Freescale ARM® MCUs and MPUs: A Review of the Industry's Broadest Portfolio of SoCs Based on ARM Technology

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Regional Sales
Comprehensive Portfolio Based on ARM Technology

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.

Vybird 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 Application 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.

Automotive

Kinetis
Vybird
QorIQ

Industrial

Freescale has the industry’s broadest range of solutions built on ARM® technology for automotive, industrial, consumer and networking applications.

Find your ideal solution at the price, performance and power level you desire, and leverage the extensive software and tool bundles available to speed and ease your design process.

Consumer

Networking
**Scalability** – 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

**Flex Memory** – Fast, low-power 90nm Thin-Film Storage Flash. Innovative FlexMemory technology delivers fast, flexible, high-endurance on-chip EEPROM

**Enablement** – Freescale bundled MQX RTOS and CodeWarrior IDE with Processor Expert auto code generator. 3rd party support from IAR, KEIL and other ARM ecosystem providers
Kinetis Portfolio Roadmap

**Kinetis X Series**
High-performance ARM Cortex-M4/Mx MCU families with advanced memory and feature integration for robust, networked industrial and consumer systems.

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

**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+ & ARM Cortex-M4 MCU families for use in high electrical noise environments. Safety features for high-reliability applications.

**Kinetis W Series**
Integrated wireless connectivity ARM Cortex-M4 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.

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

1Q14

1Q14 (samples now)

Coming 3Q14

1Q14

Leading Performance - Low Power - Scalability - Industrial-grade reliability & temp

Freescale Bundled IDE, RTOS & Middleware - Rapid prototyping Platform - Broad ARM Ecosystem Support

Coming 1Q14

Comes 2013

Comes 1Q14

Comes 1Q14
Kinetis K Series:
Unmatched Range of ARM® Cortex™-M4 Microcontrollers

Pin Count

32KB | 32-pin
64KB | 48-pin
128KB | 64-pin
256KB | 80-pin
512KB | 100/121-pin
1MB | 144-pin

K10: Low Power
K20: USB OTG (FS/HS)
K30: Segment LCD
K40: USB (FS) + Segment LCD
K50: Precision Analogue, IEEE 1588 Ethernet, USB OTG (FS/HS), Segment LCD, Encryption
K60: IEEE 1588 Ethernet, USB OTG (FS/HS), Encryption, Tamper Detect, DRAM Ctrlr
K70: Graphic LCD, IEEE 1588 E’net, Encryption, USB OTG (FS/HS), Tamper Detect, DRAM Ctrlr

Flash Memory

32KB | 32-pin
64KB | 48-pin
128KB | 64-pin
256KB | 80-pin
512KB | 100/121-pin
1MB | 144-pin
## Kinetis K Series: Feature Overview

### Common Features

<table>
<thead>
<tr>
<th>System</th>
<th>CPU</th>
<th>Internal Memory</th>
<th>Communication</th>
<th>HMI</th>
<th>Security</th>
<th>Memory/Expansion</th>
<th>Analog</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm® Cortex™-M4 Core + DSP</td>
<td>Floating Point Unit</td>
<td>512 KB to 1 MB Flash</td>
<td>USB OTG (FS and HS)</td>
<td>CAN</td>
<td>Ethernet (IEEE 1588)</td>
<td>Graphics LCD</td>
<td>Hardware Encryption</td>
</tr>
<tr>
<td>Multiple Low-Power Operation Modes, Clock Gating, 1.71V-3.6V, 5V Tolerant I/O</td>
<td>128 KB SRAM</td>
<td>CAN</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>DMA, Memory Protection Unit [2], Cross Bar Switch</td>
<td>Operating Temp: -40°C to +105°C [3]</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

### Optional Features

<table>
<thead>
<tr>
<th>K70 Family: Graphics LCD</th>
<th>120 to 150 MHz</th>
<th>512 KB to 1 MB Flash</th>
<th>128 KB SRAM</th>
<th>USB OTG (FS and HS)</th>
<th>CAN</th>
<th>Ethernet (IEEE 1588)</th>
<th>Graphics LCD</th>
<th>Hardware Encryption</th>
</tr>
</thead>
<tbody>
<tr>
<td>K60 Family: Ethernet, Security</td>
<td>100 to 150 MHz</td>
<td>256 KB to 1 MB Flash</td>
<td>64 KB to 128 KB SRAM</td>
<td>USB OTG (FS and HS)</td>
<td>CAN</td>
<td>Ethernet (IEEE 1588)</td>
<td>Segment LCD</td>
<td>Hardware Encryption</td>
</tr>
</tbody>
</table>

### Analog Peripherals

<table>
<thead>
<tr>
<th>Analog Peripherals</th>
<th>16-bit ADC</th>
<th>Programmable Gain Amplifiers [1]</th>
</tr>
</thead>
</table>

### Memory

<table>
<thead>
<tr>
<th>Memory</th>
<th>90nm TFS Flash Memory (High Reliability, Fast Access)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FlexMemory (EEPROM) [4]</td>
</tr>
<tr>
<td></td>
<td>Internal Memory Security/Protection</td>
</tr>
</tbody>
</table>

### Serial Interfaces

<table>
<thead>
<tr>
<th>Serial Interfaces</th>
<th>UART, SPI, PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAI (FS)</td>
<td></td>
</tr>
</tbody>
</table>

### Timers

<table>
<thead>
<tr>
<th>Timers</th>
<th>RTC</th>
<th>Motor Control Timers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low-Power Timers</td>
<td>Programmable Delay Block</td>
</tr>
<tr>
<td></td>
<td>System Timers</td>
<td></td>
</tr>
</tbody>
</table>

### Other Peripherals

<table>
<thead>
<tr>
<th>Other Peripherals</th>
<th>CRC</th>
<th>eSDHC [4]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>External Bus Interface [4]</td>
<td></td>
</tr>
</tbody>
</table>

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[1] Feature not available on 50 MHz MCUs
[2] Feature not available on 50 MHz and 72 MHz MCUs
[3] Feature not available on 50 MHz MCUs and CSP packages (K50 and CSP package are -40°C to +85°C)
[4] Feature not available on all K10, K20, K30, K40, K50, K60 and K70 MHz MCUs
[5] Feature not available on K10 and K20 50 MHz MCUs
[6] HS USB on 120/150 MHz MCUs only
[7] Feature not available on K11/12/21/22 MCUs (K50 and CSP package are -40°C to +85°C)
Kinetis K Series: MCU Family Compatibility

Hardware & software compatible MCU families with scalable performance, memory and feature integration.

- **K10 Family**
  - ARM Cortex-M4
  - Entry Point
  - 50-120MHz
  - 32-144pin
  - 32KB-1MB

- **K20 Family**
  - 50-120MHz
  - 32KB-1MB
  - 32-144pin
  - + USB

- **K30 Family**
  - 72-100MHz
  - 64-512KB
  - 64-144pin
  - + Segment LCD

- **K40 Family**
  - 72-100MHz
  - 64-512KB
  - 64-144pin
  - + Segment LCD

- **K50 Family**
  - 72-100MHz
  - 128-512KB
  - 64-144pin
  - + Analog Measurement Engine, Ethernet, Encryption

- **K60 Family**
  - 100-150MHz
  - 256KB-1MB
  - 100-256pin
  - + Ethernet, Encryption, Tamper Detect, DRAM Controller

- **K70 Family**
  - 120-150MHz
  - 512KB-1MB
  - 196-256pin
  - + Graphics LCD

**Freescale™**
Kinetis L/K Series: MCU Family Compatibility

Hardware & software compatible MCU families with scalable performance, memory and feature integration.

- **ARM Cortex-M0+**
- **ARM Cortex-M4**
- **Entry Point**
- **8-bit MCU Compatible**

**KL0x Family**
- 48MHz
- 8KB-32KB
- <24-48pin
- + Segment LCD

**KL1x Family**
- 48MHz
- 32KB-256KB
- 32-80pin
- + USB
- + Segment LCD

**KL2x Family**
- 48MHz
- 32KB-256KB
- 32-121pin
- + USB
- + Ethernet, Encryption, Tamper Detect, DRAM Controller

**KL3x Family**
- 48MHz
- 64-256KB
- 64-121pin
- + USB

**KL4x Family**
- 48MHz
- 128-256KB
- 64-121pin
- + USB

**KL5x Family**
- 48MHz
- 64-256KB
- 64-121pin
- + Segment LCD

**KL6x Family**
- 48MHz
- 64-256KB
- 64-121pin

**KL7x Family**
- 48MHz
- 64-256KB
- 64-121pin

**K10 Family**
- 48MHz
- 32KB-256KB
- 32-121pin

**K20 Family**
- 50-120MHz
- 32KB-1MB
- 32-144pin

**K30 Family**
- 72-100MHz
- 64-512KB
- 64-144pin

**K40 Family**
- 72-100MHz
- 64-512KB
- 64-144pin

**K50 Family**
- 72-100MHz
- 128-512KB
- 64-144pin

**K60 Family**
- 100-150MHz
- 256KB-1MB
- 100-256pin

**K70 Family**
- 120-150MHz
- 512KB-1MB
- 196-256pin

**K80 Family**
- 100-150MHz
- 256KB-1MB
- 100-256pin

**Freescale**
- ARM Cortex-M0+
- ARM Cortex-M4
- Entry Point
- 8-bit MCU Compatible

- + USB
- + Ethernet, Encryption, Tamper Detect, DRAM Controller
- + Graphics LCD
- + Analog Measurement Engine, Ethernet, Encryption
Kinetis L Series: Enabling Differentiation in Entry-Level Products

