Kinetis

Entry-level solutions

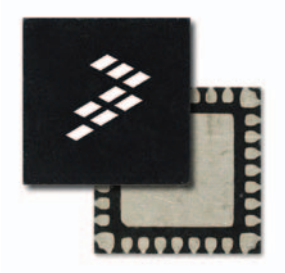
freescale.com/Kinetis

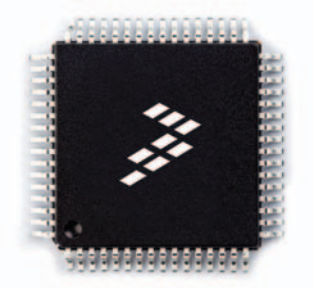
freescale™

The Kinetis MCU portfolio consists of multiple pin-, peripheral- and software-compatible MCU families based on the ARM® Cortex™-M4 core. Families are built on innovative 90 nm thin-film storage (TFS) flash technology with unique FlexMemory (EEPROM) capability, and offer industry-leading low power and mixed signal analog integration.

Kinetis K10/K20 50 MHz MCUs

The gateway to great design





Ultra-low power and high performance for space-constrained and cost-sensitive applications

The 50 MHz entry-level K10 and K20 MCUs are the lowest power Kinetis ARM® Cortex™-M4 devices with high feature integration in a small form factor, making them ideal for space- and cost-constrained applications.

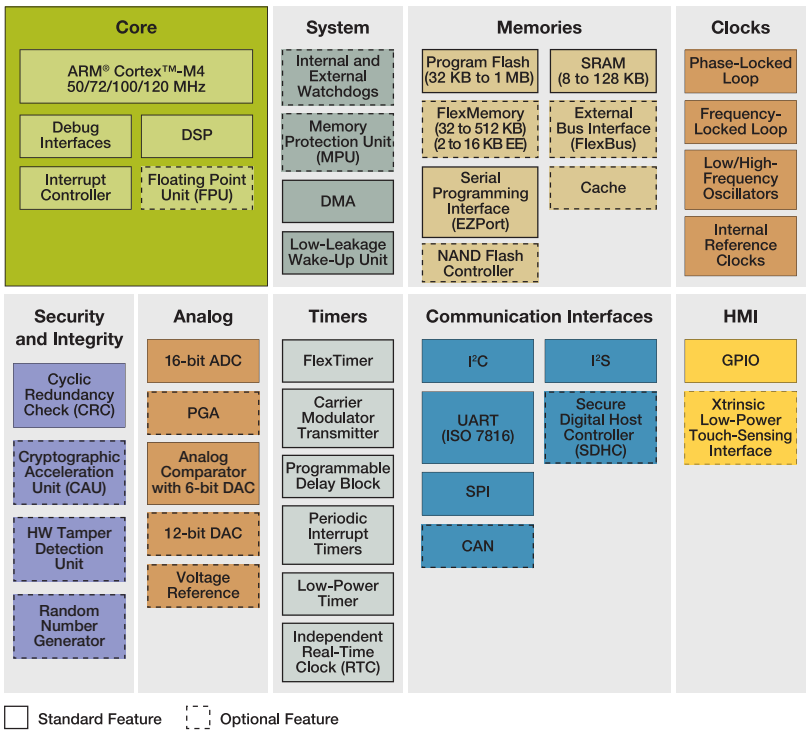
These MCUs offer 32 to 512 KB of flash memory in 32-pin QFN (5 mm x 5 mm) to 121 MAPBGA packages. Devices are built from our innovative 90 nm TFS low-leakage flash technology with up to 64 KB of optional FlexMemory (4 KB EEPROM), very low-power Run and Stop mode currents and fast wake-up times. Peripheral options include a 16-bit ADC, Full-Speed USB 2.0 On-The-Go controller with complimentary software stack, low-power touch-sensing interface, hardware crypto unit and tamper detect, as well as and several general timing, communication and control peripherals.

Target applications are broad and include input/output (I/O) modules for factory automation, portable health care instruments, USB microphones, gaming headsets and smart grid applications that demand solid processing power with aggressive low-power profiles.

Target Applications

- Power Tools
- Wireless Water Flow Sensors
- Advanced Universal Remote Controls
- USB Headsets
- Fitness Watches
- Intelligent Toys
- Electronic Point Of Sale (EPOS)
- Electricity Meters

