

Kinetis KV5x – Real-Time Control MCUs with Ethernet

Up to 1 MB Flash and 256 KB SRAM

1. Kinetis V family introduction

Kinetis V series microcontrollers (MCUs) combine the performance and precision needed for real-time control applications, such as motor control and power conversion, with the ease-of-use of ARM® Cortex®-M processor combined with the performance, peripheral set, enablement, and scalability of the Kinetis 32-bit MCU portfolio.

The Kinetis KV5x family of MCUs is a high-performance solution offering exceptional precision, sensing, and control for some of the most demanding applications in motor control and power conversion. Built upon the ARM Cortex-M7 core running at 240 MHz with single precision floating point unit, it features advanced high-speed and high-accuracy peripherals such as high-resolution pulse width modulation (PWM) with 312-picosecond resolution, four 12-bit analog-to-digital converters (ADCs) sampling at 5 mega samples per second (MSPS), a total of 44 PWM channels for support of multi-motor systems with PFC, three FlexCAN modules and optional Ethernet communications. The KV5x is supported by a comprehensive enablement suite from Freescale and third-party resources including reference designs, software libraries, and motor configuration tools.

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2. Kinetis KV5x sub-family overview

The Kinetis KV5x is a real-time control MCU family primarily targeting high-performance industrial motor control, industrial drives and automation, and power conversion applications. The KV5x provides an easy migration path from the Kinetis KV4x MCU family with additional memory, Ethernet communications, and high-precision peripheral options beyond those already offered. All Kinetis V series MCUs are compatible with the Kinetis K series MCU family (based on the ARM Cortex-M4 core) and with all Kinetis V series MCU families providing a highly scalable migration path between high performance and rich feature integration for cost-optimized solutions.

- KV56 - Broad offering with high-precision analog and digital integration and scalable Flash and RAM.
- KV58 - Expansion from the KV56 family with addition of the Ethernet communications with true random number generator and cryptography unit.

3. Kinetis KV5x key product features

- High-performance 240 MHz ARM Cortex-M7 core with a high level of analog and digital integration targeted at real-time control applications.
- Utilizes the ARM Cortex-M7, which is ideally suited for real-time control applications.
 - **DSP instructions with single precision floating point** - lower system cost by replacing the DSP or FPGA integrated circuits. Allows faster control loops for improved real-time control. Lower your average power by reducing time spent in chip processing modes.
 - 64-bit tightly-coupled memory interfaces for **high-performance deterministic processing**, increasing system performance and throughput.
 - 64-bit AXI memory interface with I-Cache and D-Cache for **efficient access to external resources**; interface to large external memories for a complete RTOS experience, support for multiple connectivity stacks and middleware.
 - **M-Class compatibility with higher performance** - scalable from existing ARM Cortex-M4 implementations to support faster time to market. Low-interrupt latency for real-time systems.
- Up to 1 MB of Flash and 256 KB of RAM, 16 KB of instruction cache and 8 KB of data cache. 256 KB of RAM includes 64 KB of ITCM RAM, ensuring maximum CPU performance of fast control loops with minimal latency.
- Wide Flash interface supports secure and fast access to safety-critical control parameters, minimizing CPU wait states.
- The four ADC blocks, two banks of two, sampling at 5 MSPS with dual sample and hold circuitry, can capture current and voltage for two motors simultaneously, giving true independent dual motor control, or provide the ability to read all three currents / voltages simultaneously, providing the most accurate results.
- Ethernet option with true random number generator and cryptographic unit provide a low-cost integrated connectivity solution.

- The multiple instantiations of timer blocks provide a vast array of timers (44 channels), simplifying the complex task of advanced motor control.
- The two eFlexPWM blocks provide four independent time bases per module with a highly flexible configuration that easily supports motor-control and power-control topologies.
- A single eFlexPWM block featuring 12 channels with nano-edge capability, providing up to 312-picosecond resolution on pulse width and frequency modulation.
- An inter-peripheral cross bar, with And or Invert logic, provides a highly-flexible connection fabric between peripherals that supports simplified control topology implementation.

