Kinetis ARM® Cortex™-M4 Microcontrollers
The most scalable portfolio of low power, mixed-signal MCUs

2010 ARM Technology Symposiums

Mohit Arora
Systems Engineer, Freescale Semiconductor
Agenda

► Product Positioning

► Key Differentiators

► Kinetis Families Overview

► Enablement (Development Tools)

► Availability

► Summary
Product Positioning
Kinetis: Overview

► The most **scalable** portfolio of **low-power ARM Cortex-M4** MCUs available today

► Innovative **90nm Thin-Film Storage Flash** with **FlexMemory** embedded EEPROM capability

► Exceptional **mixed-signal** integration

► One of the most **comprehensive ARM® enablement** portfolios, including solutions from Freescale as well as the ARM connected community
## MCU Portfolio: Solutions-Focused and Core Agnostic

### 32-bit
- **Built on...**
  - Power Architecture® Technology
  - **Kinetis**
    - based on **ARM® Cortex™-M4 core**
  - **ColdFire**
  - **ColdFire+**

  **90nm**

  - Market-leading **performance, reliability and software enablement** for automotive and industrial applications.
  - **100-400+ MIPS**
  - **50-200 MIPS**

### 16-bit
- **Digital Signal Controllers**
- **S12 and S12X**

  - Application-oriented solutions for automotive, motor control and power conversion applications.

### 8-bit
- **RS08 and S08**

  - Scalable cost & power-optimized product families for industrial, automotive and consumer applications.

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**Giving customers an ideal solution regardless of architecture preference.**
Kinetis MCUs
Scalable Mixed-Signal Consumer and Industrial Microcontroller Families

The most scalable portfolio of low-power ARM Cortex-M4 MCUs available today

Over 200 hardware and software compatible ARM Cortex-M4 devices with high performance signal processing capability and run currents of <200μA/MHz.

Innovative Low Power 90nm Thin-Film Storage Flash with FlexMemory

Offers EEPROM capability with unprecedented programming speed and endurance, capable of over 10 Million cycles

Exceptional mixed-signal integration

Flexible, High-speed, high-precision 16-bit ADCs, 12-bit DACs, Programmable Gain Amplifiers, Voltage References, and Low Power Touch Sensing lower system costs.

One of the most comprehensive ARM® enablement portfolios

Complimentary Freescale MQX RTOS and Eclipse-based CodeWarrior 10.0 IDE, as well as IAR®, KEIL™ and other ARM ecosystem providers help speed time to market

More than 200 New Parts
7 scalable families

First available broad-market MCU samples based on ARM Cortex-M4!
# Freescale’s Industrial and Multi-Market 32-bit MCU Portfolio

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Consumer</th>
<th>General Purpose</th>
<th>Energy &amp; Metering</th>
<th>Medical</th>
<th>Factory Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5V Capability</td>
<td>Low Power</td>
<td>Large, Compatible Portfolio</td>
<td>Measurement Engine</td>
<td>Precision Analog</td>
<td>Signal Processing</td>
</tr>
<tr>
<td>High-performance Timers</td>
<td>USB Connectivity</td>
<td>Full Connectivity Offering</td>
<td>Power Line Communication</td>
<td>Ultra-Low Power</td>
<td>High-Speed Peripherals</td>
</tr>
<tr>
<td>Human Machine Interface</td>
<td>Encryption</td>
<td>Low Power</td>
<td>Wireless Capability</td>
<td>Connectivity – Continua</td>
<td>Integrated Analog and Mixed-Signal</td>
</tr>
<tr>
<td></td>
<td>Touch Sensing</td>
<td>Precision Analog</td>
<td>Enablement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ColdFire+ MCUs</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Kinetis MCUs</th>
</tr>
</thead>
</table>

Offers customers **great solutions** for the architecture they **prefer**.
Key Differentiators
Memory Technology, Low power, Analog, Enablement
### 90nm TFS Flash: Differentiators

<table>
<thead>
<tr>
<th>Market Need</th>
<th>Other 90nm NVM Technologies</th>
<th>90nm TFS</th>
</tr>
</thead>
</table>
| **Reliability & Performance** | • Floating gate bit cells susceptible to charge loss when subject to even microscopic defects  
• Write times 5-10x greater | • Nanocrystal charge storage technology provides enhanced redundancy and reliability  
• Flash access times of <30ns |
| **Low stop and run currents** | • Read, program and erase down to ~2.0V  
• 3x greater run current and 5-10x greater standby currents | • Read/program/erase down to 1.71V  
• <1mA operation at low frequency |
| **EEPROM** | • No integrated EEPROM capability  
• Off-chip EEPROM has slower erase + write times (5-10 msec)  
• Off-chip EEPROM has lower endurance | • FlexMemory user-configurable as EEPROM and/or program flash  
• Write time: ~100usec  
• Erase + write time: 1.5ms |
| **Scalability** | • Area efficiency limited by cell construction | • Excellent area efficiency (low-voltage charge pump for programming). Array and analogue area efficiency allow cost-competitive low- and high-density products with single technology |

**TFS Value** = reliability, lower power, EEPROM, scalability
What is FlexMemory?

User Configurable As...