Energy-efficiency
Class-leading Coremark/mW

Scalability & Integration
Kinetis L to K Series (Cortex M0+ to M4)
Enablement
Freescale bundle + ARM ecosystem

Ultra Low Static
<1uA

Low cost
From <$0.50

Ease-of-use
Freedom Platform, Processor Expert & MCU Solution Advisor

Kinetis L Series
The evolution of the entry-level MCU

Going Green
Health & Safety
Net Effect
Kinetis L Series: Memory & Package Scalability

Flash Memory

256KB
USB + Seg. LCD
Segment LCD
USB
General Purpose
Entry Level

128KB

64KB

32KB

16KB

8KB

Small Footprint Package

Package

16 QFN
20 QFN
24 QFN
32 LQFP
35 WLCSP
48 LQFP
64 LQFP
80 LQFP
100 LQFP
121 MBGA
### Kinetis K/L Series: Packaging

#### Common Packages

<table>
<thead>
<tr>
<th>Package Type</th>
<th>Size</th>
<th>Pitch</th>
<th>Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>32QFN</td>
<td>5 x 5 mm</td>
<td>0.5mm pitch</td>
<td>(K10/20) (KLO/1/2)</td>
</tr>
<tr>
<td>48QFN</td>
<td>7 x 7 mm</td>
<td>0.5mm pitch</td>
<td>(K10/20) (KLO/1*/2*)</td>
</tr>
<tr>
<td>48LQFP</td>
<td>7 x 7 mm</td>
<td>0.55mm pitch</td>
<td>(K10/20) (KLO/1*/2*)</td>
</tr>
<tr>
<td>64LQFP</td>
<td>10 x 10 mm</td>
<td>0.5mm pitch</td>
<td>(K10/20/30/40/50) (KLO/1*/2*/3*/4*)</td>
</tr>
<tr>
<td>80LQFP</td>
<td>12 x 12 mm</td>
<td>0.5mm pitch</td>
<td>(K10/20/30/40/50) (KLO/1*/2*/3*/4*)</td>
</tr>
<tr>
<td>100LQFP</td>
<td>14 x 14 mm</td>
<td>0.5mm pitch</td>
<td>(K10/20/30/40/50/60) (KLO/1*/2*/3*/4*/5*/6<em>4</em>)</td>
</tr>
<tr>
<td>64MAPBGA</td>
<td>5 x 5 mm</td>
<td>0.5mm pitch</td>
<td>(K10/20) (KLO/1*/2*/3*/4*)</td>
</tr>
<tr>
<td>121MAPBGA</td>
<td>8 x 8 mm</td>
<td>0.65mm pitch</td>
<td>(K10/20/30/40/50/60) (KLO/1*/2*/3*/4*)</td>
</tr>
<tr>
<td>144LQFP</td>
<td>20 x 20 mm</td>
<td>0.5mm pitch</td>
<td>(K10/20/30/40/50/60) (KLO)</td>
</tr>
<tr>
<td>144MAPBGA</td>
<td>13 x 13 mm</td>
<td>0.5mm pitch</td>
<td>(K10/20/30/40/50/60) (KLO)</td>
</tr>
<tr>
<td>20WLCSP</td>
<td>2x2x0.56 mm</td>
<td>0.4mm pitch</td>
<td>(KL0)</td>
</tr>
<tr>
<td>25WLCSP</td>
<td>2.3x2.3x0.56 mm</td>
<td>0.4mm pitch</td>
<td>(KL0*)</td>
</tr>
<tr>
<td>35WLCSP</td>
<td>2.55x3x0.56 mm</td>
<td>0.4mm pitch</td>
<td>(KL1*/2*)</td>
</tr>
<tr>
<td>24QFN</td>
<td>3x3x1 mm</td>
<td>0.5mm pitch</td>
<td>(KLO)</td>
</tr>
<tr>
<td>32LQFP</td>
<td>4 x 4 x 1 mm</td>
<td>0.5mm pitch</td>
<td>(KLOx)</td>
</tr>
<tr>
<td>144LQFP</td>
<td>90WLCSP</td>
<td>3.9x4.4x0.56 mm</td>
<td>0.4mm pitch</td>
</tr>
<tr>
<td>144MAPBGA</td>
<td>140WLCSP</td>
<td>110WLCSP</td>
<td>3.9x4.4x0.56 mm</td>
</tr>
<tr>
<td>120WLCSP</td>
<td>5.3x5.3x0.56 mm</td>
<td>0.4mm pitch</td>
<td>(K10/20/60) (K10/20/60)</td>
</tr>
<tr>
<td>143WLCSP</td>
<td>6.5x5.6x0.56 mm</td>
<td>0.4mm pitch</td>
<td>(K61)</td>
</tr>
</tbody>
</table>

**Kinetis L Series Only**

<table>
<thead>
<tr>
<th>Package Type</th>
<th>Size</th>
<th>Pitch</th>
<th>Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>16QFN</td>
<td>3x3x1 mm</td>
<td>0.5mm pitch</td>
<td>(KL0)</td>
</tr>
<tr>
<td>24QFN</td>
<td>4 x 4 x 1 mm</td>
<td>0.5mm pitch</td>
<td>(KLO)</td>
</tr>
<tr>
<td>32LQFP</td>
<td>7 x 7 mm</td>
<td>0.8mm pitch</td>
<td>(KLO)</td>
</tr>
<tr>
<td>144LQFP</td>
<td>144MAPBGA</td>
<td>13 x 13 mm</td>
<td>1.0mm pitch</td>
</tr>
<tr>
<td>144MAPBGA</td>
<td>256MAPBGA</td>
<td>17 x 17 mm</td>
<td>1.0mm pitch</td>
</tr>
</tbody>
</table>

**Kinetis K Series Only**

<table>
<thead>
<tr>
<th>Package Type</th>
<th>Size</th>
<th>Pitch</th>
<th>Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>20WLCSP</td>
<td>2x2x0.56 mm</td>
<td>0.4mm pitch</td>
<td>(KL0)</td>
</tr>
<tr>
<td>25WLCSP</td>
<td>2.3x2.3x0.56 mm</td>
<td>0.4mm pitch</td>
<td>(KL0*)</td>
</tr>
<tr>
<td>35WLCSP</td>
<td>2.55x3x0.56 mm</td>
<td>0.4mm pitch</td>
<td>(KL1*/2*)</td>
</tr>
<tr>
<td>20WLCSP</td>
<td>2x2x0.56 mm</td>
<td>0.4mm pitch</td>
<td>(KL0)</td>
</tr>
<tr>
<td>35WLCSP</td>
<td>2.55x3x0.56 mm</td>
<td>0.4mm pitch</td>
<td>(KL1*/2*)</td>
</tr>
<tr>
<td>144LQFP</td>
<td>144MAPBGA</td>
<td>13 x 13 mm</td>
<td>1.0mm pitch</td>
</tr>
<tr>
<td>256MAPBGA</td>
<td>256MAPBGA</td>
<td>17 x 17 mm</td>
<td>1.0mm pitch</td>
</tr>
</tbody>
</table>

*proposed*
Kinetis Portfolio Roadmap

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

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

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**Leading Performance - Low Power - Scalability - Industrial-grade reliability & temp**

Freescale Bundled IDE, RTOS & Middleware - Rapid prototyping Platform - Broad ARM Ecosystem Support
Kinetis E series: MCUs Applications

Appliance
- Air conditioner
- Convection Oven
- Refrigerator
- Induction Cooker
- Washer

Motor Control
- E-Bike
- AC Motor
- DC Motor

Industrial
- Intelligent MCCB
- Circuit Breaker

Metering/PLC

General Purpose
- UPS
- HVAC
- Industrial HMI

Freescale™
# Kinetis E series: Key Features

<table>
<thead>
<tr>
<th>Category</th>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robust</td>
<td>Improved 5V I/O pad with digital filter</td>
<td>Better EMC performance and system robustness in harsh environments</td>
</tr>
<tr>
<td>Safety</td>
<td>IEC60730 compliant watchdog, CRC and certified IEC60730 safety software library</td>
<td>Makes system safer while reducing system cost by removing external BOM</td>
</tr>
<tr>
<td>Motor control</td>
<td>6-channel 16-bit Flextimer optimized for motor control with synchronization to ADC via PDB</td>
<td>Makes motor control easier</td>
</tr>
<tr>
<td>Fast response</td>
<td>2x Analog Comparator with 6-bit DAC</td>
<td>Provide over-current, over-voltage protection as well as zero-crossing detection for full voltage range.</td>
</tr>
<tr>
<td>High drive</td>
<td>Up to 8 high drive pins with each supporting 20mA</td>
<td>Provide direct connection to LED drive circuit without additional cost</td>
</tr>
<tr>
<td>Scalable &amp; Pin-Compatible</td>
<td>Wide range of packages with pin-compatible</td>
<td>Makes code easy to reuse and easier PCB layout</td>
</tr>
</tbody>
</table>
Kinetis Portfolio Roadmap

**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+ & ARM Cortex-M4 MCU families for use in high electrical noise environments. Safety features for high-reliability applications.