4. Kinetis KV5x product family feature summary

Table 1. Family feature summary

| Feature | Details |
|-------------------------------|--|
| System | |
| Central processing unit (CPU) | ARM Cortex-M7 |
| Max CPU frequency | 240 MHz |
| Caches | 16 KB of instruction cache + 8 KB of data cache |
| Floating point | Single-precision floating point unit (SPFPU) |
| Direct memory access (DMA) | 32 channels |
| DMA request multiplex | Two 16-channel DMAMUX; each with 64 inputs |
| Encryption | Memory-mapped crypto acceleration unit (MMCAU) |
| Software watchdog (iWDOG) | Independent clock source with windowed mode |
| External watchdog monitor | Watchdog with independent clock source |
| Debug | JTAG and 2-pin serial wire debug (SWD) |
| Trace | Instruction trace capability |
| Memory | |
| Flash memory | Up to 1 MB x 256-bit wide |
| Random-access memory (RAM) | Up to 256 KB of total RAM partitioned: 64 KB - ITCM, 64 KB - DTCM0, 64 KB - DTCM1, 64 KB - OCRAM |
| Memory protection | ARM CM7 memory-protection unit (AMPU) and system memory-protection unit (SMPU) |

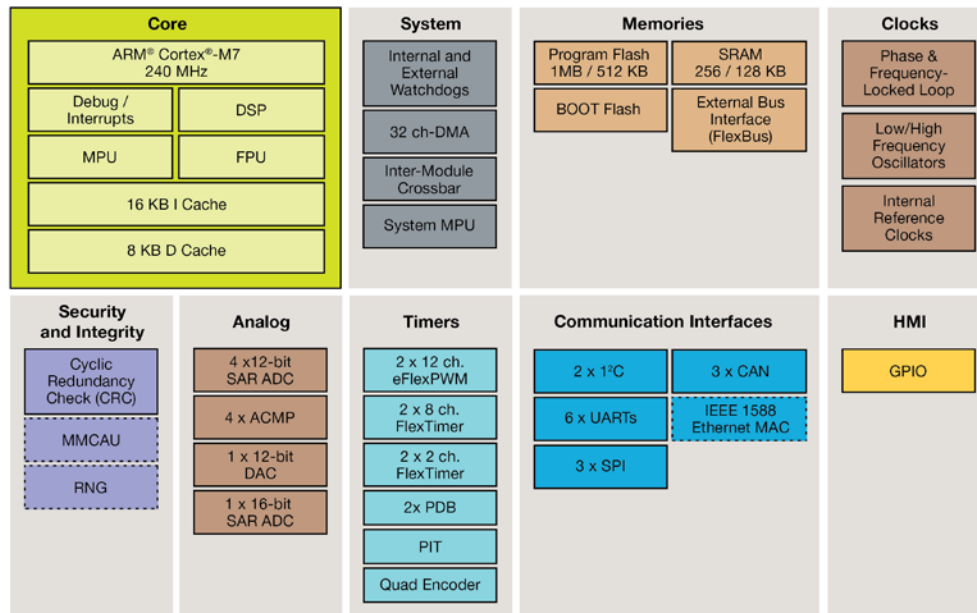
Table 1. Family feature summary

| Feature | Details |
|---|---|
| Cyclic redundancy check (CRC) | 16- or 32-bit CRC with programmable generator polynomial |
| External bus interface | Flexbus (32- / 24- / 16- / 8-bit muxed support) |
| Analog modules | |
| Analog-to-digital converters | Four 12-bit analog-to-digital converters (ADC) with a sample rate of 5 MSPS One 16-bit SAR ADC |
| High-speed comparator (HSCMP) with internal 6-bit digital-to-analog converter (DAC) | Four modules |
| 12-bit DAC | 12-bit DAC with 16-byte FIFO |
| Nano-edge module | One nano-edge module providing 312-picosecond pulse width and frequency resolution |
| Timers | |
| FlexPWM | Two eFlexPWM modules, each consisting of four submodules, with each submodule providing three PWM outputs FlexPWMA has nano-edge support FlexPWMB has dithering support |
| FlexTimer (FTM) | Two 8-channel FlexTimers backward compatible to KV4x Two 2-channel FlexTimer with quadrature decoding |
| Quadrature encode / decode unit | One module |
| Programmable delay block (PDB) | Two modules |
| LPTimer | CPU wakeup from low-power mode |
| PIT | One 4-channel PIT |
| Communication Interfaces | |
| Ethernet | 10 / 100 MB/s Ethernet MAC (MII and RMII) with hardware support for IEEE 1588 |
| Serial peripheral interface (DSPI) | Three modules with 4-word-deep FIFO |
| Inter-integrated circuit (I2C) | Two modules with SMBUS support |
| Flexible serial communications interface (FlexSCI) | Six modules All SCIs have IrDA support SCI0 and SCI1 have 8-word-deep FIFO |
| FlexCAN | Three modules |

