Overview of **Kinetis Microcontroller Portfolio** based on ARM® Cortex®-M0+ and Cortex-M4 Cores

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Adi Shieber | Field Application Engineer

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The Internet of Things is Driving **Explosive Growth** In Connected Devices

*Sense, Process, Communicate*

![Graph showing the growth of connected devices](image)

*Sources: Ericsson, February 2011; Cisco Internet Business Solutions Group (IBSG), April 2011*
Our Products Power The Internet of Things

Microcontrollers | Digital Networking | Auto MCU | Analog and Sensors | RF
Internet of Things – Data Transport Scheme

Medtronic's glucose monitor uses Bluetooth to "talk" to Ford Sync

Legend:
- S Sensors & Actuators
- P Embedded Processing
- C Connectivity: BAN/PAN/LAN/WAN

Application/Action
- User-driven actions via devices with screens or automatically driven actions based on data parameters

Insights/Big Data
- Data analytics for business intelligence
Freescale IoT Offerings

Xtrinsic Sensing
Intelligent Contextual Sensing.

The right combination of intelligent integration, logic and customizable software on the platform to deliver smarter, more differentiated applications.

For IoT it provides Context: Identity, Activity, Location, & Time

Edge products:
• Very small
• Low cost
• Low power
• Low complexity
• Industrial grade & robust

Connectivity BAN/ PAN/ LAN

Fully integrated Short Range radios with best in class power performance, and Powerline Communications

Kinetis Microcontrollers
Design Potential. Realized

Industry’s most scalable ultra-low-power, mixed-signal MCU solutions based on the ARM® Cortex™-M and Cortex™-M0+ architectures.

Vybrid Controller Solutions
Rich Apps in Real Time.

Real-time, highly integrated solutions with best-in-class 2D graphics to enable your system to control, interface, connect, secure and scale.

i.MX Applications Processors
Your Interface to the World.

Industry’s most versatile solutions for multimedia and display applications, with multicore scalability and market-leading power, performance & integration.

QorIQ Processors built on Layerscape Architecture
Accelerating the Network’s IQ

Industry’s first software-aware, core-agnostic networking system architecture for the smarter, more capable networks of tomorrow – end to end.

Scalable Industry Standard Solutions, Software and Development Ecosystem

Sensing
Embedded Processing
Communications
Microcontrollers/Processors Portfolio

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

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

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

Kinetis EA Series
Highly robust, enhanced ESD/EMC performance
ARM Cortex-M0+ solution for cost-sensitive automotive applications.

Kinetis Series
Extreme performance both Flash and Flashless version. Supports high speed Quad-SPI for code retrieval and execution.

Kinetis E Series
Robust, 5V ARM Cortex-M4 & ARM Cortex-M0+ MCU families for use in high electrical noise environments. Safety features for high-reliability applications.

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

integration

Leading Performance - Low Power - Scalability - Industrial-grade Reliability & Temp
# Leadership in Cortex-M

*World’s Broadest, Most Scalable Portfolio*

<table>
<thead>
<tr>
<th>Cortex M</th>
<th>Vendor</th>
</tr>
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<tbody>
<tr>
<td>900+</td>
<td>Freescale - <strong>Kinetis</strong></td>
</tr>
<tr>
<td>650</td>
<td>ST Micro</td>
</tr>
<tr>
<td>250</td>
<td>NXP</td>
</tr>
<tr>
<td>250</td>
<td>SiLabs / Energy Micro</td>
</tr>
<tr>
<td>280</td>
<td>Atmel</td>
</tr>
<tr>
<td>50</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>None</td>
<td>Renesas</td>
</tr>
<tr>
<td>None</td>
<td>Microchip</td>
</tr>
</tbody>
</table>

1<sup>st</sup> to market Cortex-M4
1<sup>st</sup> to market Cortex-M0+
Kinetis in Production
# Kinetis Platform Overview

<table>
<thead>
<tr>
<th>L</th>
<th>E</th>
<th>K</th>
<th>W</th>
<th>M</th>
<th>V</th>
<th>EA</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 MHz Cortex M0+</td>
<td>&lt;48 MHz Cortex M0+</td>
<td>&lt;180 MHz Cortex M4</td>
<td>&lt;50 MHz Cortex M4, Cortex M0+</td>
<td>&lt;48 MHz Cortex M0+</td>
<td>&gt;75 MHX Cortex M0+ &amp; M4</td>
<td>48 MHz Cortex M0+</td>
</tr>
<tr>
<td>8 KB – 512 kB Flash</td>
<td>8 KB – 128 kB Flash</td>
<td>32 KB – 2 MB Flash</td>
<td>32 KB – 512 kB Flash</td>
<td>32 KB – 128 kB Flash</td>
<td>&gt;16 KB Flash</td>
<td>8 KB – 128 kB Flash</td>
</tr>
<tr>
<td>&lt;128 KB RAM</td>
<td>&lt;16 KB RAM</td>
<td>&lt;256 KB RAM</td>
<td>&lt;64 KB RAM</td>
<td>&lt;32 KB RAM</td>
<td>&gt;4 KB RAM</td>
<td>1K-16 KB RAM</td>
</tr>
<tr>
<td>1.71 – 3.6 V</td>
<td>2.5 – 5.5 V</td>
<td>Now</td>
<td>1.71 – 3.6 V</td>
<td>Now</td>
<td>Now</td>
<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 L Series MCUs: Moving from 8-/16-bit Architecture to 32-bit
Kinetis L Series MCUs: Enabling Differentiation in Entry-Level Products

