three LEDs within D11 will turn on

- This will combine to produce white light

- The Dimming LED Demo uses RTC and ADC to modulate LD brightness

- RTC interrupt functions as a PWM and ADC value determines duty-cycle. A long duty-cycle, means LED is on for longer portion of period. Perceived by the human eye as brighter light

- Dial the potentiometer R13 and observe LED change brightness
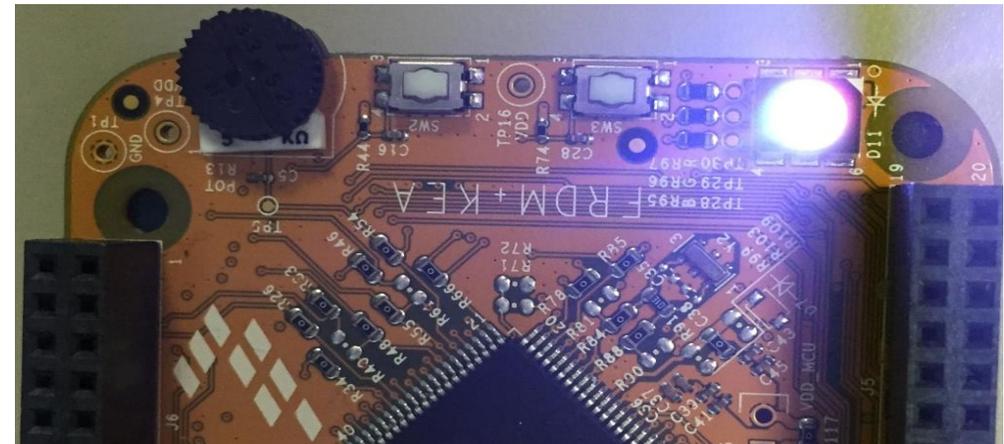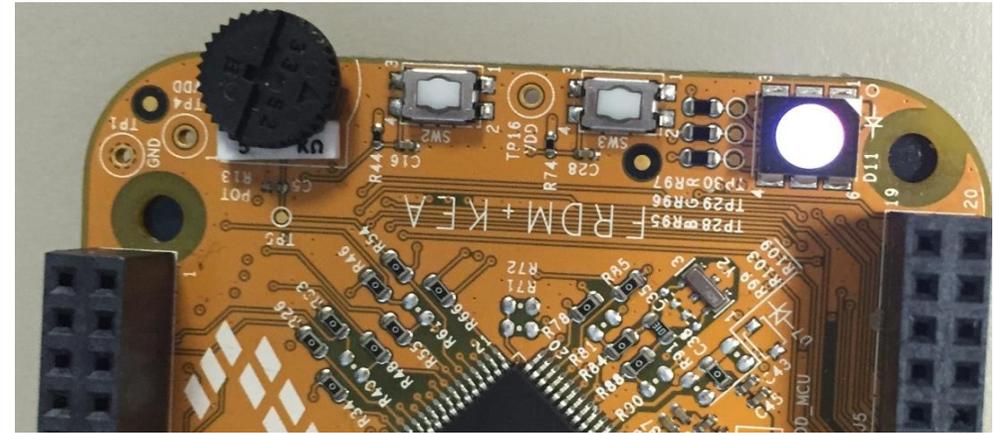
# Sample Drivers

**A step by step KEA sample driver Integration Guide in S32 Design Studio is available to assist loading drivers and code examples for each into a S32DS project**

- **Peripheral Drivers**
  - **ACMP**
  - **ADC_FIFO**
  - **ADC_Interrupt**
  - **ADC_Polling**
  - **Bitband**
  - **BME**
  - **CRC**
  - **FLASH_FTMRE**
  - **FTM_Combine**
  - **FTM_DualEdge**
  - **FTM_EPWM**
  - **FTM_OutputCompare**
  - **GPIO**
  - **I2C_MasterInt**
  - **I2C_MasterPoll**
  - **I2C_Slave**

- **Continued…**
  - **ICS_FEE**
  - **ICS_FEI**
  - **WDOG**
  - **KBI**
  - **PIT**
  - **PMC**
  - **PWT**
  - **RTC**
  - **SPI_MasterInt**
  - **SPI_MasterPoll**
  - **SPI_Slave**
  - **UART_Interrupt**
  - **UART_Loopback**
  - **UART_Polling**
  - **WDOG**

# Documentation and Reference Material

- **Documentation Links**
  - FRDM Factsheet
  - KEA128 Sub-Family Datasheet
  - KEAZN64/KEAZN32 Sub-Family Datasheet
  - S32 Design Studio Factsheet
- **Application Notes**
  - KEA Application Cookbook
  - KEA Family Appnote
  - DC Motor Control using PWT
  - Migrating from 8-bit to KEA
- **Reference Manuals**
  - KEA128 Sub-Family Reference Manual
  - KEAZN64/KEAZN32 Sub-Family Reference Manual

