



Control. Connectivity. Security.

ColdFire[®] Embedded Controllers



Inside Front Cover (pocket)

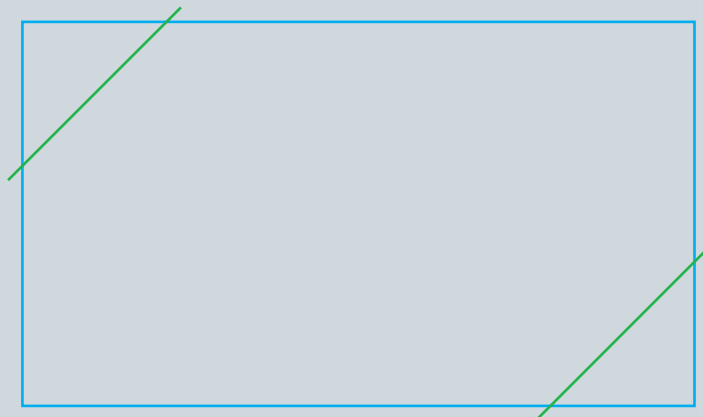


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The ColdFire® Family of 32-bit Embedded Controllers

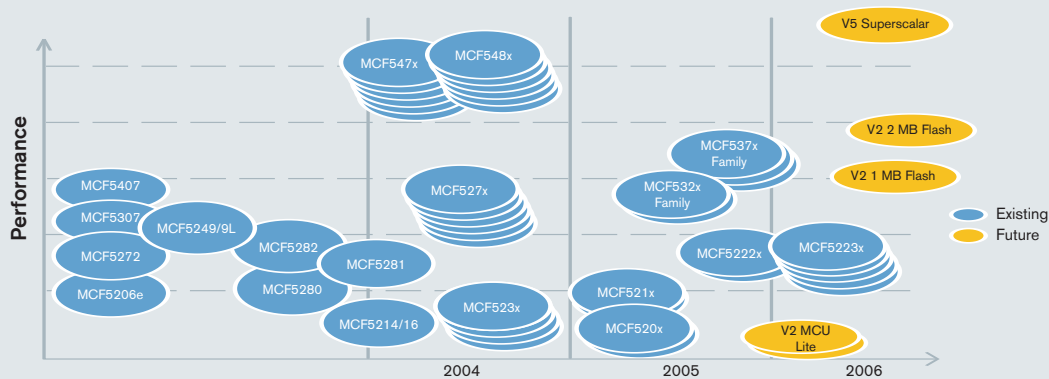
The 68K/ColdFire Portfolio Advantage

The 68K/ColdFire family of 32-bit embedded controllers is backed by a 25-year legacy of 68K development and support. Because 68K/ColdFire devices are code compatible, you can migrate throughout the portfolio according to your applications' specific needs and performance requirements, without investing in entirely new tool sets.

ColdFire Key Features

- > Ideal for network-connected control applications in commercial and industrial markets
- > Variable-length RISC architecture allows 16-, 32- and 48-bit length instructions so code can be packed into memory more efficiently
- > Optimized for low-power consumption with advanced operating modes and distributed clocking functions
- > Robust and reliable flash memory with security features that protect your IP
- > Extensive selection of hardware and software tools from Freescale and industry-leading third-party suppliers

COLDFIRE® PRODUCTS ROADMAP



Except for historical information, all of the expectations and assumptions contained in the foregoing are forward-looking statements involving risk and uncertainties. Important factors that could cause actual results to differ materially from such forward-looking statements, include but are not limited to, the competitive environment for our products, changes of rates of all related services and legislation that may affect the industry. For additional information regarding these and other risks associated with the Company's business, refer to the Company's reports with the SEC.