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

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

**General Purpose**
- Segment Focused

**Integration**
- Leading Performance - Low Power - Scalability - Industrial-grade reliability & temp
- Freescale Bundled IDE, RTOS & Middleware - Rapid prototyping Platform - Broad ARM Ecosystem Support
Kinetis MKW20 Wireless MCU

CPU
- 50 MHz Cortex M4 CPU core
- Up to 512KB Flash, 64KB SRAM, 32KB Flex Mem, 4KB EEPROM
- Typical current consume: 250 µA/Mhz run, 1.7µA RTC standby

Radio Transceiver, 2.4GHz
- IEEE-802.15.4 compliant
- -102 dBm Rx sensitivity and +10dBm Tx output power
- Peak typical current consume: 15mA Tx and 16.5mA 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
- ZigBeePro, ZigBee IP
- Smart Energy 1.x & 2.0, HA 1.x, HC 1.0

System
- UART, SPI, I2C, optional USB 2.0 FS/LS H/D/OTG
- 16-bit ADC
- Operating range: 1.7V to 3.6V, -40C to +105C

<table>
<thead>
<tr>
<th>Device</th>
<th>Flash</th>
<th>RAM</th>
<th>Feature</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MKW21D256VHA5</td>
<td>256 KB</td>
<td>32 KB</td>
<td>No USB</td>
<td>8x8 56-pin LGA</td>
</tr>
<tr>
<td>MKW22D512VHA5</td>
<td>512 KB</td>
<td>64 KB</td>
<td>USB</td>
<td>8x8 56-pin LGA</td>
</tr>
<tr>
<td>MKW24D512VHA5</td>
<td>512 KB</td>
<td>64 KB</td>
<td>USB and Smart Energy 2.0</td>
<td>8x8 56-pin LGA</td>
</tr>
</tbody>
</table>
**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 μA/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

---

![Diagram of device components]

**Device** | **Flash / Flex** | **RAM** | **Package**
--- | --- | --- | ---
MKW01Z128CHN | 128 KB | 16 KB | 8x8 56-pin LGA
Kinetis Portfolio Roadmap

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+ & ARM Cortex-M4 MCU families for use in high electrical noise environments. Safety features for high-reliability applications.

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

Kinetis W Series
Integrated wireless connectivity ARM Cortex-M4 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.

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
Energy Meter Types and Measurements

Electricity Meter Types

Electromechanical meters
- Limited accuracy
- Manual reading
- Contains moving parts (aluminum ring)

Electronic meters
- MCUs, DSPs and ASICs based
- Accurate measurement
- Enhanced security
- Equipped with AMR
- No moving parts

Measured Quantities
- Active, reactive, apparent energy
- Active, reactive, apparent power
- RMS, peak values (voltage/current)
- Line frequency
- Power factor
- Temperature

Measurement Types

Single phase
- Common in EU residential meters
- One voltage and one current measurement
- Use of shunt resistors prevail due to low system cost

Dual phase
- Common in US residential meters
- Two voltage and two current measurement
- Use of current transformers and Rogowski coils prevail

Three phase
- Used in industrial and commercial meters
- Three voltage and three current measurement
- Use of current transformers and Rogowski coils prevail
Kinetis M Highlights

• Supports 1-phase, 2-phase (Form-12S) and 3-phase power metering applications without sacrificing accuracy.

• **Highest linearity and resolution AFE with 4x24bit SD after averaging with 94 dB SNR**

• AFE Combined gain temperature drift of the PGA, SD ADC and Internal 1.2V VREF blocks (+/-75ppm/C°).

• Built-in peripheral XBAR enabling frequency detection in HW and other unique peripheral interconnections and triggering schemes.

• Bulletproof hardware support for legally relevant code separation (WELMEC/OIML).

• **Auto compensated RTC with high speed calibration with 5 ppm accuracy and 0.88 ppm resolution (1Hz output pulse)**

• **4 kV ESD, 6 kV PESD**

• **Brings a lot of value and flexibility to legal metrology applications:** Active Electrical Energy Meters, Water Meters, Gas Meters and Volume Conversion Devices, Heat Meters, Measuring Systems for the Continuous and Dynamic Measurement of Quantities of Liquids Other than Water, Weighing Instruments, Taximeters, Material Measures and Dimensional Measuring Instruments and Exhaust Gas Analyzers.
Introducing the Vybrid Controller Solutions F Series

Rich Apps in Real Time

Integrated for the First Time, an ARM® Cortex™-A5 MPU with a Cortex™-M4 microcontroller, sharing a large 1.5 MB on-chip SRAM, secure boot, anti-tamper and encryption engines, and a wide range of multimedia and communication interfaces.

Scalable System Performance, ranging from a single highly-efficient ARM Cortex-A5 core to a dual-core Cortex-A5 + Cortex-M4 MPU – for simple industrial HMI, secure control, energy conversion, integrated connectivity and mobile battery-operated applications.

Total System Solution, including application notes, integrated development environment tools, Linux® OS and MQX™ RTOS, Tower System and a rich set of Freescale partner resources.
## Vybrid Controller F Series Target Applications

<table>
<thead>
<tr>
<th>Industrial HMI</th>
<th>Secure Control</th>
<th>Energy Conversion</th>
<th>Integrated Connectivity</th>
<th>Mobile Battery Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• XGA or dual SVGA industrial HMI (2D graphics)</td>
<td>• Energy grid protection, e.g. circuit breaker or monitor</td>
<td>• Motor drive</td>
<td>• Wired and wireless communications protocols</td>
<td>• Industrial vehicle with control &amp; HMI, e.g. tractor, train, ship, heavy equipment</td>
</tr>
<tr>
<td>• Large or high-quality small appliance</td>
<td>• Infrastructure control, e.g. water treatment or gas pipeline</td>
<td>• Industrial pump or fan</td>
<td>• Energy management hub</td>
<td>• Portable patient monitor</td>
</tr>
<tr>
<td>• Portable patient monitor</td>
<td>• Building control, e.g. elevator or automated door</td>
<td>• Power inverter</td>
<td>• Networked HVAC</td>
<td>• Industrial scanner or printer</td>
</tr>
<tr>
<td>• Industrial scanner or printer</td>
<td>• Kiosk with 2D display, e.g. gas pump</td>
<td>• Appliance with motors or pumps</td>
<td>• Service robot</td>
<td>• Simple vending machine with 2D LCD or segment display</td>
</tr>
<tr>
<td>• Simple vending machine with 2D LCD or segment display</td>
<td></td>
<td>• Mobile patient care, e.g. infusion pump or respirator</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Best Reasons to Select Vybrid Controller F Series

1. **If the application uses up to 1.5 MB of on-chip SRAM**
   - Eliminates or reduces external DDR memory chips (saves >$2 to $8)
   - Much lower latency than external DDR or Quad SPI

2. **When the VF6xx on-chip ARM Cortex-M4 core replaces external MCU or FPGA**
   - Reduces components, PCB area, and power consumption (saves >$1 to >$5)
   - ARM DS-5 tools eases programming of ARM Cortex-A5 and Cortex-M4 cores

3. **When system security is important**
   - On-chip encryption, secure boot, anti-tamper and anti-clone capability
   - Optional encryption for two 10/100 Ethernet MACs with L2 switch

4. **When Graphics and/or audio are required – HMI interfaces**
   - On-chip LCD controller with 2D composition engine and PEG GUI dev platform
   - VF6xx has an on-chip video ADC for direct analog camera input (saves $4-$5)

5. **When error-correcting code (ECC) is needed for reliability**
   - 8-bit ECC on DDR3; ECC on 512 KB of SRAM, 32-bit ECC on NAND flash
**Vybrid Controller Solutions**

**F Series Portfolio**

- **VF6xx - ARM Cortex-A5 (500 MHz) + Cortex-M4 (167 MHz)**
  - Dual SVGA LCD, Camera Interface with Video ADC, Stereo Audio, DDR, Secure Boot, Tamper Detect, Dual USB OTG w/HS PHY, Dual Ethernet, L2 Switch, Dual Quad-SPI, NAND Flash Controller, 364 MAPBGA

- **VF5xx - ARM Cortex-A5 (500 MHz)**
  - SVGA LCD, Camera Interface, Stereo Audio, DDR, Secure Boot, Tamper Detect, Dual USB OTG w/HS PHY, Dual Ethernet, L2 Switch, Dual Quad-SPI, NAND Flash Controller, 364 MAPBGA

