Kinetis MCUs
The World’s Broadest ARM-based MCU Portfolio

Hansop Shim | MCU Marketing
OCT 2014
• Kinetis MCU Portfolio Overview
• MCU Market Trend
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• Kinetis MCU Enablement
Kinetis MCU Portfolio Overview

Design Potential. Realized.
Kinetis Microcontrollers
World’s Broadest ARM® Cortex®-M-based Portfolio

Kinetis L Series
Ultra-low power/cost ARM Cortex-M0+ MCU families from 48MHz/8KB with mixed-signal, connectivity & HMI features in low pin-count packages.

Kinetis E Series
Robust, 5V ARM Cortex-M0+ MCU families for use in high electrical noise environments. Safety features for high-reliability applications.

Kinetis M Series
High accuracy metrology ARM Cortex-M0+ MCU families for single chip smart meter implementations.

Kinetis W Series
Integrated wireless connectivity ARM Cortex-M4 and M0+ MCU families with class-leading sub-1 GHz and 2.4 GHz RF transceivers.

Kinetis V Series
High efficiency, high speed peripherals ARM Cortex-M0+ & Cortex-M4 MCU families for use in motor control & power conversion.

Future Kinetis Series with ARM Cortex-M7
Industry-first ARM Cortex-M4 MCU families from 50MHz/32KB with low power, FlexMemory, mixed-signal and broad connectivity, HMI & security features.

General Purpose
Segment Focused

Leading Performance - Low Power - Scalability - Industrial-grade reliability & temp
Freescale Bundled IDE, RTOS & Middleware - Rapid prototyping Platform - Broad ARM Ecosystem Support
Kinetis MCU Key Pillars by Series’

<table>
<thead>
<tr>
<th>L</th>
<th>E</th>
<th>K</th>
<th>W</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Power</td>
<td>5V Robustness</td>
<td>High Performance &amp; Rich Integration</td>
<td>Integrated RF Connectivity</td>
<td>Integrated metrology engine</td>
<td>Motor and Power Conversion</td>
</tr>
<tr>
<td>48MHz Cortex M0+</td>
<td>Up to 48MHz Cortex M0+</td>
<td>Up to 180MHz Cortex M4</td>
<td>Up to 50MHz Cortex M4, Cortex M0+</td>
<td>Up to 48MHz Cortex M0+</td>
<td>Up to 200MHz, Cortex M4, Cortex M0+</td>
</tr>
<tr>
<td>8KB to 512kB Flash</td>
<td>8KB to 128kB Flash</td>
<td>32KB to 2MB Flash</td>
<td>32KB to 512kB Flash</td>
<td>32KB to 128kB Flash</td>
<td>16KB to 2MB Flash</td>
</tr>
<tr>
<td>Up to 128KB RAM</td>
<td>Up to 16KB RAM</td>
<td>Up to 256KB RAM</td>
<td>Up to 64KB RAM</td>
<td>Up to 32KB RAM</td>
<td>Up to 256KB RAM</td>
</tr>
<tr>
<td>Now!</td>
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<td>Now!</td>
</tr>
</tbody>
</table>

Leading Performance – Low Power – Scalability – Industrial Grade reliability & temp

Freescale Bundled IDE, RTOS & Middleware – Rapid Prototyping Platform – Broad ARM Ecosystem Support
## Kinetis MCU General Purpose Product Lines

<table>
<thead>
<tr>
<th>Feature</th>
<th>Kinetis L Series</th>
<th>Kinetis E Series</th>
<th>Kinetis K Series</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Processor</strong></td>
<td>ARM Cortex-M0+</td>
<td>ARM Cortex-M0+</td>
<td>ARM Cortex-M4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(with optional SPFPU)</td>
</tr>
<tr>
<td><strong>Performance</strong></td>
<td>Up to 48MHz</td>
<td>Up to 48MHz</td>
<td>Up to 50 / 72 / 100 / 120 / 150 / 180MHz</td>
</tr>
<tr>
<td><strong>Ultra Low Power</strong></td>
<td>Typical ~50uA/MHz (VLPR Mode)</td>
<td>na</td>
<td>Typical ~130uA/MHz (VLPR Mode)</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>8kB – 256kB Flash 1kB – 32kB SRAM</td>
<td>8kB – 128kB Flash 1kB – 16kB SRAM</td>
<td>32kB – 2MB Flash 8kB – 256kB SRAM</td>
</tr>
<tr>
<td><strong>Pin-Count</strong></td>
<td>16 – 121 Pin</td>
<td>16 – 80 Pin</td>
<td>32 – 256 Pin</td>
</tr>
<tr>
<td><strong>Features</strong></td>
<td>Baseline / Mixed-Signal and optional Segment LCD, USB</td>
<td>5V / EMC / Safety (CRC) Control (Flextimer) and optional Segment LCD, CAN</td>
<td>Baseline / Mixed-Signal and optional FlexMemory, USB, Segment LCD, CAN, Ethernet, Graph LCD, DRAM-CTRL, NAND-Flash-CTRL, Crypto, Anti-Tamper</td>
</tr>
<tr>
<td><strong>Price</strong></td>
<td>From $0.49  (MKL02x, 8KB, 16QFN)</td>
<td>From $0.78  (MKE02x, 16KB, 32LQFP)</td>
<td>From $0.79  (MK02, 64KB, 32QFN)</td>
</tr>
<tr>
<td><strong>Demo Board</strong></td>
<td><img src="image" alt="Demo Board" /></td>
<td><a href="http://www.freescale.com/FREEDOM">www.freescale.com/FREEDOM</a>  <a href="http://www.freescale.com/TOWER">www.freescale.com/TOWER</a></td>
<td><a href="http://www.freescale.com/KINETIS">www.freescale.com/KINETIS</a></td>
</tr>
</tbody>
</table>

Freescale free RTOS called MQX www.freescale.com/MQX including USB / Ethernet / MS File System / Peripherals Driver

MQX-Lite +USB and Peripherals Drivers (also within Processor Expert – Code Generator)

Note: Availability device dependent
MCU Market Trend
## Implications for Entry-Level MCUs

<table>
<thead>
<tr>
<th>Connectivity</th>
<th>8/16-bit MCUs</th>
<th>32-bit MCUs</th>
<th>Kinetis L Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Interface</td>
<td>![USB Icon]</td>
<td>![Bluetooth Icon]</td>
<td></td>
</tr>
<tr>
<td>Power Consumption</td>
<td>![Battery Icon]</td>
<td>![Energy Efficiency Icon]</td>
<td></td>
</tr>
<tr>
<td>Computation</td>
<td>![Math Symbols]</td>
<td>![Math Symbols]</td>
<td></td>
</tr>
<tr>
<td>Software/Cost of Ownership</td>
<td>Unique platforms, MCU dependent/$$$</td>
<td>Scalable, reusable platforms with modern software techniques/$</td>
<td></td>
</tr>
<tr>
<td>Scalability</td>
<td>Limited choice, single source</td>
<td>Broad MCU portfolios, multi-source</td>
<td></td>
</tr>
</tbody>
</table>
32-bit MCU in Low power and Low cost market

**Energy efficiency**
Class-leading CoreMark/mW

**Scalability and integration**
Kinetis L to K Series MCUs (ARM Cortex-M0+ to Cortex-M4)

**Enablement**
Freescale bundle + ARM ecosystem

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**Kinetis L Series MCUs**

*The evolution of the entry-level MCU*

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**Ultra-low static**
<1uA

**Low cost**
From <$0.50

**Ease of use**
Freedom Platform, Processor Expert and MCU Solution Advisor
Smaller package, Low power consumption

Banking
- OTP
- Cash Registers

Building Control
- Smoke Detector
- Thermostat

Instrumentation & Medical
- Joy Sticks
- Remote Controller
- Aero Model
- Scale
- Shaver
- Mouse
- GPS Watch