# Development Tools Ecosystem

**IDE / Compilers & Debuggers**
- Free S32 Design Studio IDE
    - Processor Expert coming in 2016
- Free KDS IDE support w/ Processor Expert support
- CodeWarrior 10.6 IDE w/ Processor Expert support
- Keil w/ CMSIS compliant drivers
- IAR
- Cosmic IDE for Kinetis ARM based MCUs

**Programmers**
- OpenSDA
- P&E MultiLink

**Support Tools**:
- FREEMASTER run time debug monitor and instrumentation/calibration tool
- MCAT – Motor Control Application Tool
- Automotive math and motor control library for Cortex® M0+ based products
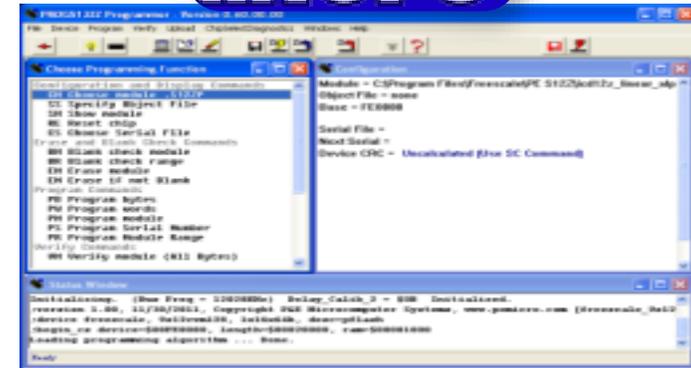
# Kinetis KEA Family — Feature Set Comparison

| MCU | FEATURES | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Flash | RAM | EE PROM | FREQ | MS-CAN | SCI | SPI | ATD | PWT | Flex-Tim | ACMP | IIC | GPIO | Packages |
| KEAZ128 | 128K | 16K | emulate | 48MHz | 1 | 3 | 2 | 16c12b | 1 | 6c+2c+2c 16b | 2 | 2 | Up to 71 | 64/80 LQFP |
| KEAZ64 | 64K | 8K | emulate | 48MHz | 1 | 3 | 2 | 16c12b | 1 | 6c+2c+2c 16b | 2 | 2 | Up to 71 | 64/80 LQFP |
| KEAZN64 | 64K | 4K | 256B | 40MHz | 0 | 3 | 2 | 16c12b | NA | 6c+2c+2c 16b | 2 | 2 | Up to 57 | 32/64 LQFP |
| KEAZN32 | 32K | 4K | 256B | 40MHz | 0 | 3 | 2 | 16c12b | NA | 6c+2c+2c 16b | 2 | 2 | Up to 57 | 32/64 LQFP |
| KEAZN16 | 16K | 2K | 256B | 40MHz | 0 | 3 | 2 | 16c12b | NA | 6c+2c+2c 16b | 2 | 2 | Up to 57 | 32/64 LQFP |
| KEAZN8 | 8K | 1K | emulate | 48MHz | 0 | 1 | 1 | 12c12b | 1 | 6c+2c 16b | 2 | 1 | Up to 22 | 16 TSSOP/ 24 QFN |

▭ Available Freescale Freedom development kit

# Ordering Information

| Hardware | Type | Part Number | Package | Pricing |
|---|---|---|---|---|
| Evaluation (EVB) | NXP Freedom Board | FRDM-KEAZ128Q80 | 80 LQFP | $29 |
| Evaluation (EVB) | NXP Freedom Board | FRDM-KEAZ64Q80 | 64 LQFP | $29 |
| Evaluation (EVB) | NXP Freedom Board | FRDM-KEAZN32Q64 | 64 LQFP | $29 |

# 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. OpenSDA software includes a flash-resident USB mass-storage device (MSD) bootloader and a collection of OpenSDA Applications. FRDM-KL26Z comes with the MSD Flash Programmer OpenSDA Application preinstalled.
Follow these instructions to run the OpenSDA Bootloader and update or change the installed OpenSDA Application.

## Enter OpenSDA Bootloader Mode

1. Unplug the USB cable if attached
2. Press and hold the Reset button (SW2)
3. Plug in a USB cable (not included) between a USB host and the OpenSDA USB connector (labeled "SDA")
4. Release the Reset button

A removable drive should now be visible in the host file system with a volume label of BOOTLOADER. You are now in OpenSDA Bootloader mode.

**IMPORTANT NOTE:** Follow the "Load an OpenSDA Application" instructions to update the MSD Flash Programmer on your FRDM-KL26Z to the latest version. It is likely that the version provided in this package is newer than what was preprogrammed on your FRDM-KL26Z.