EEPROM:
- No external EEPROMs
  - Reduced system cost
- No system resource impact
  - System performance maintained
  - No complex coding schemes
- Configurable & high endurance
  - Up to 10 Million w/e cycles
- High performance
  - Fast write time = ~100 uSec
  - Erase+write = 1.5mSec
- Use cases
  - Critical data retention (power loss)
  - Frequently updated data

Main Program Memory

System SRAM

Program or Data Flash:
- Flexibility
  - Space for future expansion needs
  - Contiguous with main program Flash
- Efficient
  - Read-while-write with the main program Flash
- Use cases
  - Program Flash: bootloader code space
  - Data Flash: large data tables

FlexNVM
Firmware Co-processor
FlexRAM

Or a combination of both

EEPROM
Program/Data Flash

FlexMemory

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## Freescale FlexMemory vs. Traditional EEPROM

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Traditional Embedded EEPROM</th>
<th>FlexMemory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read-while-write with program memory</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Granularity</td>
<td>Byte write/erase</td>
<td>Byte write/erase</td>
</tr>
<tr>
<td>Write time</td>
<td>~1-5msec (byte write only)</td>
<td>~100μsec (word or byte program, brown-outs w/o loss or corruption of data)</td>
</tr>
<tr>
<td>Erase + write time</td>
<td>~5-10 msec</td>
<td>~750 μsec + ~750 μsec (1.5 msec)</td>
</tr>
<tr>
<td>Endurance</td>
<td>50-300K cycles (fixed)</td>
<td>SoC implementation and user configurable, can exceed 10M cycles</td>
</tr>
<tr>
<td>Minimum write voltage</td>
<td>≥ 2.0V</td>
<td>1.71V</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Fixed by part number</td>
<td>Programmable trade-off - quantity vs. endurance</td>
</tr>
</tbody>
</table>

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Kinetis: Low Power Capabilities

- **Flexible power modes**
  - 10 Run, Wait & STOP modes – customise power usage to application requirements

- **Industry leading 90nm process technology**
  - 1/3 dynamic power reduction vs. existing technologies
  - Intelligent power management controller reduces dynamic and leakage currents

- **Low power design techniques**
  - Clock gating: only leakage currents are incurred
  - Power gating: shuts down un-used modules reducing leakage

- **Ultra fast wake up times**
  - 4µs wake up from low leakage stop mode
  - New Low Leakage Wake-up Unit for leakage current reduction
## Kinetis Power Modes

### Typical Power Modes in an Embedded System

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run</td>
<td>Active mode</td>
</tr>
<tr>
<td>Wait</td>
<td>Low power mode</td>
</tr>
<tr>
<td>Sleep</td>
<td>Sleep mode</td>
</tr>
<tr>
<td>Stop</td>
<td>Deep sleep mode</td>
</tr>
</tbody>
</table>

### ARM Cortex M4 Power Modes

- Run
- Sleep
- VLPR
- VLPW

### Kinetis Extended Power Modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Recovery Time</th>
<th>“Typical” Idd Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run</td>
<td>4us</td>
<td>Starting @ &lt;200µA/MHz</td>
</tr>
<tr>
<td>VLPR</td>
<td>4us</td>
<td>Starting @ &lt;200µA/MHz</td>
</tr>
</tbody>
</table>

### Freescale Adds Low Leakage Wake-up Unit

- Enables complete shut-down of core logic, including WIC, further reducing leakage currents in all low power modes
- Supports 16 external input pins and 8 internal modules as wakeup sources
- Wakeup inputs are activated in LLS or VLLS modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Recovery Time</th>
<th>Idd Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLS</td>
<td>4us</td>
<td>1.2µA - 7µA</td>
</tr>
<tr>
<td>VLLS3</td>
<td>35us</td>
<td>1µA - 5µA</td>
</tr>
<tr>
<td>VLLS2</td>
<td>35us</td>
<td>750nA - 2µA</td>
</tr>
<tr>
<td>VLLS1</td>
<td>100us + EE</td>
<td>500nA - 1.5µA</td>
</tr>
</tbody>
</table>

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## Definition of Kinetis Power Modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run</td>
<td>MCU can be run at full speed.</td>
</tr>
<tr>
<td>Wait</td>
<td>Allows peripherals to function, while CPU goes to sleep reducing power consumption.</td>
</tr>
<tr>
<td>VLP Run</td>
<td>CPU and peripheral clock maximum frequency is restricted. CPU/Platform clock is restricted to 2 MHz. Flash access is restricted to 1 MHz. LVD is off.</td>
</tr>
<tr>
<td>VLP Wait</td>
<td>Similar to VLP Run, with CPU in sleep to further reduce power.</td>
</tr>
<tr>
<td>Stop</td>
<td>MCU is in static state. Lowest power mode that retains all registers while maintaining LVD protection.</td>
</tr>
<tr>
<td>VLP Stop</td>
<td>MCU is in static state with LVD operation off. Lowest power mode with ADC, LPT, RTC, LCD, HSCMP, DAC, and pin interrupts functional.</td>
</tr>
<tr>
<td>LL Stop</td>
<td>MCU is in low leakage state retention power mode. LLWU controls wakeup sources including LPT, RTC, LCD, HSCMP, DAC and select pin interrupts.</td>
</tr>
<tr>
<td>VLL Stop 3</td>
<td>MCU is placed in a low leakage mode powering down most internal logic. All system RAM contents are retained and I/O states held. LLWU controls wakeup sources including LPT, RTC, LCD, HSCMP, DAC and select pin interrupts.</td>
</tr>
<tr>
<td>VLL Stop 2</td>
<td>Similar to VLL Stop 3, with only partial system RAM retention. FlexRAM contents can optionally be retained.</td>
</tr>
<tr>
<td>VLL Stop 1</td>
<td>Similar to VLL Stop 3, with only 32 byte register file retention.</td>
</tr>
</tbody>
</table>
Kinetis Mixed Signal (Analogue)

- **16-bit SAR ADCs**
  - 1.15V minimum reference
  - Differential or Single Ended
  - Averaging by 1, 4, 8, 16, or 32
  - Automatic Compare Function
  - Triggering synchronization with DAC
  - Configurable resolution, sample time, speed and power (8/10/12/16-bit resolution)
  - Up to 20 input channels per converter

- **Voltage Reference (Vref)**
  - Trimmable
  - < 33ppm/°C temp variation (0°-50°C temp range)

- **12-bit DACs**
  - 16 word DAC FIFO
  - Hardware or software trigger

- **High Speed Comparators**
  - Programmable hysteresis control, and interrupt trigger
  -Selectable inversion on comparator output
  - Integrated 6-bit DAC for reference

- **Programmable Gain Amplifiers**
  - X64 gain

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ARM Cortex-M4 Processor Microarchitecture