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

Ultra-low static
<1μA

Low cost
From <$0.50

Ease of use
Freedom Platform, Processor Expert and MCU Solution Advisor

Kinetis L Series MCUs
The evolution of the entry-level MCU

Going Green
Health & Safety
Net Effect
Benefits of Moving from 8/16-bit Architecture to a 32-bit Architecture Built on the ARM Cortex-M0+ Processor

<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></td>
<td>• Fast single-cycle access to I/O</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 kgates</td>
<td>• 12-35 kgates</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>
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Kinetis L Series MCUs
Design Made Simple

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

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.

Super Simple
It’s 32-bit functionality with 8-bit ease-of-use. Built on the new 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.
Kinetis L: A Scalable Portfolio
Production-qualified Cortex-M0+

- **KL0 Family**: 8–32 KB, 8-bit compatible
- **KL1 Family**: 32–256 KB, General Purpose
- **KL2 Family**: 32–256 KB, USB OTG (FS)
- **KL3 Family**: 64–256 KB, SLCD
- **KL4 Family**: 128–256 KB, USB OTG (FS), SLCD

**Pin Count**
- 16 pin
- 32 pin
- 48 pin
- 64 pin
- 80 pin
- 100 pin
- 121 pin
- 144 pin
- 256 pin

10K# Suggested Resale Price shown
The NEW Kinetis KL03

The New World’s Smallest & Most Energy Efficient 32-bit MCU
Starting with 35% smaller package size than any other competing 32-bit MCU based on ARM architecture, and designed for power efficiency, the Kinetis KL03 family takes advantage of ARM’s ultra-low-power Cortex-M0+ architecture and features peripherals that help you optimize power consumption.

Size represents actual comparison.
Kinetis L has Real Low-Power Capabilities

- **Best in Cortex-M0 class for low-power**
  Up to 25% lower power than STM32F0x, SAMD20 or NXP LPC11x (Typ.)
  50% lower power than STM32L1 in RUN mode

- **Better low-power flexibility**
  12 Low-Power Modes (incl. Compute mode) when competitor MCUs have max 7 LP Modes

- **Energy saving peripherals**
  More peripherals available in lowest-power modes (LPTMR, CMP, TSI) than competition

- **High-performance processor**
  9% increased performance from Cortex-M0 (1.77Coremark/MHz)
Kinetis K Series MCUs: Performance Without Compromise
Ultra-Scalable – Over 300 hardware and software compatible ARM Cortex-M4 MCUs with DSP + low-power, connectivity, communications, HMI and security features

Mixed Signal – Exceptional integration with fast 16-bit ADCs, DACs, PGAs and more. Powerful, cost-effective signal conversion, conditioning and control

Innovative Flex Memory – Low-power 90nm Thin-Film Storage Flash with FlexMemory offers EEPROM capability with unprecedented programming speed and endurance

Comprehensive Enablement – Freescale MQX RTOS and Eclipse-based CodeWarrior IDE, as well as IAR, KEIL and other ARM ecosystem providers
Cortex-M4: Efficient Blend

**MCU**
- Ease of use
- C Programming
- Interrupt handling
- Ultra low power

**DSP**
- Harvard architecture
- Single cycle MAC
- Floating Point
- Barrel shifter

The Cortex-M4 is ~2X more efficient on most DSP tasks than leading 16 and 32 bit MCU devices with DSP extensions.
Kinetis K 1st Generation

Key Pillars:

- **Ultra-Scalable** hardware and software compatible Cortex-M4 MCUs
- Exceptional **mixed signal** integration
- **Innovative Flex memory** offers EEPROM capability with unprecedented programming speed, low-power and endurance
- **Comprehensive enablement** – Freescale MQX RTOS and Eclipse-based CodeWarrior IDE, as well as IAR, KEIL and other ARM ecosystem providers

Key Application Examples:

- Applications requiring:
  - Rich Mixed-Signal integration
  - Broad offer of FlexMemory (EEPROM)
  - Rich HMIs (SLCD, GLCD, Touch Sensing)

1st Generation K-Series Families

- **Building Control**: Rich HMI Security & access control
- **Factory Automation**
- **Medical**: Heart rate monitors, Blood glucose monitors
- **Metering**: Flow meters, SLCD meters
- **HMI Rich Point of Sale**
- **Portable Instrumentation**

| K70 – Graphics | K60/K61 – Ethernet (optional Tamper) |
| K5x – Measurement (Medical) | K40 – SLCD + USB |
| K30 – SLCD | K20 – USB |
| K10 – Baseline |
Kinetis K Series: Original Portfolio Complete!