- **VF3xx – ARM Cortex-A5 (266 MHz)**
  - WQVGA LCD, Audio, Secure Boot, Tamper Detect, USB OTG w/HS PHY, Dual Ethernet, L2 Switch, Dual Quad-SPI, NAND Flash Controller, 176 LQFP

---

**Rich Apps in Real Time**

---

**freescale™**
Cortex-A, Classic ARM Comparison

<table>
<thead>
<tr>
<th></th>
<th>ARM9</th>
<th>ARM11</th>
<th>Cortex-A5</th>
<th>Cortex-A8</th>
<th>Cortex-A9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Architecture</strong></td>
<td>ARMV5</td>
<td>ARMV6</td>
<td>ARMv7 + MP</td>
<td>ARMv7</td>
<td>ARMv7 + MP</td>
</tr>
<tr>
<td><strong>Multi-Core Capable</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Pipeline and Machine</strong></td>
<td>5-stage</td>
<td>8-stage</td>
<td>8-stage, Single issue, In-Order</td>
<td>13-stage, Dual Issue, in-order</td>
<td>8-Stage, Dual issue, Out of Order</td>
</tr>
<tr>
<td><strong>Frequency Range (40nm)</strong></td>
<td>366MHz</td>
<td>483MHz</td>
<td>300-950+MHz</td>
<td>600-2000 MHz</td>
<td>600-1900+ MHz</td>
</tr>
<tr>
<td><strong>Power Efficiency (DMIPS/mW)</strong></td>
<td>4.5</td>
<td>3.9</td>
<td>14.4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td><strong>DMIPS/MHz</strong></td>
<td>1.1</td>
<td>1.26</td>
<td>1.6 per CPU</td>
<td>2.0</td>
<td>2.5 per CPU</td>
</tr>
</tbody>
</table>

Source: ARM™ Presentation
**Vybird VF3xx Family**

Single Chip solution with dual XiP Quad SPI, Dual Ethernet and L2 Switch for appliance and energy control

**Core**
- Up to 266 Hz ARM Cortex-A5 with TrustZone

**HMI**
- TFT LCD up to XGA resolution
- Segment LCD

**Memory**
- 32 KB I and D L1 Cache
- 512 KB L2 cache
- On Chip: up to 1 MB SRAM. ECC support on 512 KB
- NAND flash controller with 32b ECC

**Analog**
- 2 x 12-bit ADC (12-ch), 2 x 12-bit DAC

**Communication**
- 4 x UART, 2 x CAN, 3 x SPI, 2 x I2C
- Ethernet MAC with IEEE 1588
- USB2.0 OTG with PHY

**Audio**
- 3 x SAI for full-duplex serial interfaces like I2S, AC97
- ESAI - Enhanced serial audio interface

**Video**
- Video Interface unit with parallel camera interface

**Security**
- Tamper detect, high assurance boot
- True RNG

**Power Management**
- Internal regulator (PMIC)

**Package**
- 176-pin LQFP, 364 BGA
- Spec’d to Freescale Industrial standards (-40 to 85C)
Vybrid VF5xx Family
Single Chip solution with Dual Ethernet and L2 Switch for Automation and Control

Core
- Up to 450MHz ARM™ Cortex-A5 with TrustZone

HMI
- TFT LCD up to XGA resolution

Memory
- 32KB I and D L1 Cache
- 512KB L2 Cache
- On Chip: up to 1.0MB SRAM . ECC support on 512KB
- On Chip: LPDDR2/DDR3 DRAM controller
- NAND Flash Controller

Analog
- 2 x 12-bit ADC(16-Ch), 2 x 12-bit DAC
- Communication
- 6 x UART, 2 x CAN, 4 X SPI, 4 X I2C
- 2 Ethernet MAC with IEEE1588 and L2 Switch
- USB2.0 HOST and OTG with PHY

Audio
- 4 x SAI for full-duplex serial interfaces like I2S, AC97
- ESAI – Enhanced Serial Audio Interface
- SPDIF

Video
- Video Interface unit with parallel camera interface
- OpenVG GPU

Security
- Tamper Detect, High Assurance Boot
- True RNG

Power Management
- Internal regulator (PMIC)

Package
- 17x17 0.8mm pitch 364-pin MAPBGA
- Spec’ed to Freescale Industrial standards (-40 to 85C)

Changes from VF3 family
Changes from VF5 family
Crossbar – 17 Masters & 10 Slaves
# Vybrid Power Modes

*Preliminary*

<table>
<thead>
<tr>
<th>Typical Power Modes in an embedded system</th>
<th>Cortex A5/M4 Power Modes</th>
<th>Vybrid Extended Power Modes</th>
<th>Recovery Time</th>
<th>“Typical” Idd Range Starting @ &lt;320uA/MHz *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run</td>
<td>Run</td>
<td>RUN</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Wait</td>
<td>Sleep</td>
<td>WAIT</td>
<td>6-8 mA</td>
<td></td>
</tr>
<tr>
<td>Stop</td>
<td>DeepSleep</td>
<td>Stop</td>
<td>1.5 – 7 us</td>
<td>4-6 mA</td>
</tr>
</tbody>
</table>

**Power Gate modes with Wakeup capability**

- Enables complete shut-down of core logic, including WKUP, 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 LPSTOP modes

<table>
<thead>
<tr>
<th>LPSTOP3</th>
<th>400us</th>
<th>80-100 uA</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPSTOP2</td>
<td>400us</td>
<td>40-45 uA</td>
</tr>
<tr>
<td>LPSTOP1</td>
<td>400us</td>
<td>35-40 uA</td>
</tr>
<tr>
<td>VBAT</td>
<td>N/A</td>
<td>7-8uA</td>
</tr>
</tbody>
</table>

*All modules OFF, A5@500Mhz,M4@167Mhz at TYP condition*

- 24 Mhz Operation, PLL bypass, Peripherals OFF
- 32Khz/128 Khz Operation, PLL bypass, Peripherals OFF

---

*Freescale*
# DS-5 for Vybrid: Comparison Table

<table>
<thead>
<tr>
<th></th>
<th>Vybrid Tower SK</th>
<th>Vybrid Edition</th>
<th>Professional</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Code Generation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARM Compiler</td>
<td>256KB</td>
<td>1MB</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Target Connection</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Devices</td>
<td>Vybrid Tower System</td>
<td>Vybrid family</td>
<td>All supported</td>
</tr>
<tr>
<td>Debug Connection</td>
<td>CMSIS-DAP (USB)</td>
<td>CMSIS-DAP (USB)</td>
<td>All supported</td>
</tr>
<tr>
<td></td>
<td>ARM DSTREAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Debug</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OS aware run control</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Linux/Android application debug</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Non-intrusive processor and system trace</td>
<td>On chip only</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>System Optimization</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streamline performance analysis</td>
<td>CE features</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Streamline power analysis</td>
<td>-</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Simulation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cortex-A8 FVP</td>
<td></td>
<td>-</td>
<td>✔</td>
</tr>
<tr>
<td>Quad-Core Cortex-A9 FVP</td>
<td></td>
<td>-</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Licensing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Node Locked / Floating</td>
<td>NL</td>
<td>NL</td>
<td>NL or FL</td>
</tr>
<tr>
<td>Term</td>
<td>1 year</td>
<td>1 year</td>
<td>1 year or perpetual</td>
</tr>
<tr>
<td>Support &amp; Maintenance</td>
<td>Freescale</td>
<td>Freescale</td>
<td>ARM</td>
</tr>
<tr>
<td>Tower Kits Part Number</td>
<td>Suggested Resale Price</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWR-VF65GS10 (Tower board)</td>
<td>$199</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWR-VFGS10-KIT (Tower, elevator &amp; serial boards)</td>
<td>$269</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWR-VG65GS10-DS5 (Tower, elevator &amp; serial boards + DS-5)</td>
<td>$1500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Industry’s **most scalable** family of multimedia applications processors

Easily build scalable product lines with the i.MX 6 series—**ultimate versatility** with compatible single, dual and quad core devices

**Best-in-Class Performance** enabled by quad core processing, low power consumption and bleeding-edge multimedia and graphics

**Optimized peripheral sets** tailored to serve auto, industrial and consumer markets

**Fast development** through simplified hardware design, flexible interfaces and easy-to-use development kits
## Six Generations of Application Processors

<table>
<thead>
<tr>
<th>Year</th>
<th>Processor</th>
<th>Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>Dragonball</td>
<td>1st FSL Apps Processor</td>
</tr>
<tr>
<td>2001</td>
<td>i.MX1</td>
<td>1st FSL ARM9 Apps Processor</td>
</tr>
<tr>
<td>2003</td>
<td>i.MX2 Series</td>
<td>90nm LP HW Video Accel, Analog Integration</td>
</tr>
<tr>
<td>2005</td>
<td>i.MX3 Series</td>
<td>ARM11 GPU Integration</td>
</tr>
<tr>
<td>2009</td>
<td>i.MX5 Series</td>
<td>65nm LP/GP ARM Cortex-A8 &gt;1GHz</td>
</tr>
<tr>
<td>2011</td>
<td>i.MX 6 Series</td>
<td>40nm LP ARM Cortex-A9 Multi-core family</td>
</tr>
</tbody>
</table>