## Load an OpenSDA Application

1. While in OpenSDA Bootloader mode, double-click *SDA_INFO.HTML* in the *BOOTLOADER* drive. A web browser will open the OpenSDA homepage containing the name and version of the installed Application. This information can also be read as text directly from *SDA_INFO.HTML*
2. Locate the *OpenSDA Applications* folder in the FRDM-KEA Quick Start Package
3. Copy & paste or drag & drop the MSD Flash Programmer Application *to the BOOTLOADER drive*
4. Unplug the USB cable and plug it in again. The new OpenSDA Application should now be running and a *FRDM-KEA* drive should be visible in the host file system

You are now running the latest version of the MSD Flash Programmer. Use this same procedure to load other OpenSDA Applications.

The MSD Flash Programmer is a composite USB application that provides a virtual serial port and an easy and convenient way to program applications into the KEA MCU. It emulates a FAT16 file system, appearing as a removable drive in the host file system with a volume label of FRDM-KEA. Raw binary and Motorola S-record files that are copied to the drive are programmed directly into the flash of the KEA and executed automatically. The virtual serial port enumerates as a standard serial port device that can be opened with standard serial terminal applications.

## Using the MSD Flash Programmer

1. Locate the Precompiled Examples folder in the FRDM-KEAZ128 Quick Start Package
2. Copy & paste or drag & drop one of the .srec files to the FRDM-KEA drive

The new application should now be running on the FRDM-KEA. Starting with v1.03 of the MSD Flash Programmer, you can program repeatedly without the need to unplug and reattach the USB cable before reprogramming.

Drag one of the .srec code examples from the KEA code example folder onto the FRDM-KEA board over USB to reprogram the preloaded code example to another example.

**NOTE:** Flash programming with the MSD Flash Programmer is currently only supported on Windows operating systems. However, the virtual serial port has been successfully tested on Windows, Linux and Mac operating systems.

## Using the Virtual Serial Port

1. Determine the symbolic name assigned to the FRDM-KEAZ128 virtual serial port. In Windows open Device Manager and look for the COM port named "PEMicro/Freescale – CDC Serial Port".
2. Open the serial terminal emulation program of your choice. Examples for Windows include Tera Term, PuTTY, and HyperTerminal
3. Program one of the "code example programs" from the Code Examples folder using the MSD Flash Programmer.
4. Configure the terminal program. Most embedded examples use 8 data bits, no parity bits, and one stop bit (8-N-1). Match the baud rate to the selected serial test application and open the port.
5. Press and release the Reset button (SW0) at anytime to restart the example application. Resetting the embedded application will not affect the connection of the virtual serial port to the terminal program.

**NOTE:** Refer to the OpenSDA User's Guide for a description of a known Windows issue when disconnecting a virtual serial port while the COM port is in use.

# Recommendations

- For faster debugging, debug from RAM, because this cuts down the lengthy Flash erase operation cycles. Follow the Software Integration Guide (SWIG) for details.

- By default "New Project" in S32 Design Studio IDE makes application to run at 37.5 kHz Internal RC (IRC) oscillator. For faster performance, configure FLL to desired frequency and d switch clock source to FLL before executing application code.

- Keep S32 Design Studio IDE and OpenSDA firmware Up-to-date for best results

- Post Technical Questions on NXP community for Kinetis MCUs.

- Useful Links:
  - KEA Webpage
  - FRDM-KEA Page
  - S32 Design Studio
  - NXP Community

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SAFETI-HSK-RM48  PICOHOBBITFL  CC-ACC-MMK-2443  TWR-MC-FRDMKE02Z  EVALSPEAR320CPU  EVB-SCMIMX6SX
MAX32600-KIT#  TMDX570LS04HDK  TXSD-SV70  OM13080UL  EVAL-ADUC7120QSPZ  OM13082UL  TXSD-SV71
YGRPEACHNORMAL  OM13076UL  PICODWARFFL  YR8A77450HA02BG  3580  32F3348DISCOVERY  ATTINY1607 CURIOSITY
NANO  PIC16F15376 CURIOSITY NANO BOARD  PIC18F47Q10 CURIOSITY NANO  VISIONSTK-6ULL V.2.0  80-001428  DEV-17717
EAK00360  YR0K77210B000BE  RTK7EKA2L1S00001BE  MAX32651-EVKIT#  SLN-VIZN-IOT  LV18F V6 DEVELOPMENT SYSTEM
READY FOR AVR BOARD  READY FOR PIC BOARD  READY FOR PIC (DIP28)  EVB-VF522R3  AVRPLC16 V6 PLC SYSTEM
MIKROLAB FOR AVR XL  MIKROLAB FOR PIC L  MINI-AT BOARD - 5V  MINI-M4 FOR STELLARIS  MOD-09.Z  BUGGY +
CLICKER 2 FOR PIC32MX + BLUETOOT  1410  LETS MAKE PROJECT PROGRAM. RELAY PIC  LETS MAKE - VOICE
CONTROLLED LIGHTS  LPC-H2294  DSPIC-READY2 BOARD  DSPIC-READY3 BOARD  MIKROBOARD FOR ARM 64-PIN
MIKROLAB FOR AVR