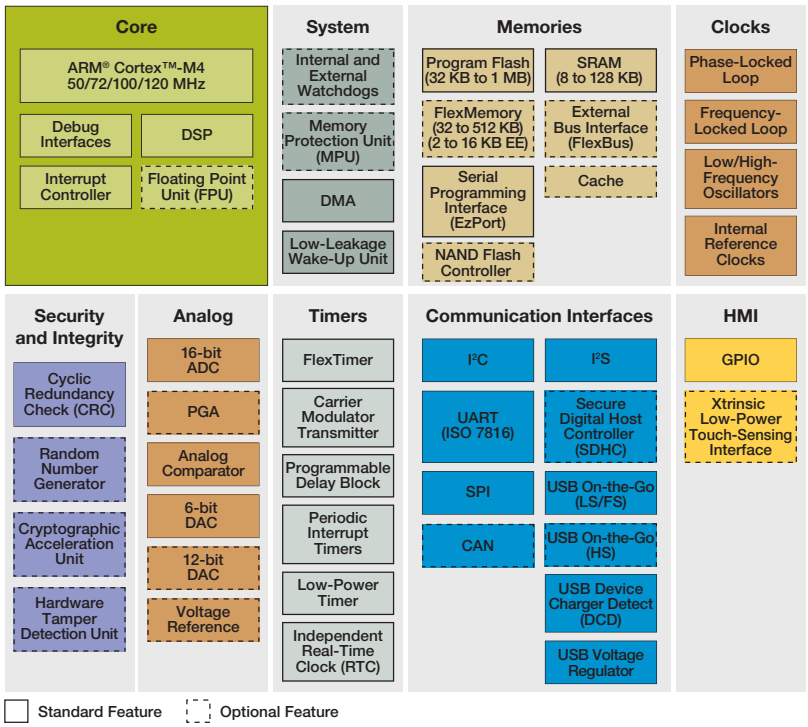
Kinetis K10 Family



One-Stop Enablement

- Freescale Tower System modular development platform
  - TWR-K20D50M MCU module
  - TWR-K21D50M MCU module
- Integrated development environments
  - Eclipse-based CodeWarrior V10.x IDE and Processor Expert
  - IAR Embedded Workbench
  - Keil MDK
- Runtime software and RTOS
  - Math, DSP and encryption libraries
  - Motor control libraries
  - Complimentary USB stack with personal health care device and USB audio classes
  - Complimentary Xtrinsic touch-sensing software (TSS) suite
  - Complimentary bootloaders (USB, serial)
  - Complimentary Freescale MQX™
  - Cost-effective Nano™ SSL/Nano™
- Full ARM® ecosystem

Kinetis K20 Family



Documentation

Document Number	Title	Description
KNTSK10FMLYFS	Kinetis K10 Family Fact Sheet	Kinetis K10 MCU overview
KNTSK20FMLYFS	Kinetis K20 Family Fact Sheet	Kinetis K20 MCU overview
K10PB	K10 Family Product Brief	Selector guide for K10 MCUs
K20PB	K20 Family Product Brief	Selector guide for K20 MCUs
KQRUG	Kinetis Peripheral Module Quick Reference Guide	Compilation of demonstration software for Kinetis modules

Kinetis K10 50 MHz MCUs Selector Guide

Part Number	CPU (MHz)	Memory			Feature Options								Other	√ Package									
		Flash (KB)	Flex NVM (KB)	SRAM (KB)	Single Precision Floating Point Unit	CAN	Memory Protection Unit	Secure Digital Host Controller	External Bus Interface	12-bit DAC	Prog. Gain Amplifier	5 V Tolerant I/O		FM 32 QFN (5 x 5)	FT 48 QFN (7 x 7)	LF 48 LQFP (7 x 7)	MP 64 MAPBGA (5 x 5)	LH 64 LQFP (10 x 10)	LK 80 LQFP (12 x 12)	LL 100 LQFP (14 x 14)	AB 120 WLCSP (5 x 5)	MC 121 BGA (8 x 8)	LQ 144 LQFP (20 x 20)	MD 144 BGA (13 x 13)
MK10DN32Vyy5	50	32	-	8										√	√	√	√	√						
MK10DN64Vyy5	50	64	-	16										√	√	√	√	√						
MK10DX32Vyy5	50	32	32	8										√	√	√	√	√						
MK10DX64Vyy5	50	64	32	16										√	√	√	√	√						
MK10DN128Vyy5	50	128	-	16										√	√	√	√	√						
MK10DX128Vyy5	50	128	32	16										√	√	√	√	√						
MK12DX128Vyy5	50	128	64	32						√						√		√	√			√		
MK12DX256Vyy5	50	256	64	32						√						√		√	√			√		
MK12DN512Vyy5	50	512	-	64						√								√	√			√		
MK11DX128Vyy5	50	128	64	32						√*			Tamper Detect, CAU + RNG						√			√		
MK11DX256Vyy5	50	256	64	32						√*			Tamper Detect, CAU + RNG						√			√		
MK11DN512Vyy5	50	512	-	64						√*			Tamper Detect, CAU + RNG						√			√		

yy = package designator * 121 BGA package only ** C temp only (–40 °C to +85 °C) Refer to family product brief on freescale.com for full product specs.