### Key Achievements

- **Clear market leader** for eReader apps processors (IDC)
- **No. 2** in Auto Infotainment (Strategy Analytics)
- **No. 3** in Mobile Apps Processors (Linley 5/2011)
Freescale Multimedia Traction

**Automotive**
- Leadership in Telematics and advanced automotive infotainment
- Selected by 7 out of the top 10 automotive OEMs for next-generation designs

**eReaders**
- #1 market share in e-Reader market
- Selected by 4 out of the top 5 e-Reader vendors for next-generation designs
- >2X unit shipments in 2010

**Smart Mobile Devices**
- Pioneer in portable media players
- 20+ tablet products based on i.MX shipping in the market and design win momentum continuing to build

**Embedded Multimedia**
- Broad traction in the embedded market
- Connected display based devices in consumer, medical and industrial markets
Applications Processor Family Roadmap

Premium
- i.MX 6Quad

Balanced
- i.MX 6Dual
- i.MX53
- i.MX51
- i.MX50
- i.MX 6Dual Lite

Entry
- i.MX 6Solo
- i.MX35
- i.MX31
- i.MX28
- i.MX25
- i.MX233

2012
2013
2014
2015

40nm – ARM v7, 4x CPU; 3x GPU, 1080p60 performance
28nm – Next Generation i.MX

PMO
- ARM9
- Cortex-A8
- A5+M4
- ARM v7
- ARM v8

Planning
Proposal
Samples
Production
Product Qual
VM
Mass Market Availability

ARM11
Cortex-A9
ARM v7

 texasmicro TM
38

Freescale:
- ARM v8
- ARM v7
- Cortex-A8
- Cortex-A9
- A5+M4
- ARM9
- ARM11
i.MX 6 Series Overview

Scalable series of **five** ARM Cortex A9-based SoC families

- **i.MX 6SoloLite**
  - 1x 1GHz
  - x32 400MHz DDR3
  - No HW video accel.
  - 2D graphics (2 GPUs)
  - LCD, EPD

- **i.MX 6Solo**
  - 1x 1GHz
  - x32 400MHz DDR3
  - HD1080p video
  - 2D+3D (2 GPUs), 53Mtri/s
  - LCD, EPD

- **i.MX 6DualLite**
  - 2x 1GHz
  - x32 400MHz DDR3
  - HD1080p video
  - 2D+3D (2 GPUs), 53Mtri/s
  - LCD, EPD

- **i.MX 6Dual**
  - 2x 1/1.2GHz
  - x64 533MHz DDR3
  - Dual HD1080p video
  - 2D+3D (3 GPUs), 176 Mtri/s
  - LCD

- **i.MX 6Quad**
  - 4x 1/1.2GHz
  - x64 533MHz DDR3
  - Dual HD1080p video
  - 2D+3D (3 GPUs), 176 Mtri/s
  - LCD

Pin-to-pin Compatible

Software Compatible
## i.MX6 series – Supported Package

<table>
<thead>
<tr>
<th>Supported Package</th>
<th>i.MX6 Solo</th>
<th>i.MX6 Dual Lite</th>
<th>i.MX6 Dual</th>
<th>i.MX6 Quad</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGA 21x21mm 0.8P</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PoP 12x12mm 0.4P</td>
<td>-</td>
<td>-</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PoP 14x14mm 0.4P</td>
<td>TBD</td>
<td>Yes</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Case-1
- 21x21mm 0.8P BGA
  - i.MX6 Quad
    - ARM A9 – Quad Core
    - USB / MLB
  - i.MX6 Dual
    - ARM A9 – Dual Core
    - USB / MLB
  - i.MX6 Dual Lite
    - ARM A9 – Dual Core
    - USB / MLB
  - i.MX6Solo
    - ARM A9 – Single core
    - USB / MLB

### Case-2
- 12x12mm 0.4P PoP TBD
  - i.MX6 Quad
    - ARM A9 – Quad Core
    - USB / MLB
  - i.MX6 Dual
    - ARM A9 – Dual Core
    - USB / MLB

### Case-3
- 14x14mm 0.4P PoP TBD
  - i.MX6 Dual Lite
    - ARM A9 – Dual Core
    - USB / MLB
  - i.MX6Solo
    - ARM A9 – Single core
    - USB / MLB

Pin Compatible
Software Compatible
Common IP
## i.MX 6 Series feature list (1/3)

<table>
<thead>
<tr>
<th></th>
<th>i.MX 6SoloLite</th>
<th>i.MX 6Solo</th>
<th>i.MX 6DualLite</th>
<th>i.MX 6Dual</th>
<th>i.MX 6Quad</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core</strong></td>
<td>1x 1GHz Cortex-A9, 256KB L2 cache, 32K+32K I/D L1</td>
<td>1x 1GHz Cortex-A9, 512KB L2 cache, 32K+32K I/D L1</td>
<td>2x 1GHz Cortex-A9, 512KB L2 cache, 32K+32K I/D L1</td>
<td>2x 1/1.2 GHz Cortex-A9, 1MB L2 cache, 32K+32K I/D L1</td>
<td>4x 1/1.2 GHz Cortex-A9, 1MB L2 cache, 32K+32K I/D L1</td>
</tr>
<tr>
<td>DMIPS</td>
<td>2400 DMIPS</td>
<td>2900 DMIPS</td>
<td>4800 DMIPS</td>
<td>5700 DMIPS</td>
<td>11500 DMIPS</td>
</tr>
<tr>
<td>Process Tech</td>
<td>40nm, LP</td>
<td>40nm, LP</td>
<td>40nm, LP</td>
<td>40nm, LP</td>
<td>40nm, LP</td>
</tr>
<tr>
<td>DDR Memory</td>
<td>x32 LP-DDR2, DDR3, DDR3L, Page interleaving</td>
<td>x32 LP-DDR2, DDR3, DDR3L, Page interleaving</td>
<td>2x32 LP-DDR2, 1chx64 DDR3 / DDR3L, Page and channel interleaving</td>
<td>2x32 LP-DDR2, 1chx64 DDR3 / DDR3L, Page and channel interleaving</td>
<td>2x32 LP-DDR2, 1chx64 DDR3 / DDR3L, Page and channel interleaving</td>
</tr>
<tr>
<td>Max DDR Speed</td>
<td>400MHz (800MT/s)</td>
<td>400MHz (800MT/s)</td>
<td>400MHz (800MT/s)</td>
<td>533MHz, (1066MT/s)</td>
<td>533MHz, (1066MT/s)</td>
</tr>
<tr>
<td>NAND</td>
<td>-</td>
<td>SLC/MLC, 40-bit ECC, ONFI2.2, DDR</td>
<td>SLC/MLC, 40-bit ECC, ONFI2.2, DDR</td>
<td>SLC/MLC, 40-bit ECC, ONFI2.2, DDR</td>
<td>SLC/MLC, 40-bit ECC, ONFI2.2, DDR</td>
</tr>
<tr>
<td>Video Codecs</td>
<td>SW Only</td>
<td>SW Only</td>
<td>SW Only</td>
<td>SW Only</td>
<td>SW Only</td>
</tr>
<tr>
<td>Video Decode</td>
<td>SW Only</td>
<td>1080p30 + D1</td>
<td>1080p30 + D1</td>
<td>1080p30 + D1 Dual 1080p decode</td>
<td>1080p30 + D1 Dual 1080p decode</td>
</tr>
<tr>
<td>Video Encode</td>
<td>SW Only</td>
<td>1080p30 H.264BP Dual 720p encode</td>
<td>1080p30 H.264BP Dual 720p encode</td>
<td>1080p30 H.264BP Dual 720p encode</td>
<td>1080p30 H.264 BP Dual 720p encode</td>
</tr>
</tbody>
</table>
### i.MX 6 Series feature list (2/3)