ColdFire Core Architecture

V1 68K/ColdFire Core

- > Up to 50 MHz-pipelined 32-bit core with 32-bit address bus for improved access to local flash and RAM
- > 8-bit data bus can allow 16-bit references to peripherals by decomposing into two 8-bit cycles
- > S08 compatible peripherals and single-wire background debug interface with on-chip in-circuit emulation

V2 68K/ColdFire Core

- > Up to 166 MHz-32-bit address and data buses with integrated debug module
- > Enhanced multiply accumulate (eMAC) provides DSP-like performance
- > Cryptography acceleration unit helps protect data

V3 68K/ColdFire Core

- > Up to 240 MHz-features refined instruction prefetch pipeline, branch prediction capabilities and higher operating frequencies

- > Delivers up to 300-percent performance improvement over the V2 ColdFire core
- > EMAC and encryption available on many products

V4/V4e 68K/ColdFire Cores

- > Up to 266 MHz-limited superscalar execution with Harvard memory organization
- > Memory management unit (MMU) and floating point unit (FPU) execute engines boost performance
- > EMAC and encryption available on many products

V5/V5x 68K/ColdFire Cores

- > Up to 300 MHz-superscalar hardware featuring 64-bit Harvard local memory interfaces
- > Dual execution pipeline capable of sustained execution rates of two instructions per machine cycle
- > Superscalar eMAC unit capable of four accumulations per cycle with full data trace debug



ON-CHIP PERIPHERAL SELECTION

Connectivity

10/100 FEC (Fast Ethernet Controller)	Performs the full set of IEEE® 802.3/Ethernet CSMA/CD media access control and channel interface functions. It requires an external transceiver (PHY) to complete the interface to the media.
EPHY (Ethernet Physical Interface)	IEEE 802.3 compliant 10/100 Ethernet physical transceiver supports both the medium-independent interface (MII) and the MII management interface. When combined with FEC, delivers a single-chip Ethernet solution.
USB (Universal Serial Bus)	USB 2.0 input/output bus protocol incorporates three speeds: High Speed (480 Mbps), Full speed (12 Mbps) and Low speed (1.5 Mbps). The PHY is standard on all modules.
USB Host	The USB host controller is configured for a single port, which can connect to downstream hubs to support connection of up to 127 devices.
USB-OTG (On-The-Go)	The dual-role feature allows device-to-device connectivity without the need for a host PC (e.g., digital camera to photo printer). The OTG module supports high-speed (480 Mbps) operation via an external ULPI transceiver.
CAN (Controller Area Network)	Commonly used as an industrial control serial data bus, meeting the specific requirements of real-time processing, reliable operation in a harsh EMI environment, cost-effectiveness and required bandwidth.
ZigBee™ Technology	802.15.4 is an IEEE low data rate WPAN standard in both the 2.4 GHz and 868/915 MHz bands. Freescale is a driver of the IEEE 802.15.4 standard and a promoter of the ZigBee™ Alliance. Freescale Semiconductor offers a broad portfolio of RF products serving both the wireless infrastructure and subscriber markets.

Communication

I²C (Inter-Integrated Circuit)	The I²C bus provides a method of communication between a number of devices. The interface is designed to operate up to 100 Kbps with maximum loading and timing.
I²S (Inter-Integrated Sound)	I²S bus is a serial link especially for digital audio. A 3-line serial bus is used consisting of a line for two time-multiplexed data channels, a word select and a clock line.
PCI (Peripheral Communications Interface)	PCI 2.2 compliant bus controller and arbiter. The PCI bus is capable of 66 MHz operation with a 32-bit address/data bus. PCI controller acts as the central resource, bus arbiter, and configuring master on the PCI bus.
PSC (Programmable Serial Controller)	Independently programmable serial controllers that can be configured to operate as UART, IrDA SIR, MIR or FIR; 8-bit, 16-bit or AC97 soft modem. PSCs can also interface to full-function modems or external codecs for soft modem support.
QSPI (Queued Serial Peripheral Interface)	Provides a high-speed synchronous serial peripheral interface with queued transfer capability. It allows up to 16 transfers to be queued at once, eliminating CPU intervention between transfers.
SCI (Serial Communications Interface)	SCI module is used to connect to the RS232 serial I/O port of a computer and other embedded controllers. The SCI receiver employs an advanced data sampling technique that ensures reliable communication and noise detection.
SPI (Serial Peripheral Interface)	The SPI uses a synchronous serial bus to communicate with external peripherals and other MCUs.
SSI (Synchronous Serial Interface)	Full-duplex, serial port that allows the chip to communicate with a variety of serial devices, including audio codecs, DSPs and microprocessors that implement the inter-IC sound bus standard (I²S) or Intel AC97 standard.
UART(Universal Asynchronous Receiver Transmitter)	UART modules are used to connect to the RS232 serial I/O port of a computer and other embedded controllers. A flexible 12-bit modulo-based baud rate generator supports a broad range of standard rates beyond 115.2 Kbaud.