► Backwards compatible with ARM Cortex-M3

► New features
  • Single cycle MAC (Up to 32 x 32 + 64 -> 64)
  • DSP extensions
  • Single Precision Floating Point Unit

► Freescale IP and Innovation
  • On-chip cache for instructions and data
  • Cross-Bar Switch for concurrent multi-master/slave accessing
  • On-chip DMA for CPU off-load
  • Low-leakage Wake-up Unit adds flexibility for low power operation

► Architected for Digital Signal Processing
  • Motor Control - advanced algorithms, longer lifespan, power efficiency
  • Automation - high calculation and algorithm bandwidth at a low cost
  • Power management – designed for low/battery powered systems
  • Audio and Video – 5x performance improvement over software, making batteries last longer
Freescale MQX + MCU

**Free MQX RTOS**

- Full-featured, scalable, proven RTOS
- Simplifies HW management, streamlines SW development
- Reduces development costs while helping to speed time to market

**Freescale MQX + MCU**

- Modular, expandable and cost-effective development platform for 8/16/32-bit MCUs and MPUs
- Rapid eval and prototyping with maximum HW reuse.
- Supported by a diverse range of MCU and peripheral plug-in boards and a growing web community

**+ Tower System**

- Eclipse environment
- Processor Expert code generation wizard
- Build, debug and flash tools
- Software analysis
- Kernel-aware debug
- Host platform support

**+ CodeWarrior IDE**

- Comprehensive solution for embedded control and connectivity
- Open source hardware platform for prototyping application development
- Visual and automated framework to accelerate development time

**One-stop-shop for silicon, IDE & RTOS**
Kinetis Families Overview
An Unmatched Range of ARM Cortex-M4 Microcontrollers

>200 individual compatible, scalable Kinetis devices announced to date!

Multiple compatible families with scalable performance, memory and peripherals
### Kinetis Product Family Features

#### AVAILABILITY
- 144 pin MAPBGA available Nov, 2010
- 144pin & 256pin MAPBGA available Early Q4 ’11
- Additional packages every other month
- <80pin packaging: Q4 2011
- Announcement Q111, samples April 2011

#### Development Tools
- Bundled IDE w/ Processor Expert
- Bundled OS USB, TCP/IP, Security
- Modular Tower Hardware Development System
- Application Software Stacks, Peripheral Drivers & App. Libraries (Motor Control, HMI, USB)
- Broad 3rd party ecosystem

#### Common System IP
- 32-bit ARM Cortex-M4 Core w/ DSP Instructions
- Next Generation Flash Memory
- High Reliability, Fast Access
- FlexMemory w/ EEPROM capability
- Memory Protection Unit
- Low Voltage, Low Power Multiple Operating Modes, Clock Gating (1.71V-3.6V with 5V tolerant I/O)
- Low-power Touch Sensing
- -40 to 105C

#### Common Analog IP
- 16-bit ADC
- Programmable Gain Amplifiers
- SRAM
- 12-bit DAC
- High-speed Comparators
- SRAM
- eSDHC

#### Common Digital IP
- CRC
- I²C
- Programmable Delay Block
- UART/SPI
- External Bus Interface
- Motor Control Timers
- RTC

#### MCU Family

<table>
<thead>
<tr>
<th>Family</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>K70 Family</td>
<td>512KB-1MB, 196-256pin</td>
</tr>
<tr>
<td>K60 Family</td>
<td>256KB-1MB, 100-256pin</td>
</tr>
<tr>
<td>K50 Family</td>
<td>128-512KB, 64-144pin</td>
</tr>
<tr>
<td>K40 Family</td>
<td>64-512KB, 64-144pin</td>
</tr>
<tr>
<td>K30 Family</td>
<td>64-512KB, 64-144pin</td>
</tr>
<tr>
<td>K20 Family</td>
<td>32KB-1MB, 32-144pin</td>
</tr>
<tr>
<td>K10 Family</td>
<td>32KB-1MB, 32-144pin</td>
</tr>
</tbody>
</table>

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K10/K20 Family Block Diagram

- Up to 150MHz ARM Cortex-M4 Core
- DSP & Floating Point Unit 1.25DMIPs/MHz
- 32-ch DMA
- (K20 Only) Full/High-Speed USB (H/D/OTG) with DCD
- NAND Flash Host Controller
- Secure Digital Host Controller
- Clock Module: 2 Crystal inputs, 2 internal oscillators, PLL and FLL
- CrossBar Switch (XBS)
- Memory Protection Unit
- FlexBus
- Up to 1M Flash Memory
- Up to 128KB SRAM
- FlexMemory: up to 16KB EEPROM or 512KB Flash
- Peripheral Bus Controllers (x2)
  - Timers
    - 4x FlexTimers
    - Carrier Modulator Timer, Programmable Interrupt Timer, Low Power Timer, Programmable Delay Block
  - Analog
    - 2x 16-bit SAR ADC
    - 12-bit DAC
    - 3x High Speed Comparators
    - 2x Programmable Gain Amplifiers
    - Internal Voltage Ref (1.2V)
  - Communications
    - 2x I2C
    - 6x UART
    - 3x SPI
    - 2x CAN
    - 2x IIS
    - 32-bit Cyclic Redundancy Check
  - Low Power Touch Sense Interface
    - Watchdog + External Watchdog Monitor
    - Up to 104 GPIO
**K10/K20 Family Overview**

**High Integration Mixed-Signal MCUs**

- **Processing Performance and FlexMemory**
  - Direct Memory Access, Cross Bar Switch, and on-chip Cache maximize bus bandwidth and Flash execution
  - FlexMemory provides on-chip, high-endurance configurable EEPROM and/or additional Flash memory

- **(K20 Only) Connect via USB AND charge a battery**
  - USB 2.0 Full-Speed Device/Host/OTG Controller with integrated transceiver, HS via ULPI interface
  - Includes Device Charge Detector (DCD) and Regulator to supports battery charging via USB for Portable Devices