Mass Market
- Electronic Label
- ETC
- Fiber Module
- RFID

Energy Efficiency

Mass Market
- ETC
- Fiber Module

Kinetis L Series
The ARM Cortex-M0+ Core:
No compromise in performance

Shorten run time in low-power applications.
- **More than 2x CoreMark/mA performance** than the closest 8/16-bit competitor
- **2-stage pipeline**—reduced number of cycles per instruction (CPI) enables faster branch instruction and ISR entry, reduced power consumption and increased performance
- **Fast I/O port**—single-cycle access to I/O (2x faster than normal I/O)
  - Improves reaction time to external events, allowing bit-banding and software protocol emulation
  - Implemented as FGPIO on Kinetis L series MCUs

![CoreMark/MHz Comparison](chart)

**Official data:** www.coremark.org
### CoreMark Code in kB

<table>
<thead>
<tr>
<th>Architecture</th>
<th>Code Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corex-M0+</td>
<td>4,896 kB</td>
</tr>
<tr>
<td>A (16-bit)</td>
<td>6,446 kB</td>
</tr>
<tr>
<td>B (16-bit)</td>
<td>10,206 kB</td>
</tr>
<tr>
<td>C (8-bit)</td>
<td></td>
</tr>
<tr>
<td>D (8/16-bit)</td>
<td></td>
</tr>
</tbody>
</table>

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### 16-bit Multiplication Example

<table>
<thead>
<tr>
<th>16-bit</th>
<th>8-bit</th>
<th>ARM Cortex-M0+</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOV R2, R1</td>
<td>MUL A, B</td>
<td>MOV A, B</td>
</tr>
<tr>
<td>ADDC A, R0, R1</td>
<td>MUL B, C</td>
<td>ADDC A</td>
</tr>
<tr>
<td>MOV R0, R1</td>
<td>ADDC A</td>
<td>MOV R0</td>
</tr>
<tr>
<td>MOV R1, R0</td>
<td>MOV R1, R0</td>
<td>MOV R1</td>
</tr>
<tr>
<td>MOV R2, R0</td>
<td>MOV R2, R0</td>
<td>MOV R2</td>
</tr>
<tr>
<td>MOV R0, R2</td>
<td>MOV R0, R2</td>
<td>MOV R0</td>
</tr>
<tr>
<td>MOV R1, R2</td>
<td>MOV R1, R2</td>
<td>MOV R1</td>
</tr>
<tr>
<td>MOV R2, R1</td>
<td>MOV R2, R1</td>
<td>MOV R2</td>
</tr>
</tbody>
</table>

- **48 cycles**, 48 Byte Code Size
- **8 cycles**, 8 Byte Code Size
- **1 cycle**, 2 Byte Code Size

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*8051 needs at least 1 cycle per instruction byte fetch as they only have an 8-bit interface.*

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**N.B.** The Cortex-M multiply in fact performs a 32-bit multiply, hence assume C and D contain 16-bit data.

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CoreMark code compiled optimized for size. Same MCUs as for CoreMark/mA benchmark.
Cortex-M4: Efficient Blend

The Cortex-M4 is ~2X more efficient on most DSP tasks than leading 16 and 32 bit MCU devices with DSP extensions.
Sensor Hub vs. Sensor Fusion

**Sensor Hub (Kinetis L)**

- A Sensor Hub controls the communication, power, and state of the individual sensors in the system but acts more as a pass through of the data.
- Provides a single unified interface for sensor data regardless of sensor types
- Enables developer to concentrate on using sensor data, not getting sensor data
- Eliminates intensive sensor integration effort
- Provides power management of the platform to achieve lowest power mode of operation
- Create applications with ANY market available sensor

**Sensor Fusion (Kinetis K)**

- A full Sensor Fusion Solution takes in data from 3 or more sensors and provides a calculated output that is calibrated, compensated and calculated depending on the sensors in the system.
- Matrix calculations to determine position and orientation of a device within an earth frame of reference requiring:
  - Quaternion
  - Euler Angles
  - Rotation Matrix
- Calibration and Compensation such as:
  - Ecompass Calibration and Compensation Algorithms
  - Gyro drift calibration
  - Virtual gyro with mag and accel for lower power modes of operation
Freescale Sensor Fusion Solution

- **Sensing Integration / Fusion**
  - Kinetis low power microcontrollers
  - Process sensor fusion algorithms, communicate and control
  - Complete scalable low power solution
  - Mini form factors, starting at 1.6x2.0 CSP package

- **Intelligent Software Framework**
  - Proven platform to facilitate sensor firmware
  - Power management and communications services
  - Scalable over MCU and sensor families

- **Sensors**
  - Stability of temperature/media
  - Low power
  - Broad portfolio
  - Sensor integrated MCUs
Freescale Kinetis Mini MCUs for the IoT
INTERNET of THINGS

It’s the *Network of All Networks*, which will be connected through the Largest Control Data Network in the World

It’s all about the service layer infrastructure, because …

It’s ALL About the Services

Rolling out the IoT is like rolling out the largest control data network in the world
Trends in Embedded Product Design

Internet of Things (IoT) is driving massive expansion of smart, connected devices requiring maximum energy efficiency and small form factors enabled by MCUs with:

- **Ultra-small package footprints**
  - Miniaturized PCB area for space-constrained applications; portable consumer devices, remote sensor nodes, motor control and healthcare monitoring

- **Increased energy efficiency**
  - Rapid MCU wake-up, process and return-to-sleep profiles. Flexible low-power modes & peripherals for extracting maximum system life from the smallest power budgets

- **Advanced performance, feature integration and software support**
  - 32-bit processing power to support complex algorithms, connectivity stacks and HMI
  - Rich connectivity and analog capabilities for precision sensing, communication and control
Kinetis KL03 CSP – The World’s Smallest ARM-based MCU

- **Miniature Package Size**
  - 1.6 x 2.0 mm² – 35% smaller and 60% more GPIO than the competition
  - Ideal for space-constrained applications where cost or environmental factors prevent use of larger QFN/LQFP/BGA packages – IoT enabled consumer devices, remote sensing nodes, wearable devices, ingestible medical sensors
  - Newest member of the Kinetis ‘Mini’ portfolio – >10 million L & K Series CSP MCUs shipped to date with high performance/feature integration and ultra low power capabilities

- **Energy Efficiency & Feature Integration**
  - Cortex-M0+ core delivers CoreMark/mA – 2-8 x improvement vs. 8/16-bit MCUs
  - Multiple low power RUN, WAIT & STOP modes – from 41µA@MHz Very-Low-Power-Run mode, to 77nA Very Low-Leakage STOP 0 mode with 16byte register file retention
  - High accuracy ADC voltage reference, 1Mbit/s IIC, low power UART
  - 8KB ROM bootloader – in-system flash programming via I2C, LPUART or SPI. S/ware flexibility during development, manufacture or in-field deployment

- **Scalability & Enablement**
  - More than 200 Kinetis L Series MCUs from 8-256kB, 16-121pin with precision mixed-signal, connectivity and HMI peripheral options. Starting from $0.50
  - Low cost FRDM-KL03Z development board, complimentary Kinetis Design Studio IDE (no code size limit) & Software Development Kit (SDK). Broad ARM ecosystem support

> 20,000 KL03 20WLSCPs fit inside a golf ball!
Kinetis L Series KL03 Block Diagram

Core/System
- ARM Cortex-M0+ @ 48MHz

Memory
- 8/16/32KB Flash,
- 2KB SRAM
- 8KB ROM with build-in Bootloader
- 16 bytes register file retention

Communications
- Low-power UART, SPI
- High Speed I2C up to 1Mbps

Analog
- 12-bit ADC with internal voltage reference
- CMP with 6-bit DAC
- Embedded 1.2V voltage reference for analog peripherals