Table 1. Family feature summary

| Feature | Details |
|---------------------------------------|--|
| Human-machine interface (HMI) | |
| General-purpose input / output (GPIO) | Three V I/Os with enhanced ESD protection |
| Maximum number of I/Os | 74 on 100-pin 111 on 144-pin |
| Hardware characteristics | |
| Package | 100 LQFP (14 mm x 14 mm) 144 LQFP (20 mm x 20 mm) 144 MAPBGA (13 mm x 13 mm) |
| Voltage range | 1.71 V to 3.6 V |
| Temperature range (TA) | -40°C to 105°C |

5. Kinetis KV5x family block diagram



Optional

Figure 1. Kinetis KV5x family block diagram

6. Kinetis KV5x product family

Table 2. Product family

| Device | Max. Freq. | Pins | Flash | SRAM | ENET | Flex. Bus | HS ADC | | eFlexPWM | FlexTimers | CAN | Max I/O |
|-----------|------------|------|--------|--------|------|-----------|--------|------|-----------|-----------------------|-----|---------|
| MKV58F1M0 | 240 MHz | 144 | 1 MB | 256 KB | Yes | Yes | 4 | 8-ch | 2 x 12-ch | 2 x 8-ch, 2 x 2-ch | 3 | 111 |
| MKV58F1M0 | 240 MHz | 100 | 1 MB | 256 KB | Yes | Yes | 4 | 8-ch | 2 x 12-ch | 2 x 8-ch, 2 x 2-ch | 3 | 74 |
| MKV56F1M0 | 240 MHz | 144 | 1 MB | 256 KB | No | Yes | 4 | 8-ch | 2 x 12-ch | 2 x 8-ch, 2 x 2-ch | 2 | 111 |
| MKV56F1M0 | 240 MHz | 100 | 1 MB | 256 KB | No | Yes | 4 | 8-ch | 2 x 12-ch | 2 x 8-ch, 2 x 2-ch | 2 | 74 |
| MKV58F512 | 240 MHz | 144 | 512 KB | 128 KB | Yes | Yes | 4 | 8-ch | 2 x 12-ch | 2 x 8-ch, 2 x 2-ch | 3 | 111 |
| MKV58F512 | 240 MHz | 100 | 512 KB | 128 KB | Yes | Yes | 4 | 8-ch | 2 x 12-ch | 2 x 8-ch, 2 x 2-ch | 3 | 74 |
| MKV56F512 | 240 MHz | 144 | 512 KB | 128 KB | No | Yes | 4 | 8-ch | 2 x 12-ch | 2 x 8-ch, 2 x 2-ch | 2 | 111 |
| MKV56F512 | 240 MHz | 100 | 512 KB | 128 KB | No | Yes | 4 | 8-ch | 2 x 12-ch | 2 x 8-ch, 2 x 2-ch | 2 | 74 |

7. Comprehensive enablement solutions

7.1. Freescale Embedded Motor Control and Power Conversion libraries

- Extensive suite of complimentary software libraries for motor-control and power-conversion applications.
- A group of algorithms, ranging from basic mathematical operations to advanced transformations and observers that can be easily incorporated into complex real-time control applications.
- The complimentary algorithms help to speed up development and ease of use in applications that require intensive math computation and control.

7.2. Freescale MQX™ RTOS and complimentary TCP/IP stack

- Freescale MQX RTOS is a full-featured, complimentary, real-time operating system including the MQX kernel, TCP/IP stack, embedded MS-DOS file system, and more.
- The MQX multi-tasking kernel provides preemptive scheduling, fast interrupt response, extensive inter-process communication and synchronization facilities.
- The MQX RTOS features the Freescale MQX real-time TCP/IP Communication Suite (RTCS) that now supports IPv6. The RTCS provides IP networking for embedded devices, supporting a rich assortment of TCP/IP networking application protocols.