- **512 KB-1 MB Flash, 120-150 MHz, FPU**
- **128-512 KB Flash, 100 MHz**
- **64 KB-256 KB Flash, 72 MHz**
- **32 KB-128 KB Flash, 50 MHz**

**Feature Integration**

- **72 MHz**
  - 64-256 KB, 64-121pin
  - **K50 Family (Medical)**
    - Analog, USB, S. LCD, Ethernet, Encryption
  - **K40 Family**
    - USB, Segment LCD
  - **K30 Family**
    - Segment LCD
  - **K20 Family**
    - USB
  - **K10 Family**
    - Mixed-Signal

- **100 MHz**
  - 128-512 KB, 80-144pin
  - **K60 Family**
    - Ethernet, Encryption, USB
  - **K50 Family (Medical)**
    - Analog, USB, S. LCD, Ethernet, Encryption
  - **K40 Family**
    - USB, Segment LCD
  - **K30 Family**
    - Segment LCD
  - **K20 Family**
    - USB
  - **K10 Family**
    - Mixed-Signal

- **120-150 MHz**
  - Floating Point Unit, 512 KB-1 MB, 144-256pin
  - **K70 Family**
    - + Graphics LCD
  - **K60 Family**
    - + USB (HS), Tamper, NAND Flash, DRAM
  - **K50 Family (Medical)**
    - Analog, USB, S. LCD, Ethernet, Encryption
  - **K40 Family**
    - USB, Segment LCD
  - **K30 Family**
    - Segment LCD
  - **K20 Family**
    - USB
  - **K10 Family**
    - + NAND Flash

**Families**

- **K10 Family**
  - Mixed-Signal
- **K20 Family**
  - USB
- **K30 Family**
  - Segment LCD
- **K40 Family**
  - USB, Segment LCD
- **K50 Family (Medical)**
  - Analog, USB, S. LCD, Ethernet, Encryption
- **K60 Family**
  - + USB (HS), Tamper, NAND Flash, DRAM
- **K70 Family**
  - + Graphics LCD
- **K10 Family**
  - Mixed-Signal
- **K20 Family**
  - USB
- **K30 Family**
  - Segment LCD
- **K40 Family**
  - USB, Segment LCD
- **K50 Family (Medical)**
  - Analog, USB, S. LCD, Ethernet, Encryption
- **K60 Family**
  - + USB (HS), Tamper, NAND Flash, DRAM
- **K70 Family**
  - + Graphics LCD
K2 The next generation of Kinetis
Kinetis K2 – the Next Generation

1. Improved ease of use and time to market with **new set of product enablement**

2. New products with **head turning low power** capabilities and **processing efficiency**

3. **New price points** to open new doors to faster market share gain
Next Generation Ease-of-Use Software Development
Launch with K2 and then supporting all Kinetis Families

✓ Kinetis Software Development Kit (SDK)
  - A complete software framework for developing applications across all Kinetis MCUs
  - HAL, peripheral drivers, libraries, middleware, utilities, and usage examples.

✓ Kinetis Design Studio
  - No-cost integrated development environment (IDE) for Kinetis MCUs
  - Eclipse and GCC-based IDE for C/C++ editing, compiling and debugging

✓ Kinetis Bootloader
  - In-system flash programming over a serial connection: erase, program, verify
  - ROM or flash based bootloader with open-source software and host-side programming utilities.
Kinetis K2 Tools Solutions (Addition to existing Kinetis Enablement)

- mbed Support – Expanding to Kinetis K-Series Families
  - Rapid and easy Kinetis prototyping and development through the global mbed Developer Community providing free software libraries

- Expand Offer of K-Series Freedom Boards
  - Ultra low-cost/low-power development platform
  - Enables quick application prototyping and demonstration of Kinetis MCU families

Cloud enablement through freely available online design tools, communities, part selectors
K2 – The Next Generation of Kinetis Solutions

Key Pillars:
- Market’s Most **Comprehensive Software Development**
- New Heights in **Scalability** with **New Lows in Price**
- The Pinnacle in **Performance** and **Power Efficiency**

Key Application Examples:

<table>
<thead>
<tr>
<th>Building/Home Control</th>
<th>Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security &amp; access control</td>
<td>Gaming systems / Wearables</td>
</tr>
<tr>
<td>Factory Automation</td>
<td>Printers / Portable media players</td>
</tr>
<tr>
<td>Metering</td>
<td>Point of Sale</td>
</tr>
<tr>
<td>Smart metering</td>
<td>Remote Sensing</td>
</tr>
<tr>
<td>Grid Concentrators</td>
<td>Wireless Nodes</td>
</tr>
<tr>
<td></td>
<td>Audio &amp; Video Controllers</td>
</tr>
</tbody>
</table>

2nd Generation Kinetis K Families

- K64, K66 – Ethernet MCUs
- K63, K65 – Ethernet. w/ Tamper MCUs
- 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 MCUs
Kinetis K Series – Next Wave of Devices

Available & Scalable
Maximize R&D investment

Smart Optimization
Find perfect balance

Exceptional Enablement
Develop smart solutions faster

K66F 180 MHz
1.25 M-2 MB, 144-169-pin
K66F: Ethernet+2xUSB(HS PHY)+Ext.RAM

K64F / K24F 120 MHz
640 K-1 MB, 100-144-pin
K64F: Ethernet + USB + Ext. RAM
K24F: USB + Ext. RAM

K22F 120 MHz
256 KB-1MB, 64-144pin
K22F: USB + FPU

K22F 100 MHz
128 KB, 32-64pin
K22F: USB + FPU

Maximize R&D investment

Find perfect balance

Develop smart solutions faster

Available & Scalable

Smart Optimization

Exceptional Enablement

Higher Memory / Performance
# Kinetis K Series Portfolio

## Feature Rich MCUs
- Analog Mixed Signal
  - Up to 4x 16-bit ADCs
  - 16-bit ADCs w/ PGAs
  - AmpOp
  - TriAmp

## Analog Mixed Signal
- FlexMemory
  - EEPROM
  - Read-While-Write

## HMI:
- Touch Sensing
- Segment LCD
- Graphic LCD

## 1st Generation Key Differentiators
- K70 Family
  - Graphics LCD
- K60/K61 Family
  - Ethernet, USB
- K5x Family (Measurement)
  - Analog, USB, SLCD, Ethernet, Encryption
- K40 Family
  - Segment LCD + USB
- K30 Family
  - Segment LCD

## 2nd Generation Key Differentiators
- K66F Family
  - Ethernet + 2xUSB (HS PHY) + High RAM
- K64F Family
  - Ethernet + USB + High RAM
- K5x Family (Measurement)
  - Analog, USB, SLCD, Ethernet, Encryption
- K40 Family
  - Segment LCD + USB
- K30 Family
  - Segment LCD
- K24F Family
  - USB + High RAM
- K21/K22 Family
  - USB w/ opt. Tamper
- K11/12 Family
  - Baseline w/ opt. Tamper
- K02 Family
  - L-Series Bridge

## Power / Processing Efficiency
- Excel in Power Efficiency
- Cortex-M4 w/ FPU >100MHz from 64KB to 2MB of Flash
- Power conscious peripherals

## Streamline Feature Set
- Smart Integration: right features at the right price.
- Save BOM cost with Crystal-less USB device functionality

## Introduction of New Tools
- Kinetis Software Development Library (SDK)
- Kinetis Development Studio
- Embed support
- Expansion of ultra-low cost development board offer (Freedom Boards)

## Comprehensive Enablement - Hardware and Software Scalability
Kinetis K-Series 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
- 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
K2 Improvements over K 1st Generation

Kinetis K 2nd Generation leverages Freescale’s proven L-Series low power technology and drive a quantum performance/power efficiency leap over Kinetis K 1st Generation of Microcontrollers

✅ Highest Performance Efficiency
- Dynamic power consumption reduced of 30% compare to Kinetis 1st gen
- Half the dynamic power consumption in Very Low Power Run than previous gen

✅ Best-in-Class State Retention Low Power Modes
- Up to 50x lower currents than previous Kinetis devices at 120MHz

✅ 10x lower Shelf Mode than previous generation
- K2 Deepest low-power mode down to 150nA
K2 Leading Performance / Power Efficiency

Kinetis K 2nd Generation leverages Freescale’s proven L-Series low power technology and set a new height of performance / power efficiency for Cortex-M3/M4 MCUs

- **Highest Performance Efficiency**
  - Half the dynamic power consumption than STM32F103/F105 and STM32F3
  - 15% lower dynamic power consumption than STM32F401 and Atmel SAMG

- **Best-in-Class State Retention Low Power Modes**
  - From 5 to 50x lower currents than STM32F devices
  - 3x lower than Atmel SAM5G

- **10x lower Shelf Mode than STM32F**
  - K2 Deepest low-power mode down to 180nA