Security

CAU (Cryptography Acceleration Unit)	Incorporates small, fast, dedicated hardware accelerators for random number generation, message digest and hashing, and the DES, 3DES and AES block cipher functions for the implementation of common Internet security protocol cryptography operations.
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Display Interface

LCD (Liquid Crystal Display) Controller	Supports black-and-white, gray-scale, passive-matrix color (passive color or CSTN), and active-matrix color (active color or TFT) LCD panels. The module also provides a direct interface to Sharp 240x320 HR-TFT panels.
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The Embedded Technology Leader

Freescale's embedded leadership position—the result of continuous innovative technology—provides customers with the opportunity to build market share in an evolving industry. Freescale's vast technology library completes the ColdFire architecture by enabling a product portfolio that offers a broad mix of performance, price,

integration and debugging capabilities.

From microcontrollers to integrated processors, with performance levels ranging from 10 to 400+ MIPS and suggested retail pricing starting below \$5—the ColdFire family has something to meet your needs, whatever your system performance and integration requirements may be.

A Peripheral Mix That Gets You Connected

How would you like to connect? Ethernet? USB? PCI? CAN? The ColdFire family has you covered. ColdFire embedded controllers are specifically targeted at network-connected control applications: health care instrumentation devices, POS clients, security systems, building/home automation networks, process control equipment and factory automation applications, all of which require connection with protection. The ColdFire family of 32-bit controllers is uniquely positioned to deliver control, connectivity and security within one piece of silicon.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.



ColdFire Development Tools

Evaluation Boards and Development Kits

Freescale Semiconductor	www.freescale.com
Axiom	www.axman.com
FSI Systems	www.fsisys.com
Logic Product Development	www.logicpd.com
NetBurner	www.netburner.com
Intec Automation	www.steroidmicros.com

Real-Time Operating Systems (RTOSes)

Accelerated Technology/Mentor Graphics	www.acceleratedtechnology.com
eCosCentric	www.ecoscentric.com
CMX Systems	www.cmx.com
ExpressLogic	www.rtos.com
Green Hills Software, Inc.	www.ghs.com
InterNiche Technologies	www.iniche.com
Linux	www.linux.com
MicroDigital	www.smx-rtos.com
MQX Embedded	www.mqxembedded.com
NetBurner	www.netburner.com
Quadros Systems, Inc.	www.quadros.com
Wind River Systems Inc.	www.windriver.com
µClinux	www.uclinux.org

Compilers, Simulators, Debuggers

Accelerated Technology/Mentor Graphics	www.acceleratedtechnology.com
CodeWarrior™ tools	www.codewarrior.com
GNU	www.gnu.org
Green Hills Software, Inc.	www.ghs.com
P&E Microcomputer Systems	www.pemicro.com
NetBurner	www.netburner.com
Wind River Systems Inc.	www.windriver.com

Stacks, Drivers, Translators

Accelerated Technology/Mentor Graphics	www.acceleratedtechnology.com
CMX Systems	www.cmx.com
ExpressLogic	www.rtos.com
Freescale	www.freescale.com
Green Hills Software, Inc.	www.ghs.com
InterNiche Technologies	www.iniche.com
Ixxat	www.ixxat.com
Micro APL	www.microapl.com
Mocana Corporation	www.mocana.com
MQX Embedded	www.mqxembedded.com
NetBurner	www.netburner.com
OpenTCP	www.opentcp.org
Quadros Systems, Inc.	www.quadros.com
Treck	www.treck.com
Wind River Systems Inc.	www.windriver.com