Kinetis Features and Benefits

Feature	Benefit	K10	K20
• ARM® Cortex™-M4 core with DSP instruction support • 4-channel DMA. Cross bar switch	• High-performance and power-efficient 50 MHz core includes DSP instruction support for intensive processing needs • Peripheral and memory servicing with reduced CPU loading • Optimized bus bandwidth and flash execution performance • Concurrent multi-master bus accesses for increased bus bandwidth	√	√
• Full-Speed USB On-The-Go with device charger detect	• Optimized charging current/time for portable USB devices, enabling longer battery life • USB low-voltage regulator supplies up to 120 mA off chip at 3.3 volts to power external components from 5-volt input		√
• 11 low-power modes with power and clock gating for optimal peripheral activity and recovery times	• Stop currents of 190 nA, run currents of <272 uA/MHz, 4 µs wake-up from Stop mode make 50 MHz Kinetis devices ideal for battery-operated applications	√	√
• Memory protection unit • Hardware cyclic redundancy check engine • Independent-clocked COP • External watchdog monitor • Cryptographic acceleration unit (CAU) • Hardware tamper detection unit • Random number generator	• Provides memory protection for all cross bar switch masters, increasing software reliability • Validates memory contents and communication data, increasing system reliability • Prevents code runaway in fail-safe applications • Drives output pin to safe state external components if watchdog event occurs • Secure data transfer and storage. Faster than software implementations and with minimal CPU loading. Supports a wide variety of algorithms: DES, 3DES, AES, MDS, SHA-1, SHA-256 • Secure key storage with internal/external tamper detect for unsecured flash, temperature/ clock/supply voltage variations and physical attack	√	√*
• High-speed 16-bit ADCs with configurable resolution • Two high-speed comparators	• Single or differential output mode operation for improved noise rejection. 500 ns conversion time achievable with programmable delay block triggering • Analog comparators provide fast and accurate motor over-current protection by driving PWMs to a safe state	√	√
• 2 x FlexTimers with up to 10 channels • Carrier modulator transmitter • 4-channel, 32-bit periodic interrupt	• General-purpose timers with hardware dead-time insertion and quadrature decoding for motor control • Infrared waveform generation for remote control applications • Time base generation for RTOS task scheduler or trigger source for ADC conversion and programmable delay block	√	√
• Multiple serial interfaces: Up to four UARTs, up to one DSPI and one I²C • Inter-IC sound (I²S) serial interface for audio system interfacing	• Variety of data size, format and transmission/reception settings supported for multiple industrial communication protocols • One UART supports RS232 with flow control, RS485, ISO7816 and IrDA • All other two UARTS support RS232 with flow control and RS485 • I²S interface allows easy connection to external codecs for audio applications	√	√
• Low-power hardware touch-sensing interface with up to 16 inputs	• Operates in low-power modes (minimum currrent added when enabled) • Hardware implementation avoids software polling method • High sensitivity level allows use of overlay surfaces up to 5 mm thick	√	√*
• 32–512 KB flash Up to 64 KB of SRAM • Optional 64 KB FlexMemory	• High reliability, fast access program memory with 4-level security protection • Independent flash banks allow concurrent code execution and firmware updating • FlexMemory provides 32 byte–2 KB of user-segmentable byte write/erase EEPROM plus 32 KB FlexNVM or extra program code, data or EEPROM backup	√	√

*Not a common feature in all K10 and K20 devices

Kinetis K20 50 MHz MCUs Selector Guide

Part Number	CPU (MHz)	Memory			Feature Options								Other	√ Package										
		Flash (KB)	Flex NVM (KB)	SRAM (KB)	Single Precision Floating Point Unit	CAN	Memory Protection Unit	Secure Digital Host Controller	External Bus Interface	12-bit DAC	Prog. Gain Amplifier	5 V Tolerant I/O		FM	FT	LF	MP	LH	LK	LL	AB	MC	LQ	MD
														32 QFN (5 x 5)	48 QFN (7 x 7)	48 LQFP (7 x 7)	64 MAPBGA (5 x 5)	64 LQFP (10 x 10)	80 LQFP (12 x 12)	100 LQFP (14 x 14)	120 WLCSP (5 x 5)	121 BGA (8 x 8)	144 LQFP (20 x 20)	144 BGA (13 x 13)
MK20DN32Vyy5	50	32	-	8									USB OTG (FS)	√	√	√	√	√						
MK20DN64Vyy5	50	64	-	16									USB OTG (FS)	√	√	√	√	√						
MK20DX32Vyy5	50	32	32	8									USB OTG (FS)	√	√	√	√	√						
MK20DX64Vyy5	50	64	32	16									USB OTG (FS)	√	√	√	√	√						
MK20DN128Vyy5	50	128	-	16									USB OTG (FS)	√	√	√	√	√						
MK20DX128Vyy5	50	128	32	16									USB OTG (FS)	√	√	√	√	√						
MK22DX128Vyy50	50	128	64	32						√			USB OTG (FS)			√		√	√			√		
MK22DX256Vyy50	50	256	64	32						√			USB OTG (FS)			√		√	√			√		
MK22DN512Vyy50	50	512	-	64						√			USB OTG (FS)					√	√			√		
MK21DX128Vyy50	50	128	64	32						√*			USB OTG (FS), Tamper Detect, CAU + RNG						√			√		
MK21DX256Vyy50	50	256	64	32						√*			USB OTG (FS), Tamper Detect, CAU + RNG						√			√		
MK21DN512Vyy50	50	512	-	64						√*			USB OTG (FS), Tamper Detect, CAU + RNG						√			√		

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Application Use Case

Power Tools

Overview

Power tools are typically powered by electrical motors and can be either stationary or handheld (portable). Both may be used onsite or in the home for drilling, cutting, shaping, grinding, polishing, painting and heating.

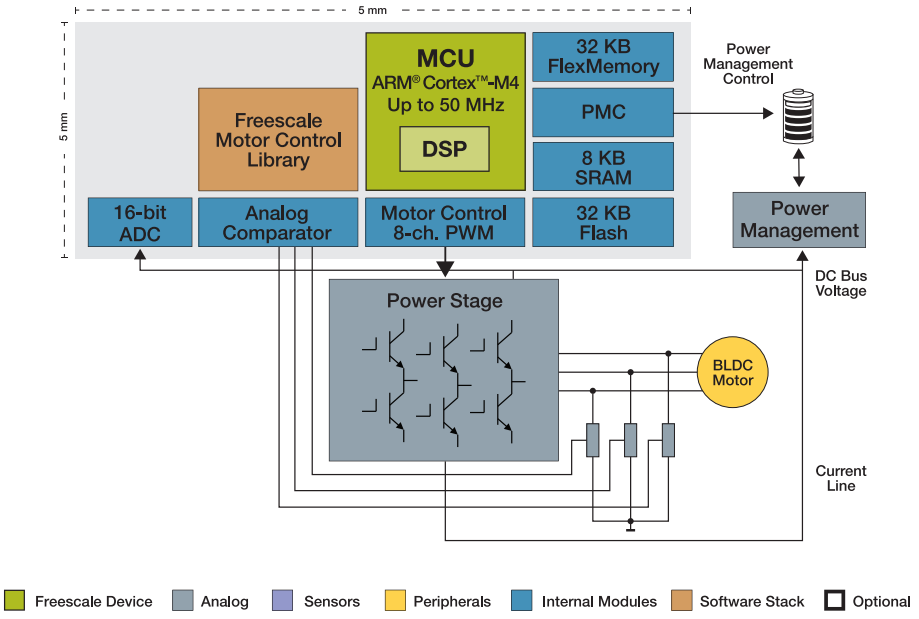
Requirements and Design Challenges

- Maintain high functionality (speed and accuracy) at low costs
- Longer battery life for portable power tools
- Easy to operate
- Safety functions