- **Flexible and Powerful Mixed Signal Capability**
  - 16-bit ADC enables small signal capture for medical/sensing applications, or high speed conversions for motor control.
  - 12-bit DAC, High-Speed Comparator, and Voltage Reference on-chip reduces system cost

- **Ultra-low power with 1.71V operation**
  - Multiple low power modes and Flash & analog operation down to 1.71V – power profile optimization and prolonged battery life
  - Stop Currents <500nA, run currents <200uA/MHz

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**Enablement Bundle**

TOWER development system
Complementary MQX RTOS with USB Stack
Eclipse-Based CodeWarrior 10.0 IDE
Processor Expert Rapid Application Development Tool
IAR, Keil and full ARM Ecosystem Support
Motor Control and DSP Libraries

<table>
<thead>
<tr>
<th>Family</th>
<th>USB OTG + DCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>K10</td>
<td>-</td>
</tr>
<tr>
<td>K20</td>
<td>X</td>
</tr>
</tbody>
</table>
K30/K40 Family Block Diagram

- **Up to 100MHz ARM Cortex-M4 Core DSP**
- **1.25DMIPs/MHz**
- **16-ch DMA**
- **(K40 Only) Full-Speed USB (H/D/OTG) with DCD**
- **Clock Module:** 2 Crystal inputs 2 internal oscillators PLL and FLL
- **Secure Digital Host Controller**
- **CrossBar Switch (XBS)**
- **Memory Protection Unit**
- **Peripheral Bus Controllers (x2)**
  - **Timers** 3x FlexTimers
  - **Carrier Modulator Timer**, Programmable Interrupt Timer, Low Power Timer, Programmable Delay Block
  - **Analog** 2x 16-bit SAR ADC
  - **2x 12-bit DAC**
  - **3x High Speed Comparators**
  - **2x Programmable Gain Amplifiers**
  - **Internal Voltage Ref (1.2V)**
  - **Communications** 2x I2C
  - **6x UART**
  - **3x DSPI**
  - **2x CAN IIS**
  - **32-bit Cyclic Redundancy Check**
  - **Segment LCD** (8x40 /4x44)
  - **Low Power Touch Sense Interface**
  - **Watchdog + External Watchdog Monitor**
  - **Up to 98 GPIO**

**FlexMemory:** up to 4KB EEPROM or 256KBFlash

Up to 512KB Flash Memory

Up to 128KB SRAM

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For Segment LCD HMI Applications

► Flexible, low power LCD Interface
  • Segment LCD Blink mode lowers average power
  • Segment Failure Detection prevents erroneous readouts and reduces LCD test cost
  • Front/back plane reassignment provides pin-out flexibility and allows configuration changes in firmware

► Diverse communications suite
  • A multitude of serial interfaces, with UART support for ISO7816 SIM/Smart Cards & IrDA interfaces
  • Dual CAN for industrial network bridging

► System reliability & safety
  • Hardware Cyclic Redundancy Check safeguards memory contents and communication data
  • Memory Protection Unit – increase SW reliability
  • Independently-clocked watchdog prevents code runaway for fail-safe applications e.g. IEC60730

► Hardware and software compatibility
  • Common packages & peripherals across families enable rapid feature growth with minimal hardware & software disruption

Enablement Bundle
TOWER development system
Complementary MQX RTOS with USB Stack
Eclipse-Based CodeWarrior 10.0 IDE
Processor Expert Rapid Application Development Tool
IAR, Keil and Full ARM Ecosystem Support
Motor Control Software Library, IEC60730 test routines
K60/K70 Family Overview

Higher Performance, Security, & Connectivity

► Real-time Ethernet for precision automation
  • IEEE 1588 hardware time stamping & clock synchronization enables accurate, deterministic control over Ethernet networks

► (K70 only) Graphical LCD for advanced user interfaces
  • Single-chip QVGA support possible, allowing use of lower-cost displays without Chip-on-Glass capability
  • Up to 24-bit SVGA with external memory support

► Robust system security with tamper detection
  • Tamper detection with voltage, frequency, and temperature monitoring. External sensor support for physical attack detection

► Hardware Encryption for secure data transfer & storage
  • Significantly faster than software implementations while consuming minimal system resources.
  • Supports numerous algorithms with hardware assisted software routines – SSH, SSL, IPSec, etc

Enablement Bundle
TOWER development system
Complementary MQX RTOS with TCP/IP & USB Stack
Eclipse-Based CodeWarrior 10.0 IDE
Processor Expert Rapid Application Development Tool
IAR, Keil and Full ARM Ecosystem Support
Graphics LCD and Encryption libraries

<table>
<thead>
<tr>
<th>Family</th>
<th>Graphics LCD Controller</th>
<th>IEEE 1588 Ethernet / Encryption / Tamper Detect</th>
</tr>
</thead>
<tbody>
<tr>
<td>K60</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>K70</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
**Pin Compatibility Across Families**

**K10 → K20 & K30 → K40 = Add USB with almost zero changes**
- The only difference will be 4 extra USB pins and 4 less digital I/O pins

**K10 → K30 & K20 → K40 = Add Segment LCD with minimal board layout changes**
- Digital & Analog I/O signals maintain placement order
- Segment LCD signals are muxed with existing Digital & Analog I/O signals
- Most Digital I/O signals muxed with Segment LCD signals become available on added pins by larger package