Timers
- 2x2ch Timer/PWM
- RTC
- Low Power Timer

Other
- Up to 22 I/Os
- 3 high-drive I/Os (20mA)
- 1.71V-3.6V
- -40°C to 105 °C for QFN; -40°C to 85 °C for WLCSP

Packages
- 16/24QFN, 20WLCSP

- Standard Feature
- Optional Feature
Kinetis MCU WLCSP Roadmap

- **KL02**: 2.0 x 1.9mm 20CSP
- **KL03**: 2.0 x 1.6mm 20CSP
- **KL16**: 3.0 x 2.5mm 36CSP
- **KL17**: 2.5 x 2.4 mm 36CSP
- **K02F**: 3.4 x 3.3mm 64CSP
- **K02F**: 3.4 x 3.3mm 64CSP
- **K22F**: 3.4 x 3.3mm 64CSP
- **K22F**: 3.1 x 2.9mm 48CSP
- **K22F**: 3.4 x 3.3mm 64CSP
- **K24F**: 4.8 x 5.6mm 142CSP
- **K24F**: 4.8 x 5.6mm 142CSP
- **K20**: 5.3 x 5.3mm 120CSP
- **K20**: 5.3 x 5.3mm 120CSP
- **K20**: 5.3 x 5.3mm 120CSP
- **K22F**: 4.1 x 3.6mm 80CSP
- **K22F**: 4.1 x 3.6mm 80CSP
- **K22F**: 4.1 x 3.6mm 80CSP
- **K22F**: 4.1 x 3.6mm 80CSP
- **K60**: 5.3 x 5.3mm 120CSP
- **K60**: 5.3 x 5.3mm 120CSP
- **K60**: 5.3 x 5.3mm 120CSP
- **K65**: 5.6 x 5.5mm 169CSP
- **K65**: 5.6 x 5.5mm 169CSP
- **K65**: 5.6 x 5.5mm 169CSP
- **KL02**: 64KB
- **KL03**: 64KB
- **KL02**: 64KB
- **KL03**: 64KB
- **KL02**: 128KB
- **KL03**: 128KB
- **KL02**: 128KB
- **KL03**: 128KB
- **KL02**: 256KB
- **KL03**: 256KB
- **KL02**: 256KB
- **KL03**: 256KB
- **KL02**: 512KB
- **KL03**: 512KB
- **KL02**: 512KB
- **KL03**: 512KB
- **KL02**: 1MB
- **KL03**: 1MB
- **KL02**: 1MB
- **KL03**: 1MB
- **KL02**: 2MB
- **KL03**: 2MB
- **KL02**: 2MB
- **KL03**: 2MB

*subject to change*
MCU Software Environment
Growing Importance of Enablement

- Average MCU Flash size grew x8 in the last decade
- FIRMWARE now accounts for 83% of MCU implementation cost
- 53% of projects are delayed >3 months due to FIRMWARE

Firmware is MCU developers BIGGEST pain point

- MCU Hardware
- Drivers / HAL
- RTOS Kernel
- Stacks (TCP/IP, USB)
- File Systems
- Application Specific (Audio, Motor Ctrl)
- Libraries (DSP, Math, Encryption)

Scalable Hardware = Reusable Software
Freescale Microcontroller Enablement Bundle

Solution Advisor
Part Selector
Find best-fit processors and tools with web-based interactive product selector

Development Platforms
Tower System
Low cost hardware platforms for prototyping application development

Development Tools
Kinetis Design Studio
Visual and automated framework to accelerate development time, deliver software components

Development Software
Complimentary MQX RTOS
Comprehensive solution for embedded control and connectivity

Online Enablement
Cloud enablement through freely available online design tools, communities, part selectors

Development Platforms
Freedom Development Platform

Development Tools
Processor Expert

MQX/MOX-Lite
Software Stacks and Libraries
PEG GUI Solutions
Application Notes

Online Enablement
arrow cloud connect

Confidential and Proprietary / 23
## Kinetis Design Studio

**No-cost integrated development environment (IDE) for Kinetis MCUs**

**Eclipse and GCC-based IDE for C/C++ editing, compiling and debugging**

### Product Features

- A free of charge and unlimited IDE for Kinetis MCUs
- A basic IDE that offers robust editing, compiling and debugging
- Based on Eclipse, GCC, GDB and other open-source technologies
- Includes Processor Expert (PEx) with Kinetis SDK integration
  - Supports all existing Kinetis devices via PEx and new project wizard
  - All new Kinetis devices will also feature the Kinetis SDK with PEx configurability
- Host operating systems:
  - Windows 7/8 (32 and 64-bit)
  - Linux (Ubuntu, Redhat, Centos)
  - Mac OS X (coming Q3 2014)
- Support for SEGGER, P&E and Open SDA/CMSIS-DAP debugger targets
- Support for Eclipse plug-ins including RTOS-awareness (i.e. MQX, FreeRTOS)

### Software and Hardware Evaluation & Dev Tools

<table>
<thead>
<tr>
<th>Customer Application</th>
<th>Software and Hardware Evaluation &amp; Dev Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stacks (TCP/IP, USB)</td>
<td>Libraries (DSP, Math, Encryption)</td>
</tr>
<tr>
<td>Middleware</td>
<td>Operating System</td>
</tr>
<tr>
<td>Application Specific</td>
<td>BSP, Drivers &amp; HAL</td>
</tr>
<tr>
<td></td>
<td>Bootloader</td>
</tr>
<tr>
<td>MCU Hardware</td>
<td></td>
</tr>
</tbody>
</table>

Learn more at: [www.freescale.com/KDS](http://www.freescale.com/KDS)
Kinetis Software Development Kit (SDK)

A complete software framework for developing applications across all Kinetis MCUs

Product Features
- Open source hardware abstraction layer (HAL) provides APIs for all Kinetis hardware resources
- BSD-licensed set of peripheral drivers with easy-to-use C-language APIs
- Comprehensive HAL and driver usage examples and sample applications for RTOS and bare-metal
- GUI configurable projects and peripheral drivers using Processor Expert
- CMSIS-CORE compatible startup plus CMSIS-DSP library and examples
- RTOS Abstraction Layer (OSA) with support for Freescale MQX, FreeRTOS, Micrium uC/OS, and bare-metal
- Integrates new Freescale unified USB stack, open source TCP/IP stack (lwIP), open source FAT file system, encryption math/DSP libraries, and more
- Support for multiple toolchains including GNU GCC, IAR, Keil, and Kinetis Design Studio

Learn more at: www.freescale.com/KSDK
Processor Expert

- Processor Expert (PEx) is a complimentary Eclipse plug-in tool for software configuration.
- Provides a time-saving option for software configuration through a graphical user interface (GUI).

Board configuration and driver tuning capabilities include:
- Optional generation of low-level device initialization code for post-reset configuration.
- Pin muxing tools to generate pin muxing functions.
- Components based on Kinetis SDK drivers:
  - Users configure the SoC and Peripherals in a GUI.
  - PEx creates the configuration data structures for driver config and init.
Kinetis Design Studio Projects

• 'Bare' Projects
  - 'minimal' and expert start point
  - Startup code, linker file

• Processor Expert Projects
  - Init, peripheral and device components
  - All Kinetis Devices supported!

• Kinetis SDK Projects
  - Starting point with bare Kinetis SDK
  - KSDK beta with K64F

• Kinetis SDK + Processor Expert
  - Graphical configuration of SDK
  - SDK Components

Bare and minimal projects

Fastest and easiest way to create Kinetis applications!