7.3. Kinetis Software Development Kit (SDK)

- Extensive suite of robust peripheral drivers, stacks, middleware, and example applications designed to simplify and accelerate application development on any Kinetis MCU.
- Software examples include demonstrating the usage of the hardware abstraction layer (HAL), peripheral drivers, middleware, and RTOS's.
- The Kinetis SDK is complimentary and includes full source code under a permissive open-source license for all hardware abstraction and peripheral driver software.

7.4. Processor Expert software

- Building on the Kinetis SDK drivers, Processor Expert software is a development system to create, configure, optimize, migrate, and deliver software components that generate source code for Freescale silicon.

7.5. Integrated development environments (IDE)

- Freescale Kinetis Design Studio IDE freescale.com/kds
 - No-cost integrated development environment (IDE) for Kinetis MCUs
 - Eclipse and GCC-based IDE for C / C++ editing, compiling, and debugging
- IAR Embedded Workbench® iar.com/kinetis
- ARM Keil® Microcontroller Development Kit keil.com/freescale
- Atollic® TrueSTUDIO® atollic.com/index.php/partnerfreescale
- Green Hills Software MULTI ghs.com/partners/freescale_partner.html
- Broad ARM ecosystem support through Freescale Connect partners

7.6. Online enablement with ARM mbed™ development platform

- Rapid and easy Kinetis MCU prototyping and development
- Online mbed SDK, developer community
- Free software libraries

7.7. Bootloader

- Common bootloader for all Kinetis MCUs
- In-system flash programming over a serial connection: erase, program, verify
- Flash-based bootloader with open-source software and host-side programming utilities

7.8. Development hardware

- Tower System modular development platform
 - Rapid prototyping and evaluation
 - Low cost, interchangeable modules

8. Part identification

8.1. Description

Part numbers for the chip have fields that identify the specific part. You can use the values of these fields to determine the specific part you have received.

8.2. Format

Part numbers for this device have the following format: Q KL## A FFF T PP CC (N)

8.3. Fields

The following table lists the possible values for each field in the part number (not all combinations are valid).

Table 3. Part number field descriptions

| Field | Description | Values |
|-------|-----------------------------|---|
| Q | Qualification status | M = fully qualified, general market flow P = prequalification |
| KV## | Kinetis family | KV56 KV58 |
| A | Key attribute | F = floating point |
| FFF | Program flash memory size | 512 = 512 KB 1M0 = 1 MB |
| R | Silicon revision | (Blank) = Main A = Revision after main |
| T | Temperature range | V = -40°C to 105°C |
| PP | Package identifier | LL = 100 LQFP (14 mm x 14 mm) LQ = 144 LQFP (20 mm x 20 mm) MD = 144 MAPBGA (13 mm x 13 mm) |
| CC | Maximum CPU frequency (MHz) | 24 = 240 MHz |

Table 3. Part number field descriptions

| Field | Description | Values |
|-------|----------------|--------------------------------------|
| N | Packaging type | R = tape and reel (Blank) = trays |

9. Orderable part numbers

Table 4. Ordering information

| MC Part Number | Pin Count | Package | Flash | SRAM |
|-----------------|-----------|---------|--------|--------|
| MKV58F1M0VMD24* | 144 | MAPBGA | 1 MB | 256 KB |
| MKV58F1M0VLQ24 | 144 | LQFP | 1 MB | 256 KB |
| MKV58F1M0VLL24 | 100 | LQFP | 1 MB | 256 KB |
| MKV56F1M0VMD24* | 144 | MAPBGA | 1 MB | 256 KB |
| MKV56F1M0VLQ24 | 144 | LQFP | 1 MB | 256 KB |
| MKV56F1M0VLL24 | 100 | LQFP | 1 MB | 256 KB |
| MKV58F512VMD24* | 144 | MAPBGA | 512 KB | 128 KB |
| MKV58F512VLQ24 | 144 | LQFP | 512 KB | 128 KB |
| MKV58F512VLL24 | 100 | LQFP | 512 KB | 128 KB |
| MKV56F512VMD24* | 144 | MAPBGA | 512 KB | 128 KB |
| MKV56F512VLQ24 | 144 | LQFP | 512 KB | 128 KB |
| MKV56F512VLL24 | 100 | LQFP | 512 KB | 128 KB |

* The 144 MAPBGA package for this product is not yet available. However, it is included in the Package Your Way program for Kinetis MCUs. Visit freescale.com/KPYW for more details.

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