Solution Based on MK10DX32VFM5/ MK12DX128VLF5

- Three-phase BLDC motor control possible using high-performance ARM Cortex-M4 core with DSP instruction set
- 16-bit ADC and analog comparators offer right combination of analog for this application
- 8-channel PWM module with motor control functionality drives power stage for BLDC motor

MK10DX32VMF5/MK12DX128VLF5 Power Tool (Three-Phase BLDC)



- Freescale motor control library for ARM Cortex-M4 core (CORTEX_M4_FSLESL_1.1) simplifies development
- 11 power modes with power and clock gating provide functionality for optimal peripheral activity and reduced battery consumption
- FlexMemory can store error codes or general use parameters
- 32-pin 5 x 5 mm QFN K10 device keeps cost low and PCB size small

Application Use Case

Wireless Water Flow Sensors

Overview

Wireless low-power autonomous sensors can be distributed spatially to form a wireless network capable of measuring multiple variables such water flow, pressure, temperature or movement. Wireless transmission protocol and network topology can heavily improve network coverage.

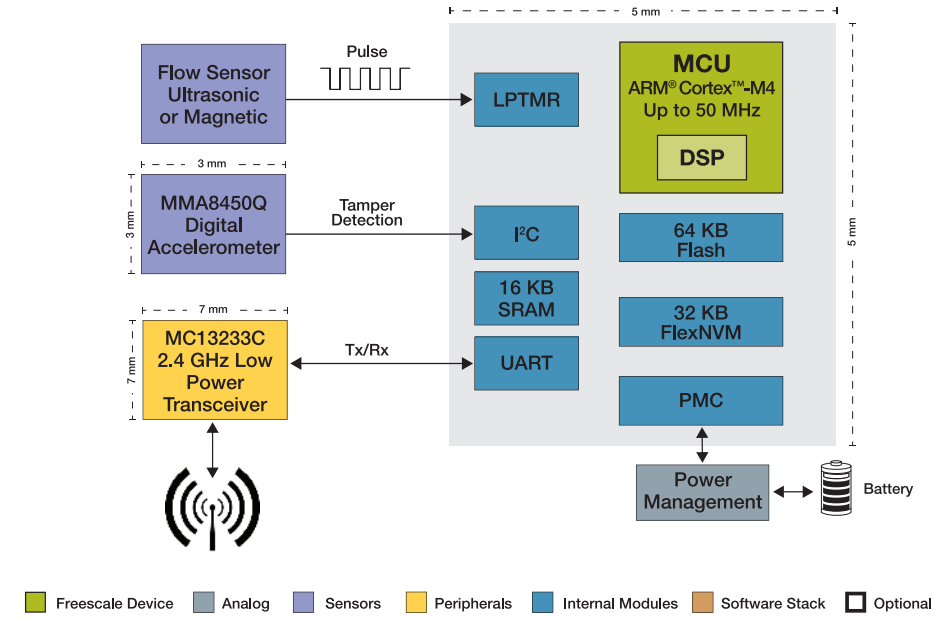
Requirements and Design Challenges

- Multi-year battery life
- Cost-sensitive application
- Kilometers outdoor range
- Anti tampering
- Wireless firmware upgrade
- Small sensor size

Solution Based on MK10DX64VFM5/ MK11DX128VLK5

- Low-power timer with optional glitch filter counts pulses delivered by flow sensor across all power modes, including low leakage modes
- ARM Cortex-M4 core executes flow calculation algorithms using the DSP instruction set
- I²C port interfaces to a low-power digital accelerometer such as the MMA4850Q and detects tamper or movement in the pipe

MK10DX64VFM5/MK11DX128VLK5 Wireless Water Flow Sensor



- Connect to the 2.4 GHz IEEE® 802.15.4/ ZigBee MC13233 transceiver through one of the UART modules
- Obtain kilometers of coverage by implementing simple star topology network
- Perform wireless firmware update or transfer data packets and keep measuring by using FlexNVM/flash combination
- Choose right combination of low-power modes for the application between 11 different operating modes
- Use lowest consumption power mode with real-time counter to achieve less than 500 nA
- Easily detect low voltage by using the power management controller embedded in Kinetis devices
- Effortlessly implement security features, such as password control, with embedded hardware cryptographic unit (Only in K11 devices)
- Freescale products reduce design size for wireless sensor applications
  - 32-pin Kinetis MCU for a 5 x 5 mm QFN package
  - Low-power wireless transceiver is available in a 48-pin 7 x 7 mm LGA
  - Accelerometer is available in a 3 x 3 mm package

Application Use Case

Advanced Universal Remote Controls

Overview

Remote controls are used in multiple consumer goods, from televisions to Blu-ray™ players and home theatre systems. An advanced universal remote control allows for simplified navigation between several devices.