For the SDK Experts

Easiest and fastest way to use the Kinetis SDK
Additional Resources

Community
https://community.freescale.com/community/kinetis-design-studio

Web
www.freescale.com/kds
Kinetis K Series MCUs
Performance and Integration
Freescale Kinetis K Series MCU Portfolio

ARM Cortex-M4 solutions for a wide range of embedded applications

**1st Gen Kinetis K-Series Families**
- K70 – Graphics
- K60/K61 – Ethernet w/ optional Tamper
- K5x – Measurement (Medical)
- K40 – SLCD + USB
- K30 – SLCD
- K2x – USB
- K1x – Baseline

**2nd Gen Kinetis K-Series Families**
- K64, K66 – Ethernet MCUs
- K63, K65 – Ethernet w/ Tamper MCUs
- K5x – Measurement (Medical)
- K40 – SLCD + USB
- K30 – SLCD + USB w/ extended RAM
- K24 – USBs MCU w/ extended RAM
- K22 – USB MCUs
- K21 – USB w/ Tamper MCUs
- K12 – Baseline MCUs
- K11 – Baseline w/ Tamper MCUs
- K02 – L-Series Bridge Cortex-M4

**Performance**
- 180 MHz
- 150 MHz
- 120 MHz
- 100 MHz
- 72 MHz
- 50 MHz

**Memory Density**
- 32KB
- 64KB
- 128KB
- 256KB
- 512KB
- 1MB
- 2MB
Kinetis L Series MCUs
The world's most energy-efficient ARM-based MCUs
Kinetis L Series MCUs

**Ultra-low Power**
Architected for power efficiency, the Kinetis L series takes advantage of ARM’s ultra-low-power Cortex-M0+ core and features peripherals that help you optimize power consumption.

**Super Simple**
It's 32-bit functionality with 8-bit ease-of-use. Built on the new ARM Cortex-M0+ core (the smallest, lowest-power ARM core), the L series simplifies development with an upward migration path to Kinetis K and X series, software reuse and flexible power optimization. And, with a comprehensive enablement bundle including CodeWarrior IDE, MQX RTOS and the ARM support ecosystem, development is simple.

**Leading Scalability and Integration**
Expanding on well-known features of the Kinetis platform with leading scalability, best-in-class integration with rich analog features and low-power connectivity, the L series redefines entry-level.
# Benefits of Moving from 8/16-bit Architecture to a 32-bit Architecture Built on the ARM Cortex-M0+ Core

<table>
<thead>
<tr>
<th>8/16-bit</th>
<th>32-bit ARM Cortex-M0+</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance</strong></td>
<td><strong>Performance</strong></td>
</tr>
<tr>
<td>• Older, slower architectures and technology</td>
<td>• 2x to 40x more than 8/16-bit, 9% more than Cortex-M0</td>
</tr>
<tr>
<td>• Increased code size/complexity when performing complex math operations</td>
<td>• Fast 32-bit math processing</td>
</tr>
<tr>
<td>• Fast single-cycle access to I/O</td>
<td></td>
</tr>
<tr>
<td><strong>Energy efficiency</strong></td>
<td><strong>Energy efficiency</strong></td>
</tr>
<tr>
<td>• Low energy efficiency</td>
<td>• &gt;2x CoreMark/mA than closest 8/16-bit MCU, +30% CM0</td>
</tr>
<tr>
<td><strong>Low cost</strong></td>
<td><strong>Low cost</strong></td>
</tr>
<tr>
<td>• 6-35 k gates</td>
<td>• 12-35 k gates</td>
</tr>
<tr>
<td>• Variable code density</td>
<td>• Excellent code density</td>
</tr>
<tr>
<td><strong>Ease of development</strong></td>
<td><strong>Ease of development</strong></td>
</tr>
<tr>
<td>• Limited addressable memory</td>
<td>• Linear 4 GB address space—no need for paging</td>
</tr>
<tr>
<td>• Simplistic interrupt controllers</td>
<td>• Full-featured interrupt controller—simpler s/w architecture</td>
</tr>
<tr>
<td>• Limited scalability (MHz, flash, features)</td>
<td>• Huge scalability—h/w and s/w reuse across end products</td>
</tr>
<tr>
<td>• Limited ecosystem support</td>
<td>• Huge ARM ecosystem—off-the-shelf software/tools/training</td>
</tr>
<tr>
<td></td>
<td>• Micro Trace Buffer—lightweight, non-intrusive trace</td>
</tr>
</tbody>
</table>

Freescale and ARM collaborated to develop a revolutionary processor that **extends battery life** by improving energy efficiency, **enables advanced peripherals and software** by increasing processing performance and **reduces system cost** by improving code density.

Freescale’s MCU experts helped define key **‘8-bit-like’ processor features** including ease of use.
# Kinetis L Series MCUs Feature Overview

## Common Features

### System
- **Cortex-M0+ Core, 48/72 MHz**
- **Multi-Low-Power Modes and Peripherals, Low-Power Boot, Clock Gating**
- **1.71-3.6 V, –40 °C to 105 °C**

### Memory
- **90 nm TFS Flash, SRAM**

### Internal Memory Security/Protection
- **Analog Peripherals**
  - **12/16-bit ADC, 12-bit DAC**
  - **High-Speed Comparator**

### Serial Interfaces
- **UART (Including 1 LPUART)**
  - **SPI, PC**

### Timers
- **Real-Time Clock**
- **16-bit Low-Power TPMs (GP Timer/PWM)**

## Optional Features

<table>
<thead>
<tr>
<th>Family</th>
<th>Flash (KB)</th>
<th>SRAM (KB)</th>
<th>Pin Count</th>
<th>Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>KL46</td>
<td>128-256</td>
<td>16-32</td>
<td>64-121</td>
<td>OTG Y Y Y 16-bit 12-bit Y Y</td>
</tr>
<tr>
<td>KL42</td>
<td>128-256</td>
<td>16-32</td>
<td>48-64</td>
<td>Slave Y Y Y 16-bit 12-bit Y Y</td>
</tr>
<tr>
<td>KL36</td>
<td>64-256</td>
<td>8-32</td>
<td>64-121</td>
<td>Y Y Y 16-bit 12-bit Y Y</td>
</tr>
<tr>
<td>KL34</td>
<td>64</td>
<td>8</td>
<td>64-100</td>
<td>Y Y Y 12-bit</td>
</tr>
<tr>
<td>KL33</td>
<td>16-256</td>
<td>2-32</td>
<td>48-64</td>
<td>Y Y Y 16-bit 12-bit Y Y</td>
</tr>
<tr>
<td>KL32</td>
<td>256-512</td>
<td>128</td>
<td>64-121</td>
<td>OTG Y Y Y 16-bit 12-bit Y Y Y Y</td>
</tr>
<tr>
<td>KL27</td>
<td>256-512</td>
<td>128</td>
<td>64-121</td>
<td>OTG Y Y Y 16-bit 12-bit Y Y Y Y</td>
</tr>
<tr>
<td>KL26</td>
<td>32-256</td>
<td>4-32</td>
<td>32-121</td>
<td>OTG Y Y Y 16-bit 12-bit Y Y</td>
</tr>
<tr>
<td>KL25</td>
<td>32-128</td>
<td>4-16</td>
<td>32-80</td>
<td>OTG Y Y Y 16-bit 12-bit Y</td>
</tr>
<tr>
<td>KL24</td>
<td>32-64</td>
<td>4-8</td>
<td>32-80</td>
<td>OTG Y Y Y 16-bit 12-bit</td>
</tr>
<tr>
<td>KL23</td>
<td>16-256</td>
<td>2-32</td>
<td>32-64</td>
<td>Slave Y Y Y 16-bit 12-bit Y Y</td>
</tr>
<tr>
<td>KL16</td>
<td>32-256</td>
<td>4-32</td>
<td>32-64</td>
<td>Y Y Y 16-bit 12-bit Y Y</td>
</tr>
<tr>
<td>KL15</td>
<td>32-128</td>
<td>4-16</td>
<td>32-80</td>
<td>Y Y Y 16-bit 12-bit Y</td>
</tr>
<tr>
<td>KL14</td>
<td>32-64KB</td>
<td>4-8</td>
<td>32-80</td>
<td>Y Y Y 16-bit 12-bit</td>
</tr>
<tr>
<td>KL13</td>
<td>16-256</td>
<td>2-32</td>
<td>32-64</td>
<td>Y Y Y 16-bit 12-bit Y Y</td>
</tr>
<tr>
<td>KL05</td>
<td>8-32</td>
<td>1-4</td>
<td>24-48</td>
<td>Y Y 12-bit 12-bit Y</td>
</tr>
<tr>
<td>KL04</td>
<td>8-32</td>
<td>1-4</td>
<td>24-48</td>
<td>Y Y 12-bit</td>
</tr>
<tr>
<td>KL03</td>
<td>8-32</td>
<td>1-2</td>
<td>16-24</td>
<td>Y 12-bit Y</td>
</tr>
<tr>
<td>KL02</td>
<td>8-32</td>
<td>1-4</td>
<td>16-32</td>
<td>12-bit</td>
</tr>
</tbody>
</table>