**K20 → K60 = Add Ethernet with NO changes**
- All Ethernet signals are muxed with existing Digital & Analog I/O signals

**DIGITAL I/O = UART, SPI, I2C, CAN, TIMER, etc.**

**ANALOG I/O = OSC, ADC, CMP, etc.**
# Package Options

<table>
<thead>
<tr>
<th>Type</th>
<th>Body Size</th>
<th>Pitch</th>
<th>Families</th>
</tr>
</thead>
<tbody>
<tr>
<td>32-pin QFN</td>
<td>5 x 5 mm</td>
<td>0.5 mm</td>
<td>K10, K20</td>
</tr>
<tr>
<td>48-pin QFN</td>
<td>7 x 7 mm</td>
<td>0.5 mm</td>
<td>K10, K20</td>
</tr>
<tr>
<td>48-pin LQFP</td>
<td>7 x 7 mm</td>
<td>0.5 mm</td>
<td>K10, K20</td>
</tr>
<tr>
<td>64-pin QFN</td>
<td>9 x 9 mm</td>
<td>0.5 mm</td>
<td>K10, K20, K30, K40</td>
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<tr>
<td>64-pin LQFP</td>
<td>10 x 10 mm</td>
<td>0.5 mm</td>
<td>K10, K20, K30, K40</td>
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<td>80-pin LQFP</td>
<td>12 x 12 mm</td>
<td>0.5 mm</td>
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<tr>
<td>81-pin MAPBGA</td>
<td>8 x 8 mm</td>
<td>0.65 mm</td>
<td>K10, K20, K30, K40</td>
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<tr>
<td>100-pin LQFP</td>
<td>14 x 14 mm</td>
<td>0.5 mm</td>
<td>K10, K20, K30, K40, K60</td>
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<tr>
<td>104-pin MAPBGA</td>
<td>8 x 8 mm</td>
<td>0.65 mm</td>
<td>K10, K20, K30, K40, K60</td>
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<tr>
<td>144-pin LQFP</td>
<td>20 x 20 mm</td>
<td>0.5 mm</td>
<td>K10, K20, K30, K40, K60</td>
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<tr>
<td>144-pin MAPBGA</td>
<td>13 x 13 mm</td>
<td>1.0 mm</td>
<td>K10, K20, K30, K40, K60</td>
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<td>196-pin MAPBGA</td>
<td>15 x 15 mm</td>
<td>1.0 mm</td>
<td>K60</td>
</tr>
<tr>
<td>256-pin MAPBGA</td>
<td>17 x 17 mm</td>
<td>1.0 mm</td>
<td>K60</td>
</tr>
</tbody>
</table>

- **QFN/LQFP packages** optimized for cost reduced 2 layer board designs
- **MAPBGA packages** optimized for cost reduced 4 layer board designs
Enablement (Development Tools)
The Freescale Tower System

► A modular development platform for 8/16/32-bit MCUs & MPUs
  • Quickly combine Tower Modules to build a prototype of your application
  • Modules sold individually or in kits
  • Open Source: Build your own Tower Module to integrate your IP
  • Cost-optimized hardware
  • Software support from Freescale and Third Parties
  • Growing community of Third Party hardware support
  • On-line community: www.towergeeks.org

Rapidly build a prototype of your end application

MCU/MPU Module:
  • Tower controller board
  • Standalone or in Tower System

Peripheral Module:
  • Up to 3 per system: Serial, Memory, LCD...
  • Mix & match with different MCU modules

Primary Elevator

Board Connectors

Secondary Elevator

Support for all Kinetis MCUs!
## Kinetis Tower Systems: Overview

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Contents</th>
<th>Price (SRP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TWR-K40X256</td>
<td>TWR-K40X256 module (includes TWRPI-SLCD daughter card)</td>
<td>$69</td>
</tr>
<tr>
<td>TWR-K40X256-KIT</td>
<td>TWR-K40X256 module (includes TWRPI-SLCD daughter card) TWR-ELEV module TWR-SER module</td>
<td>$139</td>
</tr>
<tr>
<td>TWR-K60N512</td>
<td>TWR-K60N512 module</td>
<td>$69</td>
</tr>
<tr>
<td>TWR-K60N512-KIT</td>
<td>TWR-K60N512 module TWR-ELEV module TWR-SER module</td>
<td>$139</td>
</tr>
</tbody>
</table>

### Hardware Features

- Low power touch sensing
- Tower plug in socket - add additional components: Sensors, Radio, Adaptor etc…
- USB accessible to peripheral modules
- Integrated, open-Source JTAG, On board SD Card,
- Segment LCD daughter card
- Ethernet accessible to peripheral modules

TWR-K40X256(-KIT) only
TWR-K60N512(-KIT) only
Free Scalable, fully-featured and proven RTOS with 32-bit MCUs

- Full-featured and powerful
  - BSPs incorporate tightly integrated RTOS, Middleware (USB, TCP/IP stacks), file system, and I/O drivers
  - Designed for speed and size efficiency

- Market proven
  - Available on Freescale processors for > 15 years
  - Used in millions of products including Medical and Heavy Industrial applications

- Simple and scalable
  - As small as ~10KB for smallest implementation, or scale up to support sophisticated networking and threading
  - Intuitive API & modular architecture enables straightforward fine-tuning of features
  - Production source code provided

- Similar to other “pay-for” software OS

Software integration headache

- $95K (USD) of free Software

Integrated MQX Solution

- Stable
- Upgradable
- Easy to maintain
MQX: What’s free and what’s add-on?

**Free Components**
- RTOS (Full priority-based, pre-emptive scheduler)
- Real-time TCP/IP Communication Suite (RTCS) - TCP/IP, FTP, Telnet, DHCP, SNMP etc.
- USB Host – PHDC (medical), HID, MASS, HUB, CDC
- USB Device - HID, MASS, CDC, PHDC
- MS-DOS File System (MFS)
- BSP I/O Driver: CAN, UART etc…
- Basic HTTP Web server
- Benchmarking Tool
- Base Support: Freescale TIC, FAE, AE
- Compatible Freescale embedded GUI Library

**Add-on Components**
- IAR* & CW: MQX Task Aware Debugging integrated within tools
- Freescale - Level 2 Support
- Bluetooth
- RTA & IXXAT: Industrial Protocols - 1588, CANopen etc.
- Freescale Low Cost nanoSSL™ and nanoSSH™
- Segger: Graphic Libraries
Available Tower System Modules

Processor Modules ($39-$69)
- TWR-MCF51CN
- TWR-MCF5225X
- TWR-S08LL64
- TWR-MPC5125
- TWR-MCF51MM
- TWR-S08MM128