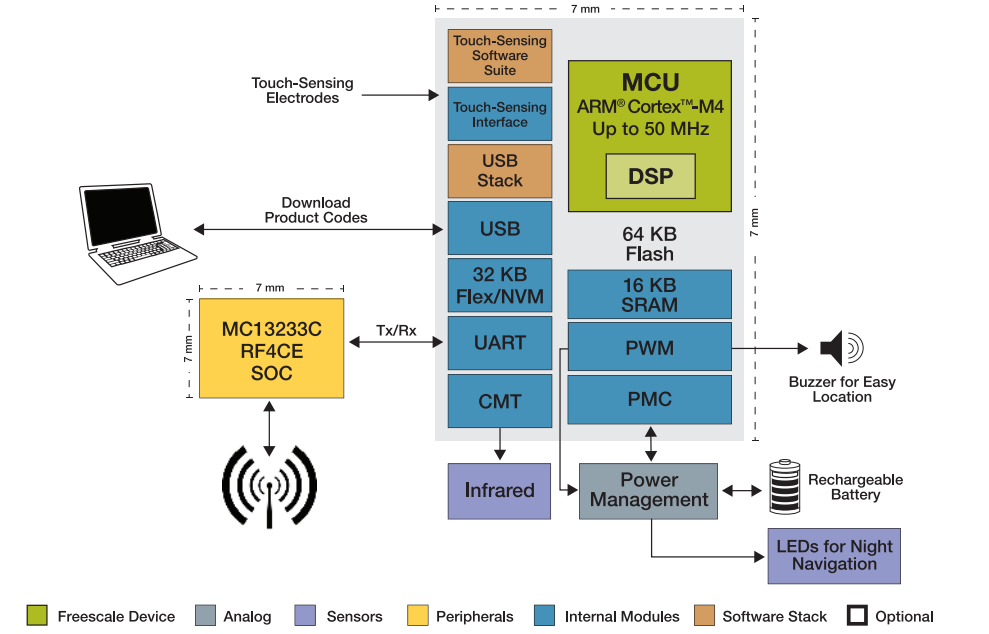
Requirements and Design Challenges

- Compatibility with multiple devices and brands
- Cost-sensitive application
- Control devices outside the user's line of vision
- High endurance/durability via touch-sensing electrodes
- Battery powered
- Improved human-machine interface (HMI)

Solution Based on MK20DX64VLF5/ MK22DX128VLF5

- Remote can be connected to a computer via Full-Speed USB for download of the necessary control codes from a web-based database, simplifying the programming process and eliminating the need for large internal memory

MK20DX64VLF5/MK22DX128VLF5 Advanced Universal Remote Control



- Low-power wireless RF4CE system-on-chip solution such as the MC13233 can be connected through the Kinetis K20 MCU UART port to control home entertainment devices. Optional RF4CE receiver which converts to infrared allows controlling traditional devices outside the user's line of vision
- Kinetis K20 50 MHz MCUs extend battery life by operating down to 40 nA in deep stop mode and having less than 232 uA/MHz run current
- Buzzer can be driven by the on-chip pulse width modulation (PWM) module for easy location of the remote control within radiofrequency range
- Long durability and easy-to-clean touch-sensing electrodes, such as keypads, rotaries or sliders, can be quickly implemented with the touch-sensing interface (TSI) module together with the complimentary TSS, which can be downloaded from **freescale.com/TSS** (Only in K20 devices)
- LEDs or HBLEDs can be connected to the system to allow navigation in dark environments or to use the control as a portable lamp

Application Use Case

USB Headsets

Overview

USB headsets are widely used in tele-conferencing and gaming. USB microphones often have sound-enhancing features such as noise reduction and filters for a clearer signal compared to a traditional analog microphone. Voice recognition software performance is enhanced by using corded USB headsets. Gaming headsets often combine analog headphones and USB microphones to add voice chat to the gaming experience.

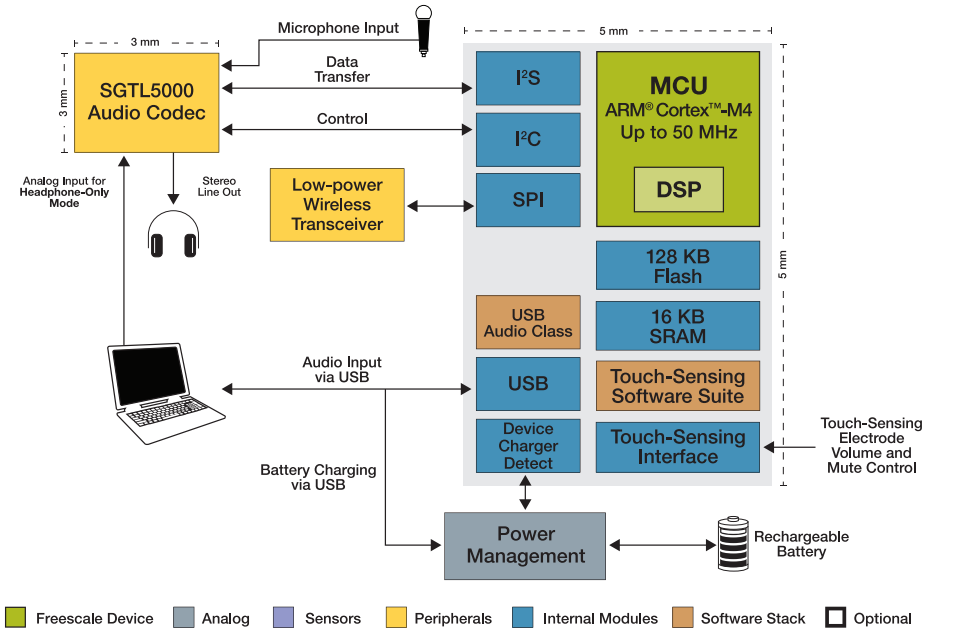
Requirements and Design Challenges

- Starting from scratch to develop a USB stack can be overwhelming and time intensive
- DSP capability is required for filtering and sound-enhancing features
- Smaller size of electronics allows greater freedom to design stylized headsets
- Easy to use, quick setup