<table>
<thead>
<tr>
<th></th>
<th>i.MX 6SoloLite</th>
<th>i.MX 6Solo</th>
<th>i.MX 6DualLite</th>
<th>i.MX 6Dual</th>
<th>i.MX 6Quad</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Display</strong></td>
<td>WXGA (1366 x 768)</td>
<td>2 x WXGA (1366 x 768)</td>
<td>2 x WXGA (1366 x 768)</td>
<td>2 x 4XGA (2048x1536) or 2 x [1080p + WXGA (1280x720)]</td>
<td>2 x 4XGA (2048x1536) or 2 x [1080p + WXGA (1280x720)]</td>
</tr>
<tr>
<td><strong>Displays Interfaces</strong></td>
<td>Types: EPDC, Parallel, Two outputs</td>
<td>Types: 2x Parallel, 2xLVDS, MIPI-DSI, HDMI, EPDC Two outputs</td>
<td>Types: 2x Parallel, 2xLVDS, MIPI-DSI, HDMI, EPDC Two outputs</td>
<td>Types: 2x parallel, 2x LVDS, MIPI-DSI, HDMI Four outputs</td>
<td>Types: 2x parallel, 2x LVDS, MIPI-DSI, HDMI Four outputs</td>
</tr>
<tr>
<td><strong>Camera Interface</strong></td>
<td>16-bit parallel</td>
<td>Types: 2x20-bit parallel, MIPI-CSI2 (2 lanes) Two inputs</td>
<td>Types: 2x20-bit parallel, MIPI-CSI2 (2 lanes) Two inputs</td>
<td>Types: 2x 20-bit parallel, MIPI-CSI2 (4 lanes) Three inputs</td>
<td>Types: 2x 20-bit parallel, MIPI-CSI2 (4 lanes) Three inputs</td>
</tr>
<tr>
<td><strong>GPU 2D (Vector Graphics)</strong></td>
<td>Vivante GC355 300Mpxl/s OpenVG 1.1</td>
<td>via GPU 3D</td>
<td>via GPU 3D</td>
<td>Vivante GC355 300Mpxl/s OpenVG 1.1</td>
<td>Vivante GC355 300Mpxl/s OpenVG 1.1</td>
</tr>
<tr>
<td><strong>GPU 2D (Composition)</strong></td>
<td>via GPU 2D</td>
<td>Vivante GC320 600Mpxl/s, BLIT</td>
<td>Vivante GC320 600Mpxl/s, BLIT</td>
<td>Vivante GC320 600Mpxl/s, BLIT</td>
<td>Vivante GC320 600Mpxl/s, BLIT</td>
</tr>
<tr>
<td><strong>Hard Drive I/F</strong></td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>S-ATA II 3Gbps</td>
<td>S-ATA II 3Gbps</td>
</tr>
<tr>
<td><strong>Audio accel</strong></td>
<td>n/a</td>
<td>ASRC</td>
<td>ASRC</td>
<td>ASRC</td>
<td>ASRC</td>
</tr>
<tr>
<td><strong>Audio Interfaces</strong></td>
<td>3x I2S, SPDIF Tx/Rx</td>
<td>3x I2S, SPDIF Tx/Rx, ESAI</td>
<td>3x I2S, SPDIF Tx/Rx, ESAI</td>
<td>3x I2S, SPDIF Tx/Rx, ESAI</td>
<td>3x I2S, SPDIF Tx/Rx, ESAI</td>
</tr>
</tbody>
</table>
## i.MX 6 Series feature list (3/3)

<table>
<thead>
<tr>
<th>Feature</th>
<th>i.MX 6SoloLite</th>
<th>i.MX 6Solo</th>
<th>i.MX 6DualLite</th>
<th>i.MX 6Dual</th>
<th>i.MX 6Quad</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Expansion Ports</strong></td>
<td>3x SD/MMC 4.4, 1x SDXC, 4x SPI, 5x UART, 3x I2C</td>
<td>3x SD/MMC 4.4, 1x SDXC, 4x SPI, 5x UART, 3x I2C, MIPI-HSI, PCIe 2.0 (1 lane), 2x FlexCan, MLB-150</td>
<td>3x SD/MMC 4.4, 1x SDXC, 4x SPI, 5x UART, 4x I2C, MIPI-HSI, PCIe 2.0 (1 lane), 2x FlexCan, MLB-150</td>
<td>3x SD/MMC 4.4, 1x SDXC, 5x SPI, 3x UART, 2x MIPI-HSI, PCIe 2.0 (1 lane), 2x FlexCan, MLB-150</td>
<td></td>
</tr>
<tr>
<td><strong>USB I/F</strong></td>
<td>Three USB2.0: 1x HS OTG + PHY, 1x Host + PHY, 1x Host USB HSIC</td>
<td>Four USB2.0: 1x HS OTG + PHY, 1x Host + PHY, 2x Host USB HSIC</td>
<td>Four USB2.0: 1x HS OTG + PHY, 1x Host + PHY, 2x Host USB HSIC</td>
<td>Four USB2.0: 1x HS OTG + PHY, 1x Host + PHY, 2x Host USB HSIC</td>
<td></td>
</tr>
<tr>
<td><strong>Ethernet</strong></td>
<td>10/100 Mbps</td>
<td><strong>1 Gbps</strong> + IEEE1588</td>
<td>1 Gbps + IEEE1588</td>
<td>1 Gbps + IEEE1588</td>
<td>1 Gbps + IEEE1588</td>
</tr>
<tr>
<td><strong>Boot</strong></td>
<td>Updated boot sources, Boot from encrypted image</td>
<td>Updated boot sources, Boot from encrypted image</td>
<td>Updated boot sources, Boot from encrypted image</td>
<td>Updated boot sources, Boot from encrypted image</td>
<td>Updated boot sources, Boot from encrypted image</td>
</tr>
<tr>
<td><strong>Temperat. Monitor</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>PMU</strong></td>
<td>PMU integration</td>
<td>PMU integration</td>
<td>PMU integration</td>
<td>PMU integration</td>
<td>PMU integration</td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td>High Assurance Boot, Secure RAM, Crypto Acc., TrustZone, NIST approved RNG</td>
<td>High Assurance Boot, Secure RAM, Crypto Acc., TrustZone, NIST approved RNG</td>
<td>High Assurance Boot, Secure RAM, Crypto Acc., TrustZone, NIST approved RNG</td>
<td>High Assurance Boot, Secure RAM, Crypto Acc., TrustZone, NIST approved RNG</td>
<td>High Assurance Boot, Secure RAM, Crypto Acc., TrustZone, NIST approved RNG</td>
</tr>
<tr>
<td><strong>Package</strong></td>
<td>13x13 0.5m BGA</td>
<td>21x21 0.8P BGA pin-compatible</td>
<td>21x21 0.8P BGA pin-compatible</td>
<td>21x21 0.8P BGA pin-compatible</td>
<td>21x21 0.8P BGA pin-compatible</td>
</tr>
</tbody>
</table>

Red indicates change from column to the left.
Packaging and Qual levels – 21x21 FCBGA Package

- **Lidded – Auto and Industrial**
  - Contains a metal lid covering the processor
  - More robust for industrial or automotive environments

- **Non-Lidded – Consumer**
  - Exposes the back side of the die (flipchip)
  - Lower Z-height for space constrained devices
  - Easier to attach custom heat spreaders

- **Three types of Qual for i.MX 6Series**
  - Consumer ➔ Highest Frequency
  - Automotive ➔ Maximum environmental support
  - Industrial ➔ Longest duration (“always on”)

- **Only Non-Lidded packaging will be available in Consumer Temp**

<table>
<thead>
<tr>
<th>Type</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| Consumer  | • -20 to 105Deg Tj  
            | • 5 year life cycle @ 50% duty cycle                |
|           | • Max of 1.2Ghz CPU speed                            |
| Automotive| • -40 to 125Deg Tj  
            | • 10 year life cycle @ 10% duty cycle               |
|           | • Max of 1Ghz CPU speed                              |
| Industrial| • -40 to 105Deg Tj  
            | • 10 year life cycle @ 100% duty cycle              |
|           | • Max of 800Mhz CPU speed                            |

FC-BGA Manufacturing App note (Lid and non-Lid) Available on freescale.com
i.MX 6Quad/6Dual Applications Processor

- **Specifications**
  - **CPU:** i.MX 6Quad 4x Cortex-A9 @1.2 GHz, 12000 DMIPS  
  i.MX 6Dual 2x Cortex-A9 @1.2 GHz, 6000 DMIPS
  - **Process:** 40nm
  - **Core Voltage:** 1.1V
  - **Package:** 21x21 0.8mm Flip-chip BGA 12x12 PoP (LP-DDR2, NAND)

- **Key Features and Advantages**
  - Multi-core architecture for high performance, 1MB L2 cache
  - 64-bit LP-DDR2, DDR3 and raw / managed NAND
  - S-ATA 3Gbps interface (SSD / HDD)
  - Delivers rich graphics and UI in HW
    - OpenGL/ES 2.x 3D accelerator with OpenCL EP support and OpenVG 1.1 acceleration
  - Drives high resolution video in HW
    - Multi-format HD1080 video decode and encode
    - 1080p60 decode, 720p60 encode
    - High quality video processing (resizing, de-interlacing, etc.)
  - Flexible display support
    - Four simultaneous: 2x Parallel, 2x LVDS, MIPI-DSI, or HDMI
    - Dual display up to WUXGA (1920x1200) and HD1080
    - MIPI-CSI2 and HSI
  - Increased analog integration simplifies system design and reduces BOM
    - DC-DC converters and linear regulators supply cores and all internal logic
    - Temperature monitor for smart performance control
  - Expansion port support via PCIe 2.0
  - Car network: 2xCAN, MLB150 with DTCP, 1Gb Ethernet with IEEE1588
i.MX 6 Series Power Management