### Memory
- **KL46, KL42**
- **KL36**
- **KL34**
- **KL33**
- **KL32**
- **KL27**
- **KL26**
- **KL25**
- **KL24**
- **KL23**
- **KL16**
- **KL15**
- **KL14**
- **KL13**
- **KL05**
- **KL04**
- **KL03**
- **KL02**

### Optional Features
- **USB, SCLD, DMA, RTC, ADC, DAC, I2S, TSI, ROM, Vref, Secure/BB**

---

[1] Feature not available on CSP packages
[2] For KL02, use software to support
Kinetis L Series MCUs: World’s Most Energy-Efficient ARM-based MCUs

- **Ultra-efficient ARM Cortex-M0+ core**
  - Very low power run at 40 uA/MHz

- **Flexible ultra-low-power modes**
  - Deep sleep down to 150 nA

- **Energy-saving architecture**
  - DMA, UART, ADC, Timers plus other peripherals functional in deep sleep

---

**Freescale KL02**

<table>
<thead>
<tr>
<th>CoreMark</th>
<th>mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>15.92</td>
</tr>
<tr>
<td>M</td>
<td>8.84</td>
</tr>
<tr>
<td>T</td>
<td>8.0</td>
</tr>
<tr>
<td>R</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>1.9</td>
</tr>
</tbody>
</table>

**MCU CoreMark/mA**

- 15.92 x1.8
## Breakthrough Power Efficiency

<table>
<thead>
<tr>
<th>Leading Dynamic Power</th>
<th>Kinetis Power Modes</th>
<th>Recovery Time</th>
<th>KL26 Measured Idd @ 3 V and 25 C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovative low-power process technology (C90TFS)</td>
<td>RUN</td>
<td>-</td>
<td>79 uA/MHz*</td>
</tr>
<tr>
<td>Low-power-focused platform design</td>
<td>VLPR</td>
<td>-</td>
<td>39 uA/MHz**</td>
</tr>
<tr>
<td>Next-generation Cortex-M0+ core</td>
<td>WAIT</td>
<td>1.6 us</td>
<td>2.7 mA @ 48 MHz</td>
</tr>
<tr>
<td></td>
<td>VLPW</td>
<td>1.6 us</td>
<td>110 uA @ 4 MHz</td>
</tr>
</tbody>
</table>

### Asynchronous DMA Wake-Up (ADMA)

<table>
<thead>
<tr>
<th>ADMA</th>
<th>Kinetis Power Modes</th>
<th>Recovery Time</th>
<th>KL26 Measured Idd @ 3 V and 25 C</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOP</td>
<td></td>
<td>1.3 us</td>
<td>301 uA</td>
</tr>
<tr>
<td>VLPS</td>
<td></td>
<td>4.2 us</td>
<td>2.3 uA</td>
</tr>
</tbody>
</table>

### Low-Leakage Wake-Up Unit

<table>
<thead>
<tr>
<th>Low-Leakage Wake-Up Unit</th>
<th>Kinetis Power Modes</th>
<th>Recovery Time</th>
<th>KL26 Measured Idd @ 3 V and 25 C</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLS</td>
<td></td>
<td>4.3 us</td>
<td>1.7 uA</td>
</tr>
<tr>
<td>VLLS3</td>
<td></td>
<td>39 us</td>
<td>1.3 uA</td>
</tr>
<tr>
<td>VLLS1</td>
<td></td>
<td>91 us</td>
<td>700 nA</td>
</tr>
<tr>
<td>VLLS0</td>
<td></td>
<td>91 us</td>
<td>139 nA /310 nA</td>
</tr>
</tbody>
</table>

* Compute Operation enabled: 4.0mA @ 48MHz core / 24MHz bus)
** Compute Operation enabled: 156uA @ 4MHz core / 1MHz bus)
Kinetis E Series MCUs
5V Vdd, EMC Robustness
Kinetis E Series MCUs

**Strong Robustness**
EMC/ESD design technology ensure strong noise immunity performance

**High Efficiency**
Cortex-M0+ core up to 48MHz and 40x more than 8/16-bit MCUs

**Low Cost**
Optimized for cost-sensitive applications offering low pin count option
Achieve Reliability with Kinetis E Series MCUs

1. Most robust portfolio based on ARM Cortex-M0+ core
   - Proven passing EFT(IEC61000-4-4) / PESD(IEC61000-4-2) tests
   - IEC60730 Class B Safety S/W routines certified by VDE
   - 5V operation provides better noise immunity
   - Lower EMI noise than 8/16bit competition

2. 3x Higher efficiency than 8/16 bit solutions
   - 3x Coremark/ MHz with 15% better code density
   - One cycle GPIO – (5 x better than nearest competitor)

3. Design made easier
   - Widely available ARM & Freescale Tools/ SW ecosystem
   - Open up your hiring options – ARM talent widely available
   - Pin compatible and Peripheral reused within Kinetis-E and S08P families
   - Freely available ESD/ EMC verification support
   - Platform SDK availability
Kinetis E Series MCUs: Master Block Diagram

Core
- Cortex M0+ @48MHz

Memory
- 128K Flash, 16K RAM, 256B EE

Communications
- SCI(LIN)x3, SPIx2, IICx2, msCAN

Analog
- 12 bit ADC, ACMPx2

Timers
- 16bit FlexTimerx3, PWT,
- 16bit RTC, 32bit PIT

Temp
- -40~105°C operation

Packages
- 80LQFP(0.65mm pitch);
- 64QFP (0.8mm pitch);
- 64LQFP(0.5mm pitch);
- 44LQFP (0.8mm pitch);
- 32LQFP (0.8mm pitch);
- 24QFN(0.5mm pitch);
- 20SOIC(1.27mm pitch);
- 16TSSOP(0.65mm pitch)

Others
- Pin compatible within KE on same package; KBIx2

---

(1) Support bit operation in RAM
(2) Faster timer running 2 x core clock
(3) 32ch KBI module
# Kinetis E Series: MCU Families

## Common Features

<table>
<thead>
<tr>
<th>System</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ARM Cortex-M0+ Core, 48MHz</td>
<td></td>
</tr>
<tr>
<td>Multiple power modes, Clock Gating, 2.7V – 5.5V</td>
<td></td>
</tr>
<tr>
<td>Operating Temp: -40 to 105°C</td>
<td></td>
</tr>
</tbody>
</table>

## Clock Management

| External OSC, 4–20MHz, 32KHz |  |
| Internal OSC, 32KHz, 1KHz |  |

## Analog Peripherals

| 12-Bit ADC |  |
| Analog Comparators |  |

## Serial Interfaces

| SCI |  |
| SPI, IIC |  |

## Timers

| Real Time Clock |  |
| 16bit Flex timers |  |
| 32bit Periodic Interrupt Timer |  |