Peripheral Modules ($15 – $149)
- TWR-SER
- TWR-PROTO
- TWR-ELEV
- TWR-MEM
- TWR-SENSOR-PAK
- TWR-LCD
- MED-EKG

Coming Soon
- TWR-WIFI-RS2101
- TWR-WIFI-G1011MI
- TWR-ADCDAC-LTC
- TWR-SER2
- TWR-AUDIO

New
- TWR-K60N512
- TWR-K40X256
- TWR-MCF5441X
- TWR-MCF51AG
- TWR-56F8257

www.freescale.com/tower
IAR Embedded Workbench - IDE

- Reliable, Powerful and Easy to Use
- The most widely used C/C++ tool chain for ARM MCUs
- Support for Kinetis 10/20/30/40/60, ColdFire+ and ColdFire
- Advanced trace debug functionality
  - Power debugging - optimize for power consumption with power profiling
  - Timeline shows graphical representations of power consumption, call stack, variable values and interrupt activity over time
  - Function profiling and code coverage
  - ETM and SWO trace support
- Freescale MQX™ RTOS integration
- Ready-made project templates
- Project examples for the Freescale Tower system
- Professional technical support organization
- Availability:
  - IAR Kinetis KickStart Kit
  - Now! Contact an IAR Systems sales office.
  - Also Freescale Version available via Freescale Buy Direct – Q4 2011

www.iar.com/ewarm to download
CodeWarrior Development Studio for Microcontrollers v10.1

► Integrated development tool suite for ColdFire, Kinetis and S08 architectures based on the Eclipse open development platform
  • Project Wizard creates a new project in as few as 9 clicks
  • MCU Change Wizard retargets a project to a new processor in as few as 6 clicks
  • CodeWarrior optimizing C/C ++ compilers for ColdFire and Kinetis Microcontrollers included
  • Extensions to Eclipse CDT to provide sophisticated features to troubleshoot and repair embedded applications
  • Processor Expert combines easy-to-use component-based application creation with an expert knowledge system
  • Trace and profile support for on-chip trace buffers to provide emulator-like debug capability without additional hardware
  • Kernel-aware debug for MQX, Linux® and OSEK
  • CodeWarrior Special Edition is a complimentary version up to 128KB code size

Beta version: Nov 2010
Production version: Jan 2011

www.freescale.com/codewarrior

“Processor Expert” demo http://www.youtube.com/watch?v=4GY1SI_Bj_s
Choose Your Partner: The Freescale Microcontroller Ecosystem

<table>
<thead>
<tr>
<th>Run-Time Software: RTOS, Stacks, File System</th>
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<tbody>
<tr>
<td>ARM® Cortex™ Microcontroller Software Interface Standard - hardware abstraction layer</td>
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<table>
<thead>
<tr>
<th>HW BDM Debugger/Emulators</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE Micro</td>
</tr>
<tr>
<td>IAR Systems</td>
</tr>
<tr>
<td>SEGGER</td>
</tr>
<tr>
<td>Raisonance</td>
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<tr>
<td>Lauterbach Instrument Tool</td>
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<tr>
<td>Rowley Associates</td>
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<table>
<thead>
<tr>
<th>IDE: Tools Compliers, Debuggers</th>
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</thead>
<tbody>
<tr>
<td>CodeWarrior</td>
</tr>
<tr>
<td>CodeSourcery</td>
</tr>
<tr>
<td>IAR Systems</td>
</tr>
<tr>
<td>KEIL</td>
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<td>GNU Tools</td>
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<table>
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<tr>
<th>MQX Support / Design Services</th>
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<tbody>
<tr>
<td>EAI</td>
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<tr>
<th>Audio/Video Codecs</th>
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<td>AllGo (embedded)</td>
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<table>
<thead>
<tr>
<th>GUI Graphical</th>
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<tbody>
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<td>SEGGER</td>
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<table>
<thead>
<tr>
<th>Security / Medical</th>
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<tbody>
<tr>
<td>mocana</td>
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<table>
<thead>
<tr>
<th>EVBs &amp; System Design</th>
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<tr>
<td>IXXAT</td>
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</table>

<table>
<thead>
<tr>
<th>Ind. Protocol Stacks</th>
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<tbody>
<tr>
<td>IXXAT</td>
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Availability
Kinetis High-Level Sample Schedule

K10, K20, K30, K40, K60
128KB - 512KB Flash

- DSP library released
- 144pin MBGA Tower EVBs
- IAR Production
- MQX 3.6.1 patch Kinetis
- 144pin LQFP
- C/W 10 Production
- 144pin MBGATower EVBs
- IAR Production
- MQX 3.6.1 patch Kinetis
- 144pin LQFP
- C/W 10 Production
- 104pin MBGA
- 100pin LQFP
- 80pin LQFP

K10, K20, K60, K70
512KB - 1MB Flash

- * First K70 Samples
- 256MBGA
- 144MBGA
- 1MB Flash
- FPU
- NAND Flash Controller
- DRAM Controller
- Tamper Detect
- Graphic LCD Controller