- i.MX 6 Series and Freescale PF Series PMICs → Maximal flexibility in power mgt system design
  - i.MX 6 + Freescale PF-Series PMIC → Flexibility to power latest Smart Devices, Auto infotainment, embedded platforms
  - i.MX 6 → Integrated PMU with efficiencies approaching 90% for high power applications, no multiple inductors, fewer caps
  - i.MX 6 → Pass through voltage rails that can be used to power external components
  - i.MX 6 → Start of day code entirely in silicon
  - Option to use discrete regulators to power i.MX 6/DDR for basic platforms with few peripheral component needs

Discrete Only
- Simple implementation
- Good for basic platforms with few components beyond CPU, Memory, Storage
- Platform flexibility is more limited vs PMIC

Freescale PF Series PMIC

Freescale PF-Series PMIC Based
- Optimized for i.MX 6 Series
- Flexible power options for driving Smart Device and Auto infotainment systems
- Supplies processor and DDR IO
- Good for more complex platforms with WI-FI, BT, data modems, FPGAs, LEDs, etc
Full Portfolio of MEMS & Sensors

- eCompass
- Magnetometers
- Accelerometers
- Touch Sensors
- Gyro
- Altimeter / Pressure
Freescale SABRE Board for Smart Devices

**i.MX 6Quad 1GHz Cortex-A9 Processor**
- Freescale PF-Series PMIC
- 1 GB DDR3 memory (non terminated)
- 3” x 7” 8-layer PCB

**External Memory**
- 8GB eMMC iNAND

**Display**
- 2x LVDS connectors
- Parallel LCD add-on card via expansion connector
- 24 bit 4.3” 800x480 WVGA with 4-wire touch screen (sold as an add-on module – MCIMX28LCD)
- HDMI Connector

**Audio**
- Wolfson Audio Codec
- Microphone and headphone jacks

**Expansion Connector**
- Camera CSI port signals
- I2C, SSI, SPI signals

**Connectivity**
- Full-size SD/MMC card slot
- 7-pin SATA data connector
- 10/100/1000 Ethernet port
- 1x high-speed USB host port
- PCI-e connector
- CAN footprint

**Debug**
- JTAG connector
- Serial to USB connector

**Additional Features**
- 3-axis Freescale accel
- Power supply- USB plug
- No battery charger

**Tools Support**
- Lauterbach, ARM, Macraigor debug/IDE tool chain

**Add-on Modules**
- 4.3” WVGA 4-wire touchscreen – MCIMX28LCD $199
- Connectivity module

**OS Support**
- Linux and Android Ice Cream Sandwich from Freescale; Windows Compact 7 from Adeneo and iWave

---

**$399 MSRP**
Freescale SABRE Platform for Smart Devices

i.MX 6Quad 1GHz Cortex-A9 Processor
- Freescale PF-Series PMIC
- 1 GB DDR3 memory (non terminated)
- 3” x 7” 8-layer PCB

External Memory
- 8GB eMMC iNAND
- SPI NOR Flash

Display
- Native 1024x768 LVDS display with kit
- 2nd LVDS connector
- Parallel LCD add-on card via expansion connector
  - 24 bit 4.3” 800x480 WVGA with 4-wire touch screen
- HDMI Connector
- MIPI DSI connector

Audio
- Wolfson Audio Codec
- Microphone and headphone jacks
- Dual 1W Speakers

Expansion Connector
- Enables parallel LCD or HDMI output
- Camera CSI port signals
- I2C, SSI, SPI signals

Tools Support
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Add-on Modules
- 4.3” WVGA 4-wire touchscreen
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- GPS receiver
- Dual 5MP Cameras
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- Battery Charger
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- 4.3” WVGA 4-wire touchscreen
  - MCIMX28LCD $199
- Connectivity module
With the **i.MX 6 series**, you do your software work **one time** and it’s done for your portfolio of products

- **i.MX Supported Software:**
  - Google Android™
  - Microsoft® Windows Embedded CE
  - Ubuntu
  - Linux® OS
  - QNX®
  - Linaro
  - Adobe® Flash®
  - Skype™

Source: IBS 2009

Breakdown of average total IC design costs for different design activities at different technology nodes
Freescale EcoMAPS for i.MX Architectures

Dev Tools
- ARM
- IAR Systems
- Lauterbach
- Macraigor Systems
- Mentor Embedded
- Segger
- Timesys

Customer Application
- Application Specific
  - AI
  - Adobe
  - ARM
  - Fast boot
- Middleware
  - Embest
  - Green Hills Software
  - Qt
- Operating Systems
  - Android
  - Windows CE
  - QNX Software Systems
  - Linux
  - Ubuntu
- i.MX Processors
  - ARM

HW & SW Engineering Services
- EBS: Embedded Board Solutions
  - Advantech
  - Boundary Devices
  - Congatec
  - Digi International
  - iWave
  - Kontron
  - NovTech
  - SECO
  - TQ
- IDH: Independent Design House
  - Compal
  - FIC
  - Foxconn
  - HMS
  - Letou
  - Netronix
- ODM: Original Design Manufacturer

Training
- Training Partners
  - Acsys
  - Adeneo
  - iWave

More Standard
More Custom

IDE: Integrated Development Environment
BDM: Background Debug Module
EBS: Embedded Board Solutions
IDH: Independent Design House
ODM: Original Design Manufacturer
SSI: Software & Solution Integrators

Advantages:
- Security
- Fast boot

Standards:
- More Standard
- More Custom
Freescale Networking: Leadership Credentials

Market Leadership:

#1 in Embedded Processors in Wired and Wireless Communications\(^1\)
#2 in Programmable DSPs\(^2\)

Key Product Families:

QorIQ
Multicore SoC Processors

QorIQ Qonverge
Heterogeneous SoC Processors

VortiQa
Software System Solutions

2012 Market Share in Embedded Processors in Wired & Wireless Communications\(^1\)

Sources:
2. Strategy Analytics, April 2012
2014: Advancing with Differentiated Solutions: Layerscape Platform

Turn Key Software
Linux SMP, KVM, Fast Path Module, Eclipse Tools

1- Core Agnostic (ARM, Power Arch)
- ARM Product Roadmap
- Small / Large footprints

2- Scalable Acceleration Elements
- Sized to Application Needs
- Turn key or C-programmable
- Wire rate I/O switching & TM

3- Ease of Use
- Real Time Monitoring / Debug
- SW Management utility
- I/O virtualization

4- Turn-key Software
- Fast path modules
- Linux / BSP
- Hypervisor: KVM
- Eclipse-based Tools

Layerscape: Networking 64b Multicore SoC Platform
a) Industry standard Tools & C-programmability
b) Abstracts I/O and Acceleration
c) Turn-key / Production-quality SW
Introducing the QorIQ LS1 Family

Highest Level of Integration Under 3 W

Leveraging over 20 years of networking expertise, the ARM®-based QorIQ LS1 family is optimized to offer high efficiency, leading integration and a broad array of high-speed interconnects for power-constrained applications.
Cortex A7 Delivers Extreme Power Efficiency

- **Power efficient microarchitecture**
  - In-order 8-stage, partial dual-issue
  - Integrated L2, improved memory system
  - 0.35 Specint2K/MHz, 1.86DMIPS/MHz

- **Architecture aligned with Cortex A-15**
  - Hardware enhanced OS virtualization
  - AMBA4 ACE system coherency
  - 1 TB physical memory addressable

- **Available Now**

**28 HPM Process Targets**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (worst/OD)</td>
<td>850 MHz/1.0 GHz</td>
</tr>
<tr>
<td>Power (P_dyn)</td>
<td>0.080 mw/MHz</td>
</tr>
<tr>
<td>Power (P_static)</td>
<td>30.7mW</td>
</tr>
<tr>
<td>Area (MP2 + L2)</td>
<td>1.86 mm²</td>
</tr>
</tbody>
</table>

* Power is per core, Dhrystone, Pdyn TT/85C, 28HPM Dual-core w/256KB L2, each core with 32K x 32K L1, NEON, FPU, Frequency at SSG, 9T, Vnom-10%, JC, OD at 0.9V (worst)

Compelling performance at <100mW
LS1 Family Differentiated Features

- **Performance starts with the core**
  - Dual ARM Cortex-A7 cores delivering over 6,000 CoreMark® of performance at under 3W (typical) for improved performance without increased power utilization
  - **Best in class** 1.7 CoreMark / mW ratio

- **Broadest range of peripheral and I/O features in its class**
  - Only product in its class to offer **ECC protection** for both L1/L2 caches, meeting networking requirements for high reliability
  - **Virtualization support** enables partitioning of CPU resources on low-power parts for increased system productivity
  - **First in its class** to offer support for DDR4 memory ensuring continued performance efficiency
  - Only communications processor to combine LCD controller, USB 3.0 with integrated PHY, SD/MMC and SATA3 on a single SoC to enable lower system-level costs
  - **QUICC Engine** provides **proven support** for protocols required in industrial, building and factory automation applications

---

**LS102x Target Applications**

- Management processor
- Multi-service IOT gateways
- 802.11ac AP routers
- Carrier line cards
- Printing & Imaging
- Networked attached storage
- Industrial Automation & control
- M2M
- Robotics
Target Markets and Applications

Enterprise Networking
- High-speed interfaces
- Security engine
- ECC-protected caches
- Virtualization

Industrial Automation and Control
- Industrial interfaces
- LCD for HMI support
- Industrial protocol support

IoT Gateways
- High-speed interfaces
- Multi-protocol support
- High-bandwidth LAN/WAN support

The LS1 processors extend Freescale’s market leadership in communications processors and enables new categories of applications under 3 W.