## Optional Features

<table>
<thead>
<tr>
<th>Family</th>
<th>Speed</th>
<th>Flash (KB)</th>
<th>SRAM (KB)</th>
<th>CAN</th>
<th>Seg. LCD</th>
<th>PWT</th>
<th>Fast Timer</th>
<th>ADC</th>
<th>TSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>KE06Z</td>
<td>48MHz</td>
<td>64-128KB</td>
<td>8-16KB</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>12-bit</td>
</tr>
<tr>
<td>KE04Z128</td>
<td>48MHz</td>
<td>128KB</td>
<td>16KB</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>12-bit</td>
</tr>
<tr>
<td>KE04Z64</td>
<td>48MHz</td>
<td>64KB</td>
<td>8KB</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>12-bit</td>
</tr>
<tr>
<td>KE04Z8</td>
<td>48MHz</td>
<td>8KB</td>
<td>1KB</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>12-bit</td>
</tr>
<tr>
<td>KE02Z</td>
<td>20MHz/40MHz</td>
<td>16-64KB</td>
<td>2-4KB</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>12-bit</td>
</tr>
</tbody>
</table>

[1] 20MHz/40MHz for KE02
Kinetis V Series MCUs
Motor Control & Power Conversion MCUs
Kinetis V Series MCUs

**Motor & Power Control**

- **Full Kinetis portfolio compatibility** targeting low cost, stand alone motor control, to high performance digital power conversion
- **Optimized for processing efficiency** with performance ranging from 75MHz to beyond 200MHz
- **ARM architecture with best in class, high speed capture and control peripherals** for motor control and power management applications
- **Enablement and tools** built around reducing customer development time and cost, whilst increasing ease of use.
Kinetis V Series MCUs: Target Applications

Motor Control

- Sensored BLDC / PMSM
  - High Dynamic Control
- Sensored ACIM
- Sensorless VOC
  - PMSM/BLDC
  - High Dynamic Control
  - Low Dynamic Control
- Sensorless ACIM

Digital Power Conversion

- Solar Inverters
  - Grid-Tied
  - Non Grid Tied
- Power factor correction
- Switch Mode
  - Power Supplies
    - AC/DC
    - DC/DC
- UPS
  - On-Line
  - Offline
- Inductive cooking
  - Multi cook plate
# Kinetis V Series Portfolio Overview

## Common Features

### System
- ARM Cortex-M0+ core (H/w DIV&SQRT)
- ARM Cortex-M4 core (DSP + FPU)
- Multiple low-power modes
- Power Supply: 1.71V - 3.6V
- Operating Temp: -40 to 105°C

### Memory
- 90nm TFS Flash, SRAM
- Internal Memory Security/Protection
- Direct Memory Access Controller

### Analog
- Dual 12/16-Bit ADCs
- 12-bit DAC
- Analog Comparators

### Serial Interfaces
- UART
- SPI, IIC

### Timers
- FlexTimer (1ns) / eFlexPWM (312ps)
- 16-bit Low Power Timer
- Programmable Delay Block

## Optional Features

<table>
<thead>
<tr>
<th>Family</th>
<th>Core / MHz</th>
<th>Flash</th>
<th>SRAM</th>
<th>ADC</th>
<th>FlexTimers</th>
<th>eFlexPWM</th>
<th>DAC</th>
<th>CAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>KV4x Family: Advanced Control Systems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KV46</td>
<td>Cortex-M4</td>
<td>128-256KB</td>
<td>24-32KB</td>
<td>2x 12-bit, up to 4.1 Msps</td>
<td>Up to 18ch</td>
<td>Up to 12ch (NanoEdge)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>KV45</td>
<td>Cortex-M4</td>
<td>128-256KB</td>
<td>24-32KB</td>
<td>2x 12-bit, up to 1.9 Msps</td>
<td>Up to 18ch</td>
<td>Up to 12ch</td>
<td>-</td>
<td>Up to 2</td>
</tr>
<tr>
<td>KV44</td>
<td>Cortex-M4 w FPU 150MHz</td>
<td>64-128KB</td>
<td>16-24KB</td>
<td>2x 12-bit, up to 4.1 Msps</td>
<td>Up to 18ch</td>
<td>-</td>
<td>Up to 12ch (NanoEdge)</td>
<td>1</td>
</tr>
<tr>
<td>KV43</td>
<td>Cortex-M4</td>
<td>64-128KB</td>
<td>16-24KB</td>
<td>2x 12-bit, up to 1.9 Msps</td>
<td>Up to 18ch</td>
<td>-</td>
<td>Up to 12ch</td>
<td>-</td>
</tr>
<tr>
<td>KV40</td>
<td>Cortex-M4</td>
<td>64-256KB</td>
<td>16-32KB</td>
<td>2x 12-bit, up to 1.9 Msps</td>
<td>Up to 18ch</td>
<td>-</td>
<td>-</td>
<td>Up to 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Family</th>
<th>Core / MHz</th>
<th>Flash</th>
<th>SRAM</th>
<th>ADC</th>
<th>FlexTimers</th>
<th>eFlexPWM</th>
<th>DAC</th>
<th>CAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>KV3x Family: High Dynamic Control Systems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KV31</td>
<td>Cortex-M4</td>
<td>128-512KB</td>
<td>24-96KB</td>
<td>2x 16-bit, up to 1.2 Msps*</td>
<td>Up to 20ch</td>
<td>-</td>
<td>Up to 2</td>
<td>-</td>
</tr>
<tr>
<td>KV30</td>
<td>Cortex-M4 w FPU 100MHz</td>
<td>64-128KB</td>
<td>16KB</td>
<td>2x 16-bit, up to 1.2 Msps*</td>
<td>Up to 12ch</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Family</th>
<th>Core / MHz</th>
<th>Flash</th>
<th>SRAM</th>
<th>ADC</th>
<th>FlexTimers</th>
<th>eFlexPWM</th>
<th>DAC</th>
<th>CAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>KV1x Family: Low Dynamic Control Systems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KV10</td>
<td>Cortex-M0+ 75MHz</td>
<td>16-32KB</td>
<td>8KB</td>
<td>2x 16-bit, up to 1.2 Msps*</td>
<td>Up to 10ch</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

* 1.2Msps rate available in 12-bit mode
Kinetis V Series MCUs: 3 Phase Motor Control

- **Entry Level**
  - FOC Motor Control
- **Integrated Motor Control Solutions**
- **Scalable Mid Range Motor Control**
- **High Performance Motor Control**

- + HS ADC
- + Advanced Timers
- + Dual Motor Control
- + FPU
- + Integrated Motor Control S/W

- **Baselines**
  - KV1x
  - KV2x
  - KV3x

- **Core**:
  - ARM Cortex-M0+
  - ARM Cortex-M4

[Diagram of Kinetis V Series MCUs with KV1x, KV2x, KV3x, KV4x]
Kinetis V Series MCUs: Power Conversion

Integrated Power Control Solutions

UPS Power Control

UPS & Solar Power Control

Mid Performance AC/DC Control

Baseline

+ Nano Edge

+ HS ADC

+ CAN

Integrated PFC Solution

KV2x

KV3x

KV4x

KV4x

KV4x

Core:

ARM Cortex-M0+

ARM Cortex-M4
Kinetis V Series MCUs Product Roadmap
Motor & Power Control specific MCUs, Based on ARM Cortex-M with best-in-class Enablement

Performance

Memory Density

0
16KB
32KB
64KB
128KB
256KB
512KB
1MB
2MB

Power Control
Advanced Motor Control with comms
Non standard Multi Pole Motors

KV7x – Ultra High Performance w/ ENET & USB
KV6x – Multi Domain w/ ENET & USB
KV5x – Leading Performance w/ High Speed IP
KV4x – High Performance w/ High Speed IP
KV3x – Scalable Mid Range w/ FPU
KV2x – Low cost Complete Solutions
KV1x – Entry Level FOC Motor Control