K10, K20, K30, K40
32KB - 256KB Flash

- 64pin LQFP
- AVAILABLE:
- 500nA low power mode
- <200mA/MHz run power
- 32pin LQFP
- 48pin LQFP
<table>
<thead>
<tr>
<th>Part #</th>
<th>10K# SRP (USD)</th>
<th>Family / Package</th>
<th>Key Features</th>
<th>CPU Speed</th>
<th>Flash / SRAM</th>
<th>Flex Memory</th>
<th>MPU / CRC</th>
<th>DMA</th>
<th>EBI</th>
<th>SDHC</th>
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<tbody>
<tr>
<td>PK60N512VMD100</td>
<td>$5.50</td>
<td>K60 144 MAPBGA</td>
<td>Ultra low power, Mixed Signal, IEEE1588 E'net, USB OTG (LS/FS + DCD), Encryption</td>
<td>100MHz</td>
<td>512KB / 128KB</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PK60X256VMD100</td>
<td>$5.30</td>
<td>K60 144 MAPBGA</td>
<td>Ultra low power, Mixed Signal, IEEE1588 E'net, USB OTG (LS/FS + DCD), Encryption</td>
<td>256KB / 64KB</td>
<td>256KB</td>
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<tr>
<td>PK40N512VMD100</td>
<td>$5.30</td>
<td>K40 144 MAPBGA</td>
<td>Ultra low power, Mixed Signal, USB OTG (LS/FS + DCD), Segment LCD (40x8/44x4)</td>
<td>256KB / 64KB</td>
<td>256KB</td>
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<td>PK40X256VMD100</td>
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<td>K40 144 MAPBGA</td>
<td>Ultra low power, Mixed Signal, USB OTG (LS/FS + DCD), Segment LCD (40x8/44x4)</td>
<td>100MHz</td>
<td>512KB / 128KB</td>
<td>-</td>
<td>Yes / Yes</td>
<td>16ch</td>
<td>Yes</td>
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<td>512KB / 128KB</td>
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<td>PK30X256VMD100</td>
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<td>K30 144 MAPBGA</td>
<td>Ultra low power, Mixed Signal, Segment LCD (40x8/44x4)</td>
<td>256KB / 64KB</td>
<td>256KB</td>
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<td>PK20N512VMD100</td>
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<td>K20 144 MAPBGA</td>
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<td>512KB / 128KB</td>
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<td>PK10N512VMD100</td>
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</table>
### November 2010 Launch Silicon (continued)

NOTE: Matrix is continued from previous slide

<table>
<thead>
<tr>
<th>Part #</th>
<th>UART / SPI / IIC / IIS / CAN</th>
<th>CMT / TSI</th>
<th>PWM (G.P) / PWM (QDEC) / PWM (IEEE 1588)</th>
<th>LPT / PIT / PDB</th>
<th>16bit ADC</th>
<th>PGA / 12-bit DAC / ACMP</th>
<th>GPIO</th>
<th>5V Tol.</th>
<th>Voltage / Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>PK60N512VMD100</td>
<td></td>
<td>1x 8ch / 2x 2ch / 1x4ch</td>
<td>(15chSE + 3chDP) + (18chSE + 3chDP)</td>
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<td>100</td>
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<tr>
<td>PK60X256VMD100</td>
<td></td>
<td>1x 8ch / 2x 2ch / 1x4ch</td>
<td>(15chSE + 3chDP) + (18chSE + 3chDP)</td>
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<td>98</td>
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<tr>
<td>PK40N512VMD100</td>
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<td></td>
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<td>2 / 2 / 3</td>
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<td>Yes</td>
<td>1.71-3.6V / -40 to 105C</td>
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<tr>
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<td>(15chSE + 3chDP) + (18chSE + 3chDP)</td>
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<tr>
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<td>(19chSE + 3chDP) + (18chSE + 3chDP)</td>
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<tr>
<td>PK30X256VMD100</td>
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<td>(15chSE + 3chDP) + (18chSE + 3chDP)</td>
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<td>(19chSE + 3chDP) + (18chSE + 3chDP)</td>
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<td>(19chSE + 3chDP) + (18chSE + 3chDP)</td>
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<tr>
<td>PK10X256VMD100</td>
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<td>(15chSE + 3chDP) + (18chSE + 3chDP)</td>
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</tr>
</tbody>
</table>
Freescale Product Longevity Program

► The embedded market needs **long-term product support**

► Freescale has a longstanding track record of providing **long-term production support** for our products

► Freescale offers a **formal product longevity program** for the market segments we serve

  • For the automotive and medical segments, Freescale will make a broad range of program devices available for a minimum of **15 years**

  • For all other market segments in which Freescale participates, Freescale will make a broad range of devices available for a minimum of **10 years**

  • **Life cycles** begin at the time of launch

► For terms and conditions and to obtain a list of available **Freescale products**, please see: [www.freescale.com/productlongevity](http://www.freescale.com/productlongevity)
Summary

- 200 scalable devices from 32KB to 1MB of flash and up to 150MHz performance
- FlexMemory delivering on-chip EEPROM
- Incredible mixed-signal integration and low power capability
- Complete enablement
  - Free MQX RTOS
  - Free CodeWarrior IDE
  - Tower system for rapid prototyping

Kinetis: the future of microcontroller technology
**Free Embedded Graphic Library (eGUI)**  
*Available Q410*

- Very lightweight software component allowing graphics LCD panels to be driven from small microcontrollers

- Structure of driver brings complete software solution for applications needing a color LCD screen

- Touch screen capability. Organization done by screen with high level objects

- Very light RAM and FLASH footprint

- eGUI version 1.0 + MQX RTOS Support

- Both Types of LCD Driving Methods
  - Traditional LCD System (Dedicated LCD MPU)
  - SPI/Parallel driven LCD (Can be driven from any MCU)

www.freescale.com/egui
Freescale acquired key assets of Swell Software on August 18, 2010, an industry leader in GUI software tools.

Swell Software provides **Graphical User Interface (GUI) Solutions for Embedded Devices.** The PEG family of tools are designed to meet widely varying power, performance and memory requirements. Helping our customers:

- Reduce product development risk
- Lower in-house development costs
- Accelerate time to market

PEG Software accelerates GUI design for embedded devices by allowing developers to create prototypes on a Windows or Linux-based PC by providing a complete visual layout and design tool to enable GUI design to take place in parallel to the embedded software/hardware development.