Solution Based on MK20DX128VFM5

- ARM Cortex-M4 core with DSP instruction set allows implementation of audio filtering functions for the microphone
- Audio data can be transferred to and from an external codec like SGTL5000 via the on-chip I²S interface. Switch back to analog mode by connecting the analog audio input directly to the codec

MK20DX128VFM5 USB Headset



- Optional Bluetooth® or RF transceiver can be connected through serial peripheral interface (SPI) to enable wireless communication
- Receive and transmit audio through the Full-Speed USB 2.0 On-The-Go controller, by using the Freescale complimentary USB stack with audio class support
- Synchronization can be done with the stack without external devices, reducing bill of materials
- Ready-to-use USB stack saves months of development time and testing
- Touch-sensing electrodes can be used for microphone or headphone volume control as well as to implement mute button functionality
- Optional USB battery charger can be detected with the USB device charger detect functionality embedded in the Kinetis K20 MCU
- Small form factor 5 x 5 mm MCU package and the 3 x 3 mm audio codec help to achieve more aesthetic designs while maintaining low costs and reducing PCB size

Application Use Case

Fitness Watches

Overview

Activity monitors are popular consumer devices, and often include a pedometer to count steps given and estimate calories burned during running or walking. A heart rate monitor can be easily added to these devices to track performance after continuous training. USB connectivity is highly desirable to download data to a computer via a standard USB class or Personal Healthcare Device Class (PHDC).

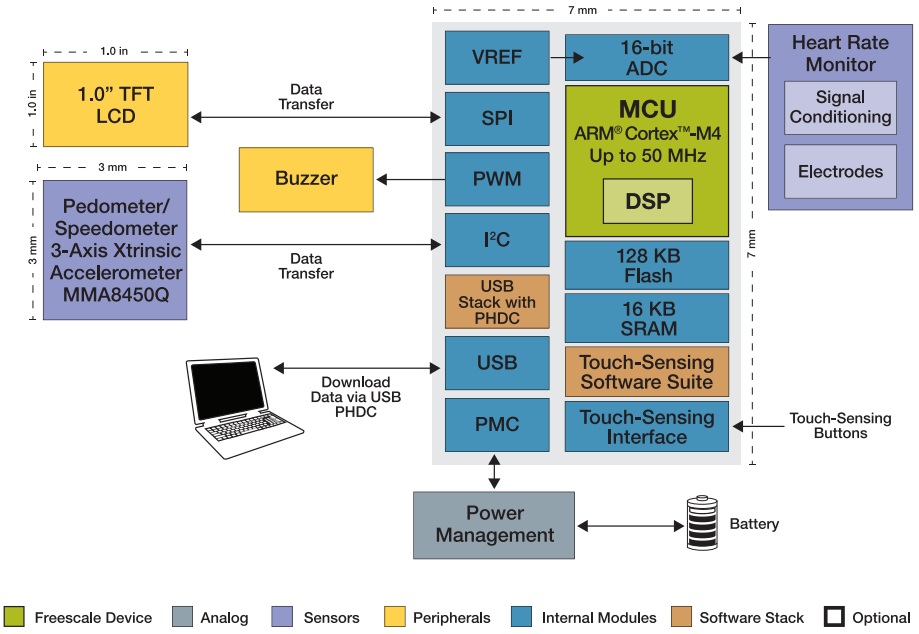
Requirements and Design Challenges

- Small form factor is a requirement
- Accurate heart rate readings must be obtained even when this is not a medical grade device
- Communication through USB is highly desirable
- Intuitive HMI
- Long battery life

Solution Based on MK20DX128VFT5/ MK22DN512VMC5

- Connect the output of a small form factor external operational amplifier to the 16-bit ADC in the Kinetis MCU. Hardware averaging further reduces noise from the signal
- ARM Cortex-M4 core with DSP instruction set allows implementation of software filters to reduce noise in the heart rate monitor signal

MK20DX128VFT5/MK22DN512VMC5 Fitness Watch



- Receive and transmit data through the Full-Speed USB 2.0 On-The-Go controller by using the complimentary Freescale USB stack and track your performance via graphical user interface
- Implement industry-standard health care device connectivity that can be certified by the Continua Health Alliance™ and uses IEEE-11073 by using the PHDC, allowing interoperability with other health care devices such as blood pressure monitors
- Connect a TFT LCD through the SPI module, but note external I²C memory might be required depending on graphics complexity
- Implement pedometer and speedometer functionality by interfacing via I²C with the low-power and cost-effective MMA8450Q Xtrinsic 3-axis accelerometer
- Save battery by using the <550 nA low leakage mode with real-time counter enabled
- Use the low-power TSI to implement rotaries, sliders or button-like electrodes (Only in K20 devices)
- Keep product size small—the K20 MCU is available in a 7 x 7 mm or 5 x 5 mm QFN package, the Freescale MMA8450Q accelerometer is only 3 x 3 mm

Application Use Case

Intelligent Toys

Overview

Intelligent toys can unleash the imagination of both children and adults, and can be built and programmed to perform a variety of tasks. The toys are often packed with sensors, multiple modular communication and control blocks to make them customizable and functional.