KV1x – CM0+
KV2x – CM0+
KV3x – CM0+
KV4x – CM0+
KV5x – CM0+
KV6x – CM0+
KV7x – CM0+

VOC BLDC & PMSM
Motors with High Dynamic Control

VOC BLDC & Low End
PMSM motors with
Low Dynamic Control

KV1x – Cortex M4
KV2x – Cortex M4
KV3x – Cortex M4
KV4x – Cortex M4
KV5x – Cortex M4
KV6x – Cortex M4
KV7x – Cortex M4

Beyond

200 MHz
150 MHz
120 MHz
100 MHz
75 MHz

KV1x – Entry Level FOC Motor Control
## Kinetis V Series KV1x MCU: Features and Benefits

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortex M0+ @75MHz</td>
<td>Fastest ARM Cortex M0+ MCU in the market. Enables advanced PMSM motor control with a small footprint, cost-effective MCU</td>
</tr>
<tr>
<td>Hardware Square Root &amp; Divide blocks</td>
<td>Up to 35% performance vs. ARM Cortex-M0 based MCUs in math-intensive applications such as Sensorless FOC algorithms</td>
</tr>
<tr>
<td>2 x 16-bit ADCs with 835nS conversion times</td>
<td>Capture current &amp; voltage simultaneously for the most accurate result</td>
</tr>
<tr>
<td>4-ch DMA</td>
<td>Reduced CPU loading, improved system performance</td>
</tr>
<tr>
<td>6-ch FlexTimer + 2 x 2-ch FlexTimer</td>
<td>Motor control PWM generation with integrated PFC, or integrated speed sensor decoder (incremental decoder / hall sensor)</td>
</tr>
<tr>
<td>Integrated 6-bit DAC &amp; CMP</td>
<td>Fault detection against over-current and over-voltage. Reduced Bom costs</td>
</tr>
<tr>
<td>Peripheral Interconnection</td>
<td>ADC and ACMP interconnected with PWM and PDB for real time hardware control</td>
</tr>
<tr>
<td>Light weight peripheral and memory configuration</td>
<td>Enough performance for the majority of motor control applications, with the right amount of memory to fit complex motor control algorithms</td>
</tr>
<tr>
<td>Dual Watchdog</td>
<td>IEC60730 Compliant solution</td>
</tr>
</tbody>
</table>
## Kinetis V Series KV4x MCU: Features and Benefits

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>150MHz cortex M4 core</td>
<td>High performance core needed for the most demanding mathematically dependant applications</td>
</tr>
<tr>
<td>128bit wide, 128Bit cache</td>
<td>Fast Flash access with reduced wait states</td>
</tr>
<tr>
<td>240ns conversion time ADC</td>
<td>The fastest ADC conversion time is the Freescale Microcontroller portfolio</td>
</tr>
<tr>
<td>eFlexPWM Timer</td>
<td>The most advanced and flexible timer options available simplifying development and implementation</td>
</tr>
<tr>
<td>Nano edge timer capability</td>
<td>First Cortex solution to feature very high resolution PWM capability enabling true power conversion</td>
</tr>
<tr>
<td>Up to 30 Timer channels</td>
<td>Manage multiple control loops in parallel</td>
</tr>
<tr>
<td>Dual CAN</td>
<td>Increased systems options, perfect for UPS applications</td>
</tr>
<tr>
<td>Quadrature Encoder</td>
<td>Integrated speed sensor decoder (incremental decoder / hall sensor)</td>
</tr>
<tr>
<td>Memory Protection Unit</td>
<td>Restricts access to key modules from within user mode enabling easier certification and greater reliability.</td>
</tr>
<tr>
<td>Floating point unit as standard across family</td>
<td>Increase numeric resolution for Math Intensive calculations and enabling</td>
</tr>
<tr>
<td>Dual ADC blocks with dual sample and hold</td>
<td>Capture current &amp; voltage simultaneously for the most accurate result</td>
</tr>
<tr>
<td>Inter Module Crossbar w/ AND &amp; OR interface</td>
<td>Configure your peripheral communication as your topology demands, simplifying pin out and reducing cross peripheral &amp; CPU communication.</td>
</tr>
<tr>
<td>Dual Watchdog</td>
<td>IEC60730 Compliant Solution</td>
</tr>
</tbody>
</table>
Kinetis W Series MCUs
Embedded Wireless Connectivity
Kinetis W Series MCUs

What is Kinetis KW2x MCU?

The new Kinetis KW2x MCU is Freescale’s next-generation 2.4 GHz 802.15.4 platform.

The Kinetis KW2x MCU platform integrates a class-leading RF transceiver, ARM Cortex-M4 core, and a robust feature set for a reliable, secure and low-power IEEE® 802.15.4 wireless solution.

Wireless protocol software is seamlessly integrated into Kinetis software development tools for rapid creation of embedded systems.
**CPU**
- 50 MHz Cortex M4 CPU core
- Up to 512KB Flash & up to 64KB SRAM
- Optional (MKW21D256): 64 KB FlexNVM & 4 KB FlexRAM
- Typical current: 250 uA/MHz run, 1.7uA RTC standby

**Radio Transceiver, 2.4GHz**
- IEEE-802.15.4 compliant
- -102 dBm Rx sensitivity and +10dBm Tx output power
- Peak typical current: 17mA Tx and 19mA Rx
- Dual Personal Area Network (PAN) support in hardware
  - Run two RF networks simultaneously
  - Antenna diversity with automatic antenna selection

**Security**
- Active and passive tamper detection with RTC timestamp
- Crypto engine: DES, 3DES, AES 128-256, SHA-1, SHA-256, MD5, RNG

**Software**
- 812.15.4 2006 MAC
- RF4CE, ZigBee Pro, ZigBee IP
- ZigBee Profiles: ZSE, ZHA, ZHC, ZRC
- Freescale IPv6 Mote Stack
- MQX Lite RTOS

**System**
- UART, SPI, I2C, optional USB 2.0 FS/LS H/D/OTG
- 16-bit ADC
- Operating range: 1.8 V to 3.6 V, -40C to +105C
Kinetis KW01 Wireless MCU (Sub 1-GHz)

- **CPU**
  - 32-bit ARM Cortex M0+ 48MHz Core
  - 128KB Flash and 16KB SRAM
- **Radio transceiver, Sub 1-GHz**
  - Supports 290-344MHz, 424-510MHz, and 862-1020MHz frequency bands
  - FSK, GFSK, MSK, GMSK and OOK modulations up to 600kbps
  - Up to -120dBm Rx sensitivity @ 1.2kbps
  - -18 to +17dBm Tx output power in steps of 1dBm
- **Ultra low power for battery operated devices**
  - Typical consumption
    - 1.7μA standby with 4.3μs wake-up time
    - <50 uA/MHz CPU system run mode
    - 16 mA Rx peak
    - 20 mA Tx peak at 0 dBm, 33 mA at +10 dBm
- **Software**
  - Simple-MAC, user modifies for their proprietary protocols
- **System**
  - 16-bit ADC, Cap Touch Sensors, I2C, UART, SPI, Timers
  - Operating Range: 1.8V to 3.6V, -40C to +85C

### Device Specifications

<table>
<thead>
<tr>
<th>Device</th>
<th>Flash / Flex</th>
<th>RAM</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MKW01Z128CHN</td>
<td>128 KB</td>
<td>16 KB</td>
<td>8x8 56-pin LGA</td>
</tr>
</tbody>
</table>
Kinetis M Series MCUs
Smart Metering, Precision Measurement
## Kinetis M Series: Smart Metering & Measurement MCUs

Enabling high accuracy, secure 1-, 2- & 3-phase electricity metering solutions through a rich analog front end, hardware tamper detection and multiple low power features in a 32-bit ARM® Cortex™-M0+ MCU