The PEG WindowBuilder™ automatically generates C++ source code that is ready to be compiled and linked into any application, further accelerating the deployment of the final product.
PEG® Product Family

**PEG Pro™**
- Screen transitions
- Multiple alpha-blended windows
- True anti-aliasing
- Gradient manager
- Open GL support
- Written in C++

**PEG+™**
- Multiple window updates
- Alpha-blended images
- Run-time image decoders & language resources
- Custom widget integration
- Dynamic themes
- Written in C++

**C/PEG™**
- Designed for:
  - Small LCDs (QVGA)
  - Low color-depth
- Very small footprint
- Single window update
- Multi-language capable
- Written in ANSI C

One of the smallest footprints and most efficient code bases available

<table>
<thead>
<tr>
<th>PEG Pro™</th>
<th>PEG+™</th>
<th>C/PEG™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting 225 KB</td>
<td>Starting at 128 KB</td>
<td>Starting at 64 KB</td>
</tr>
<tr>
<td>Typical 225-250 KB</td>
<td>Typical 160-175 KB</td>
<td>Typical 90-110 KB</td>
</tr>
</tbody>
</table>

Professional Services team provides custom consulting & software development.

Driver Development • UI Development • Graphic Design

Pricing starts as low as $4995 for a developer project license with 3 seats.
New features on TSS 2.5:

- Touch Sensing Input (TSI) in new Kinetis and Coldfire+ devices.
- Improved touch detection algorithm for reduced false touches under electrical noise.
- Simpler interface
- No need of external components per electrode

Key Features:

- Full API set support
- Support up to 64 electrodes
- No need of extra IC
- Configurable rotary, slider and keypad decoders with optimized buffer structure enabling any arrangement of electrodes.
- Smart auto-calibration mechanisms to prevent environmental hassles
- Noise rejection algorithms, new IIR filtering
- New KBI and IC functions for TSS ATL method
- Ability to enable and disable keys on runtime
- Auto repeat, stuck-up key, gorilla hand and other typical HMI function capabilities
- Ability to co-exist with other application code
- PC GUI application for electrode characterization
- Support multiple communication protocols: I2C, LIN, CAN, SPI, USB and more
- Possibility to have other peripherals working at the same time: LCD, LEDs, buzzer, ADC, other sensors, and more.

http://www.freescale.com/touchsensing

TWR-SENSOR-PAK
Sensor module featuring multiple plug-in sensors including inertial, pressure and touch sensors
Development Tools, RTOS and Middleware
Kinetis – ARM Cortex™ M4

► All tools & RTOSes owned, created and supported by Green Hills
► World’s largest ARM software tools supplier

Full Featured Real-Time Executive

- Ultra-small (2KB), fast, simple to use
- Royalty-free, includes source code
- TCP/IP v4/v6 networking suite
- Wear leveling Flash and MS/DOS file system
- USB device/mass storage class
- Embedded graphics library

μ-velOSity

JTAG and Trace Hardware Probes

- Green Hills Probe – multiuser, high-speed debugging, download, flash programming via Ethernet or USB
- SuperTrace Probe – non-intrusive trace, download, and debugging via ARM Embedded Trace (ETM)

Advanced Development

Target markets

- Printers, barcode scanners
- Programmable logic controllers
- Smart meters, remote sensors
- Building automation, HVAC
- Heart rate monitors, Blood analyzers
- Instrumentation clusters
- Surveillance cameras

High quality, professional grade
Keil Microcontroller Development Kit (MDK-ARM) - IDE

Leading supplier of MCU development tools

- ANSI C/C++ compilers,
- Debuggers and Simulation
- Middleware components

Extensive Device Database®

- Directory of over 700 supported ARM MCUs

Established support

- Phone, Email, Web and User Group Support

Huge installed base

- 100K+ users world wide

Best-in-class compilation tools

- Architecture-specific optimizations
- Smaller and faster code reduces system cost

**Availability:**

- Contact an ARM sales office.
- Also Freescale Version available via Freescale
  Buy Direct – TBD

MicroLib optimized C Libraries

- Superset of standard ARM C Library
- Optimized for embedded applications

Additional support for the Cortex-M4

- Supports Thumb2 Instruction sets including DSP and FPU
- CMSIS Signal Processing Library support
USB powered BDM emulator

- **J-link**
  - Support IDEs such as IAR, Keil, Code Sourcery, CodeWarrior and more
  - Supports JTAG, SWD, SWV Interface
  - Supported CPUs: Any ARM7,9,11, Cortex-M0, M1, M3, M4, R4.
  - Flash breakpoints allow the user to set an unlimited number of software breakpoints when debugging in flash memory.
  - Performance Comparison: (Download into RAM):
  - Embedded Trace Buffer (ETB) support

 Addition Software

- J-Link GDB Server – a remote server for the GDB.
- J-Flash (PC software) - program your Flash EEPROM devices via the On-Chip Debug connector (JTAG) on your target system.

 Flasher ARM

<table>
<thead>
<tr>
<th>Product</th>
<th>Cost</th>
<th>Peak download into RAM (KByte/sec)</th>
<th>Added Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segger J-Link Ultra</td>
<td>$648</td>
<td>1440</td>
<td>JTAG speed up to 25MHz Hi-Speed USB On Board FPGA</td>
</tr>
<tr>
<td>Segger J-Link</td>
<td>$299</td>
<td>720</td>
<td>JTAG speed up to 12MHZ</td>
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<tr>
<td>Segger J-Link Lite</td>
<td>In KIT</td>
<td>280</td>
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<tr>
<td>Abatron BDI2000</td>
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<td>340</td>
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<tr>
<td>ARM RealView Multi-ICE</td>
<td></td>
<td>130</td>
<td></td>
</tr>
</tbody>
</table>

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<tr>
<th>Product</th>
<th>Cost</th>
<th>JTAG speed of</th>
<th>Added Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Source JTAG</td>
<td>Free</td>
<td>250KHz</td>
<td>Built-in to Tower</td>
</tr>
<tr>
<td>Universal Multilink</td>
<td>$99</td>
<td>1MHz</td>
<td>Support Many architectures</td>
</tr>
<tr>
<td>Universal Multilink FX</td>
<td>$399</td>
<td>10MHz</td>
<td>Data Monitor, High Speed</td>
</tr>
<tr>
<td>Universal Multilink Trace</td>
<td>$999</td>
<td>30MHz</td>
<td>External Trace, Very High Speed</td>
</tr>
</tbody>
</table>