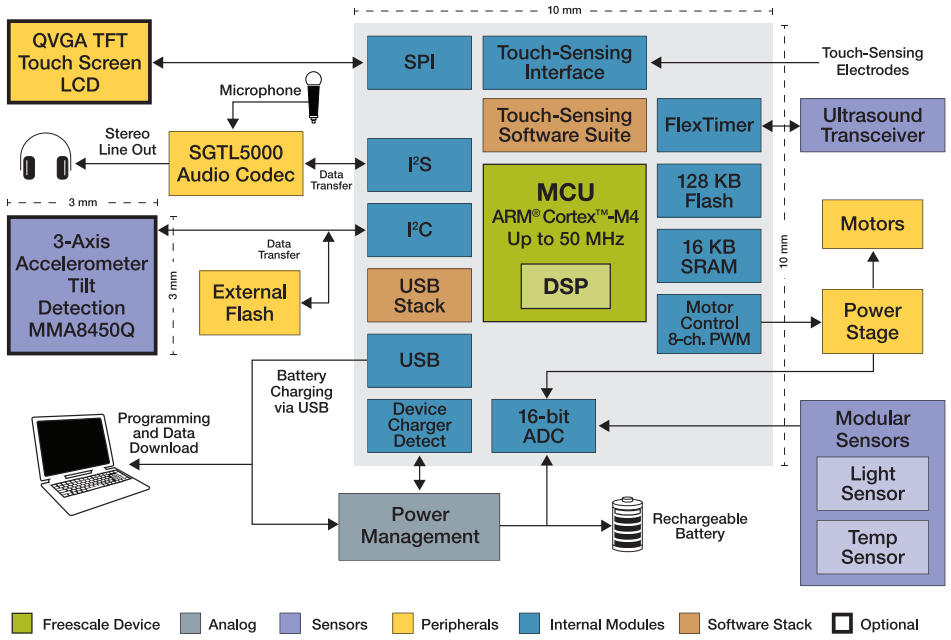
Requirements and Design Challenges

- Intelligent toys are typically battery operated, making low power consumption critical to extending autonomy and play time
- Cost-sensitive application
- Multiple communication and control interfaces must be supported to increase usage versatility
- Modular sensor blocks are added to extend toy functionality
- These toys are programmable—a standard interface such as USB is preferred to download program updates

Solution Based on MK20DX128VLH5

- ARM Cortex-M4 core with DSP instruction set allows implementation of software filters to reduce noisy signals coming from modular sensors such as light or temperature

MK20DX128VLH5 Intelligent Toy



- 16-bit ADC can be used to acquire and amplify signals coming from sensors and hardware average can be used to reduce noise even further
- USB 2.0 On-The-Go controller is used to interface with a personal computer and download the new programs to the toy/robot
- Device charger detect functionality can be used to detect a battery charger in toys using rechargeable batteries
- Connect an optional QVGA TFT LCD through the SPI module
- An external audio codec like the SGTL5000 can be used to reproduce sound, an added microphone may be used to record and filters could be implemented by using the DSP functionality in the Kinetis K20 MCU
- External I²C memory is suggested to save graphics and sounds
- MMA8450Q Xtrinsic 3-axis accelerometer can be connected to the I²C module for tilt and collision detection
- The motor control 8-channel PWM module can drive different types of DC motors via an external power amplifier
- FlexTimer can be used to generate the ultrasound signal. The signal received from ultrasound receiver must be amplified to connect to the FTM for obstacle detection during trajectory execution

Application Use Case

Electronic Point Of Sale (EPOS)

Overview

Portable point of sale (PoS) terminals are key elements in a payment system for retailers or restaurants. They are small, lightweight, battery powered and integrate functions such as a display, card reader, keypad and printer capable of transacting a sales event and performing a secure remote electronic payment.

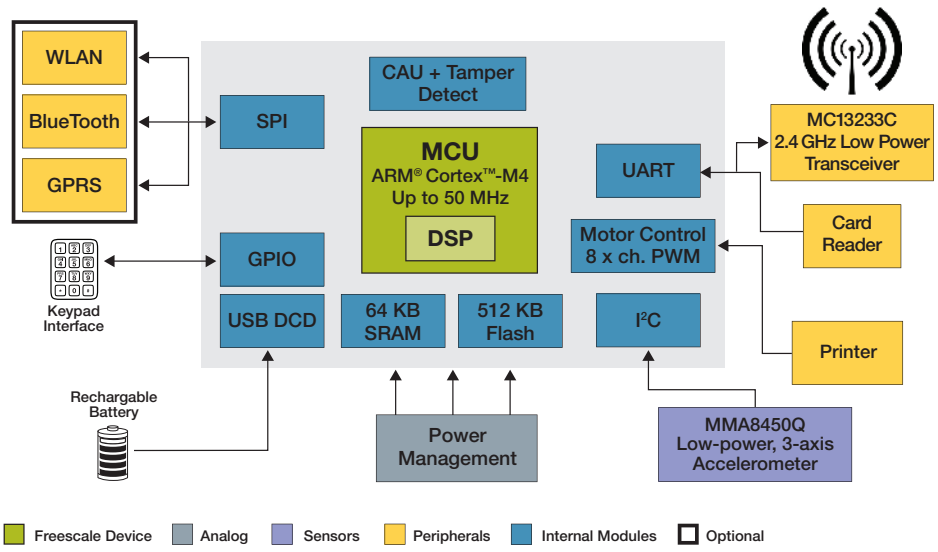
Requirements and Design Challenges

- Required to comply with highest data security and integrity requirements, and be certified by Payment Card Industry and EMV organizations
- Support magnetic, smart and contactless payment cards
- Need a wireless communication to a back-office server or a main stationary EPOS terminal
- Typically battery operated, making low power consumption critical to extended functionality