$1.9B SAM in 2015

Enterprise Networking 35%
Industrial Automation and Control 25%
IoT Gateways 25%

Source: IDC and IMS Research, World Market for Internet connected Devices, August, 2012
Scalable LS102xA Family of ARM Cortex-A7 Processors

LS102xA Family: All feature Dual Cortex A7 Cores

- Networking
  - Up to 1GHz, 2.6W Typ.
  - Enterprise & Consumer Networking
  - Enterprise WLAN AP’s
  - Gateways
  - Security Appliances

- Industrial & Printing
  - Up to 1GHz, 2.7W Typ.
  - Adds LCDC and CAN
  - Printing
  - Factory Automation
  - Building Automation
  - Defense & Aero
  - M2M

- Entry Consumer & Industrial
  - Up to 600MHz, 2W Typ.
  - For demanding low-power designs

Pin & Software Compatible
QorIQ LS1021A

- Dual ARM Cortex-A7 cores up to 1.0 GHz
  - ECC protected L1/L2 caches
  - DDR3L/4 up to 1.6GHz
- Over 5,000 Coremark at under 3.7W (TDP power)
- Industry best Coremark / mW ratio
- Outstanding security and IP forwarding
- High integration reduces BOM costs for targeted applications:
  - Industrial gateways
  - Industrial Automation
  - Printing & Imaging
  - HMI
  - M2M, Smart “X”

Key Architectural Features:
- ARM AMBA4 MPCore™ Virtualization
- DDR3L/4 32-bit with ECC support
- 3-port GigE with IEEE 1588
- 2x PCI Express Gen2
- Multi-protocol 4-Lane SerDes
- PCIe-2, SATA3, SGMII
- QUICC Engine – HDLC/TDM/ProfiBUS
- EnergyStar support with fast wakeup
- 2Gbps IP forwarding

Key System Integration Features:
- Low-cost NAND/NOR flash systems
- Low-cost DRAM systems
- USB3 SuperSpeed
- Audio networking and motor control
- QorIQ Trust Architecture and ARM TrustZone support
- Alignment with Kinetis/Vybrid portfolio

Package & Board:
- Package: 525-pin, 19x19mm, 0.8mm ball pitch
- Power: ~2.8W @1.0GHz Typical
- Temp: -40C (TA) to 105C (Tj)
- Boards: Tower low-cost board Freescale Linux BSPs
QorIQ LS1020A

- Dual ARM Cortex-A7 cores up to 1.0 GHz
  - ECC protected L1/L2 caches
  - DDR3L/4 up to 1.6GHz
- Over 5,000 Coremark at under 3.6W (TDP power)
- Industry best Coremark / mW ratio
- Outstanding security and IP forwarding
- High integration reduces BOM costs for targeted applications:
  - 802.11ac AP Routers
  - Line cards
  - Multi-service gateways
  - M2M, Smart “X”

Key Architectural Features:
- ARM AMBA4 MPCore™ Virtualization
- DDR3L/4 32-bit with ECC support
- 3-port GigE with IEEE 1588
- 2x PCI Express Gen2
- Multi-protocol 4-Lane SerDes
- PCIe-2, SATA3, SGMII
- QUIICC Engine – HDLC/TDM
- EnergyStar support with fast wakeup
- 2Gbps IP /1Gbps IPSec forwarding

Key System Integration Features:
- Low-cost NAND/NOR flash systems
- Low-cost DRAM systems
- USB3.0 Super Speed (5GT/s)
- SATA III (6GT/s)
- Audio networking
- QorIQ Trust Architecture and ARM TrustZone support
- Alignment with Kinetis/Vybrid portfolio

Package & Board:
Package: 525-pin, 19x19mm, 0.8mm ball pitch
Power: ~2.6W @1.0GHz Typical
Temp: -40C (TA) to 105C (Tj)
Boards: Tower low-cost board
Freescale Linux BSPs
QorIQ LS1022A

- Dual ARM Cortex-A7 cores up to 600 MHz
  - Coherent 512KB L2 cache
  - DDR3L up to 1GHz
- Over 3,000 Coremarks at under 3W (TDP power)
- Outstanding Coremark / mW ratio: 1.1 Coremarks / mW
- Excellent IP forwarding
- Lowest power-to-performance ratio in class, ideal for targeted applications:
  - Environmental control
  - Industrial controllers
  - M2M, Smart “X”

Key Architectural Features:
- ARM AMBA4 MPCore™ Virtualization
- DDR3L 16-bit with ECC support
- 2-port GigE with IEEE 1588
- 1x PCI Express Gen2
- 4x CAN ports for industrial applications
- EnergyStar support with fast wakeup
- 2Gbps IP forwarding

Key System Integration Features:
- Low-cost NAND/NOR flash systems
- Low-cost DRAM systems
- USB2.0
- QorIQ Trust Architecture and ARM TrustZone support
- Alignment with Kinetis/Vybrid portfolio

Package & Board:
- Package: 525-pin, 19x19mm, 0.8mm ball pitch
- Power: ~2W @ 600MHz Typical
- Temp: -40C (TA) to 105C (Tj)
- Boards: Tower low-cost board
  Freescale Linux BSPs
# Complete Enablement to Ease Development

<table>
<thead>
<tr>
<th><strong>Reference Designs</strong></th>
<th><strong>CodeWarrior</strong></th>
<th><strong>Freescale VortiQa</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Modular, cost-effective development platform that will feature an integrated on-board probe <em>(late Spring 2014)</em></td>
<td>Comprehensive IDE that provides a visual, automated framework to accelerate development of complex applications</td>
<td>Provides complete software stacks for Enterprise and SMB networking applications</td>
</tr>
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<tr>
<th><strong>ARM DS-5</strong></th>
<th><strong>Linux SDK</strong></th>
<th><strong>Worldwide Expert Support</strong></th>
<th><strong>Evaluations</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerate software development with an easy to use and professionally maintained toolchain</td>
<td>Evaluation kit includes Linux 3.12 release with optimized drivers and development tools</td>
<td>All QorIQ LS series devices are supported by our extensive third-party ecosystem</td>
<td>Leading providers of commercial operating systems, middleware and tools</td>
</tr>
</tbody>
</table>

**Evaluation Kit**
- Leading providers of commercial operating systems, middleware and tools
- Evaluation kit includes Linux 3.12 release with optimized drivers and development tools

**Worldwide Expert Support**
- All QorIQ LS series devices are supported by our extensive third-party ecosystem
Summary

QorIQ processors continue to drive networking innovation, now bringing over **20 years** of networking expertise to ARM processing.

The scalable LS1 family has been **optimized** for low-power, small-form-factor networking and industrial applications, offering the highest level of integration under 3 W.

Freescale is the first to take the highly-efficient ARM® Cortex®-A7 core into the networking market, delivering enterprise reliability and exceptional performance-per-watt.

**Powerful combination** of Freescale and ARM ecosystems for best-in-class customer support.

Samples of **LS1020A, LS1021A, LS1022A** expected to be available Q1 2014.
### Comprehensive Portfolio Based on ARM Technology

<table>
<thead>
<tr>
<th>Kinetis Microcontrollers</th>
<th>Vybrid Controller Solutions</th>
<th>i.MX Application Processors</th>
<th>QorIQ Processors built on Layerscape Architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design Potential. Realized</strong></td>
<td><strong>Rich Apps in Real Time.</strong></td>
<td><strong>Your Interface to the World.</strong></td>
<td><strong>Accelerating the Network’s IQ</strong></td>
</tr>
</tbody>
</table>

- **Industry’s most scalable ultra-low-power, mixed-signal MCU solutions based on the ARM® Cortex™-M and Cortex™-M0+ architectures.**
- **Real-time, highly integrated solutions with best-in-class 2D graphics to enable your system to control, interface, connect, secure and scale.**
- **Industry’s most versatile solutions for multimedia and display applications, with multicore scalability and market-leading power, performance & integration.**
- **Industry’s first software-aware, core-agnostic networking system architecture for the smarter, more capable networks of tomorrow – end to end.**

| Consumer | Industrial | Automotive | Consumer | Industrial | Networking |

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**Freescale has the industry’s broadest range of solutions built on ARM® technology for automotive, industrial, consumer and networking applications.**

Find your ideal solution at the price, performance and power level you desire, and leverage the extensive software and tool bundles available to speed and ease your design process.
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 is pleased to introduce 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

• A list of participating **Freescale products** is available at: [www.freescale.com/productlongevity](http://www.freescale.com/productlongevity)