<table>
<thead>
<tr>
<th>Analog Front End</th>
<th>Security &amp; HMI</th>
<th>Enablement</th>
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</thead>
</table>
| • High accuracy AFE with 4 x 24-bit Sigma Delta ADCs for simultaneous voltage and current measurement.  
• 0.1% power measurement accuracy with high SNR of 94dB and robust ESD performance (4 kV ESD, 6 kV PESD)  
• 2 x Programmable Gain Amplifiers delivering dynamic range of 200 to 1  
• 12 channel, 16-bit SAR ADC inputs for accurate measurement of phase voltage in 3-phase applications  
• Precision voltage reference with low drift over temperature and a phase shift compensator to simplify accurate power computation.  
• Auto compensated iRTC with tamper detect, fast calibration and low drift over temperature | • Core, Memory Protection Unit, Cross-Bar Peripheral Bridge, GPIO and DMA enable compliance with WELMEC & OIML regional standards requiring the separation of legally relevant (billing related) software from the main application software  
• Active and passive tamper pins with automatic time stamping to protect the meter against external intrusion.  
• Hardware Random Number Generator eases and speeds up support for encryption algorithms  
• CRC (16/32 bits) for data integrity  
• Segment LCD Controller supporting up to 288 segments and 8 backplanes. Low power blink mode operation and segment fault detect capability | • 1, 2, & 3-phase regionally specified electricity meter Reference Designs certified to international standards  
• Filter and FFT based metrology firmware provided free-of-charge  
• TWR-KM34Z50M Freescale Tower System Module compatible with multiple peripheral modules from Freescale and 3rd parties  
• Comprehensive peripheral library drivers  
• Complimentary Freescale MQX Lite RTOS  
• Freescale CodeWarrior IDE with Processor Expert code generator. ARM ecosystem support |

**freescale**

Confidential and Proprietary / 59
Kinetis Enablement
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<th>Strategic Tools Partners</th>
<th>Freescale Products</th>
<th>ARM Ecosystem Options</th>
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<td>atolllic</td>
<td>CodeWarrior for Microcontrollers</td>
<td>GNU</td>
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<tr>
<td>IAR SYSTEMS</td>
<td></td>
<td>EMPROG</td>
</tr>
<tr>
<td>Green Hills SOFTWARE</td>
<td></td>
<td>Z SYSTEM</td>
</tr>
<tr>
<td>KEIL™</td>
<td>Kinetis Design Studio</td>
<td>TASKING</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lauterbach Development Tools</td>
</tr>
</tbody>
</table>
Tower System Modular Development Platforms

MODULAR DEVELOPMENT PLATFORM FOR 8-, 16- AND 32-BIT PROCESSORS

Enables advanced development through rapid evaluation and prototyping

Product Features

- Modular and Expandable
  - Controller modules provide easy-to-use, reconfigurable hardware, can be used stand-alone
  - Interchangeable peripheral modules add functionality and make customization easy
  - Open-source hardware and standardized specifications promote customization
  - >80 modules to choose from

- Speeds Development Time
  - Open source hardware and software allow quick development with proven designs
  - Integrated debugging interface allows for easy programming and run control via standard USB cable

- Cost Effective
  - Sold individually and in complete kits, typically starting at $69 USD.
  - Tool re-use through interchangeable modules eliminates need to purchase redundant hardware

Learn more at: www.freescale.com/tower
Freescale Freedom Development Platforms

Ultra low-cost/low-power development platform

Enables quick application prototyping and demonstration of Kinetis MCU families

Product Features

- Low–cost ($12-29USD MSRP)
- Designed in an industry-standard compact form factor (Arduino R3)
- Easy access to the MCU I/O pins
- Integrated open-standard serial and debug interface (OpenSDA)
- Compatible with a rich-set of third-party expansion boards

Learn more at: www.freescale.com/freedom

Software and Hardware Evaluation & Dev Tools

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<th>Stacks</th>
<th>Middleware</th>
<th>Application Specific</th>
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<td>TCP/IP, USB</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Libraries</th>
<th>Operating System</th>
<th>Bootloader</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSP, Math, Encryption</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MCU Hardware

FRDM-KL25Z  FRDM-KL05Z  FRDM-KL46Z  FRDM-K64F (coming April 2014)
Freescale MQX™ Software Solutions

Commercial-grade MCU software platform at no cost with optional support packages

Enabling the development of connected and intelligent applications of the future

Product Features

• MQX™ Real Time Operating System Kernel
  • Deterministic multi-tasking preemptive scheduler
  • Extensive inter-task synchronization, message passing, and much more

• MQX™ Real Time Communication Suite
  Now with optional IPv6 add-on package
  • Broad networking protocol support
    (TCP, UDP, ICMP, HTTP, DHCP, FTP, Telnet, …)
  • Fully re-entrant, responsive, designed for embedded systems

• MQX™ File System
  • Embedded FAT file system compatible with FAT-12, FAT-16, or FAT-32 file systems

• MQX™ USB Host/Device Stack
  • USB 1.0/2.0; low-/full-/high-speed

• Board Support Packages
  • Pre-configured MQX Kernel, stacks, and peripheral drivers for Freescale HW

Learn more at: www.freescale.com/mqx
Freescale MQX™ Lite

Very light MQX™ kernel for Kinetis MCUs

Easy to configure – packaged as a Processor Expert component

Product Features

• MQX™ Real Time Operating System Kernel
  • Lite configuration of MQX™ Kernel requiring less than 4 KB RAM
  • All lightweight components
  • Static memory allocation
• Packaged as a Processor Expert component
• Get started in minutes – Just drop in the MQX™ Lite RTOS component to your project
• I/O capability provided by Processor Expert
• Upward code migration – MQX™ Lite RTOS is a true subset of the full MQX™ RTOS
• Available for all Kinetis K-, L-series devices and select E-series devices

Learn more at: www.freescale.com/mqx

Software and Hardware Evaluation & Dev Tools

Customer Application

Stacks (TCP/IP, USB)

Middleware

Application Specific

Operating System

Libraries (DSP, Math, Encryption)

BSP, Drivers & HAL

Bootloader

MCU Hardware

Easy to configure – packaged as a Processor Expert component

Get started in minutes – Just drop in the MQX™ Lite RTOS component to your project

I/O capability provided by Processor Expert

Upward code migration – MQX™ Lite RTOS is a true subset of the full MQX™ RTOS

Available for all Kinetis K-, L-series devices and select E-series devices

Get now within the Processor Expert Driver Suite and CodeWarrior Development Studio for MCUs
## MQX & MQX Lite Comparison

<table>
<thead>
<tr>
<th></th>
<th>MQX RTOS</th>
<th>MQX Lite RTOS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Delivery Mechanism</strong></td>
<td>Traditional installer with full source for Kernel, services and Board Support Packages</td>
<td>Processor Expert (PEx) Kernel and services component</td>
</tr>
<tr>
<td><strong>I/O Drivers</strong></td>
<td>MQX POSIX compatible drivers with option for using PEx drivers</td>
<td>PEx drivers only</td>
</tr>
<tr>
<td><strong>Configurability</strong></td>
<td>User selects needed services from full or lightweight versions</td>
<td>Reduced services available; lightweight options only</td>
</tr>
<tr>
<td><strong>Example Footprint</strong></td>
<td>&lt;10 Kbytes FLASH</td>
<td>&lt;8 Kbytes FLASH</td>
</tr>
<tr>
<td><strong>Components</strong></td>
<td>Kernel, TCP/IP stack, USB stack, file system, middleware, and peripheral drivers.</td>
<td>Kernel only, with additional components including USB stack provided by PEx</td>
</tr>
<tr>
<td><strong>Availability</strong></td>
<td>Kinetis K Series, Vybrid, select ColdFire, select Power Architecture</td>
<td>Kinetis L Series, Kinetis K Series, select Kinetis E Series</td>
</tr>
</tbody>
</table>

Learn more at: [www.freescale.com/mqx](http://www.freescale.com/mqx)