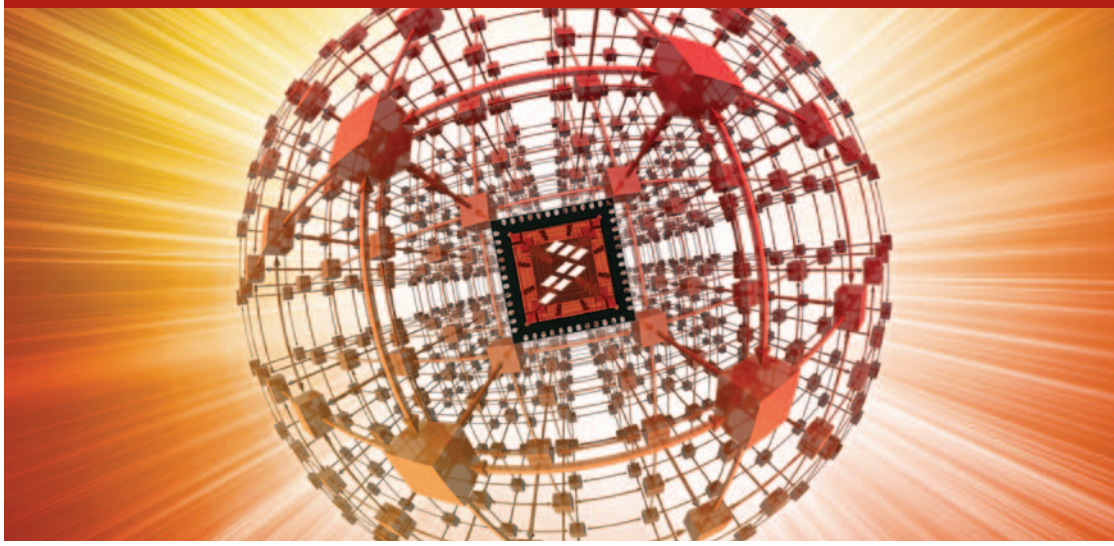
Solution Based on MK21DN512VMC5

- ARM Cortex-M4 core with DSP instruction set allows implementation of cryptographic and security software

MK21DN512VMC5 Electronic Point Of Sale



- Connect to the 2.4 GHz IEEE 802.15.4/ ZigBee MC13233 transceiver through one of the UART modules
- USB 2.0 On-The-Go controller is used to interface with a personal computer and download new programs or data from the EPOS
- Device charger detect functionality can be used to detect a battery charger
- Connect an optional QVGA TFT LCD through the SPI module
- ISO 7816-compliant UART helps to easily interface with card reader
- Hardware tamper detect unit allows certification by Payment Card Industry and EMV organizations
- Choose right combination of low-power modes for the application between 11 different operating modes
- 16-bit ADC and analog comparators offer right combination of analog for this application



Design Resources

Product Pages

freescale.com/K10

freeescale.com/K20

freescale.com/Kinetis

Freescale Tower System

freescale.com/Tower

Freescale Eclipse-Based CodeWarrior V10.x IDE and Processor Expert

freescale.com/CodeWarrior

Complimentary USB Stack with Personal Health Care Device and USB Audio Classes

freescale.com/USB

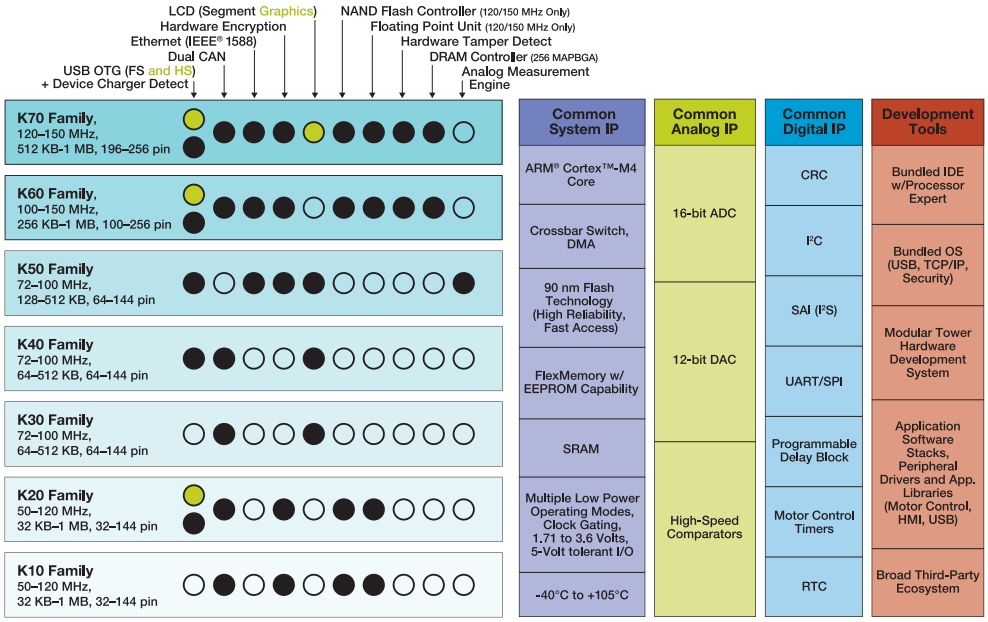
Complimentary Xtrinsic Touch-Sensing Software Suite

freescale.com/TSS

Full ARM® Ecosystem

freescale.com/Kinetis

Kinetis MCU Families



For more information, visit freescale.com/Kinetis

Document Number: BRKINETISELS REV 2