Specialized Tools

ASH WARE Inc. (eTPU)	www.ashware.com
Byte Craft Limited (eTPU)	www.bytecraft.com
Freescale (eTPU)	www.freescale.com
Nano-X (LCD)	www.microwindows.org
Swell Software (LCD)	www.swellsoftware.com

Overview

Freescale Semiconductor's ColdFire® family of 32-bit embedded controllers is backed by an unbeatable selection of development tools, both from Freescale and the industry's leading third-party vendors. These tools help you get the most out of Freescale processors in all phases of the design process.

ColdFire Evaluation/Development Boards and Systems

- > **M5206EC3**
Evaluation System for the MCF5206e
- > **M5208EVB**
Evaluation System for the MCF5207 and MCF5208
- > **M5213EVB**
Evaluation System for the MCF5211, MCF5212 and MCF5213
- > **M52223EVB**
Evaluation System for the MCF5222x Family
- > **M52235EVB**
Evaluation System for the MCF5223x Family
- > **M523xEVB**
Evaluation System for the MCF523x Family
- > **M5249C3**
Evaluation System for the MCF5249
- > **M5271EVB**
Evaluation System for the MCF5270 and MCF5271
- > **M5272C3**
Design Evaluation System for the MCF5272
- > **M5275EVB**
Evaluation System for the MCF5274/L and MCF5275/L
- > **M5282EVB**
Evaluation Board for the MCF5214/16 and MCF5280/81/82
- > **M5307C3**
Evaluation System for the MCF5307
- > **M5329EVB**
Evaluation System for the MCF532x Family
- > **M5373EVB**
Evaluation System for the MCF537x Family
- > **M5407C3**
Evaluation System for the MCF5407
- > **M5475EVB**
Evaluation System for the MCF547x Family
- > **M5485EVB**
Evaluation System for the MCF548x Family

ColdFire Low-Cost Development Systems

- > **M5206ELITE**
Low-Cost Board for the MCF5206e
- > **M5211DEMO**
Low-Cost Kit for the MCF5211
- > **M52221DEMO**
Low-Cost Board for the MCF52221
- > **M52233DEMO**
Low-Cost Board for the MCF52233
- > **M5235BCC**
Low-Cost Board—Business Card Computer—for the MCF5235
- > **M5235BCCkit**
Low-Cost Development Kit for the MCF5235
- > **M5270PROMO**
Lite Low-Cost Kit for the MCF5270
- > **M5282LITE**
Low-Cost Board for the MCF5282
- > **M5282LITEKIT**
Low-Cost Development Kit for the MCF5282
- > **M5474LITEkit**
Low-Cost Board for the MCF547x Family
- > **M5484LITEkit**
Low-Cost Board for the MCF548x Family
- > **NB5270PRO**
Full Low-Cost Kit for the MCF5270

PRODUCTION-READY MODULES

Fire Engine Part Number	DDR Memory (MB)	NOR Flash (MB)	Boot Flash	Graphics Controller	USB Host	Freescal Processor
M5329AFE	32	0	X	X	X	MCF5329CVM240
M5329BFE	32	16	X	X	X	MCF5329CVM240
M5475AFE	64	0	X	-	-	MCF5475ZP266
M5475BFE	64	16	X	-	-	MCF5475ZP266
M5475CFE	64	16	X	X	X	MCF5475ZP266
M5475DFE	64	0	X	-	X	MCF5475ZP266
M5475EFE	64	0	X	X	X	MCF5475ZP266
M5475FFE	128	32	X	X	X	MCF5475ZP266
M5485AFE	64	0	X	-	-	MCF5485CZP200
M5485BFE	64	16	X	-	-	MCF5485CZP200
M5485CFE	64	16	X	X	X	MCF5485CZP200
M5485DFE	64	0	X	-	X	MCF5485CZP200
M5485EFE	64	0	X	X	X	MCF5485CZP200
M5485FFE	128	32	X	X	X	MCF5485CZP200

MOD5270: MCF5270 processor, 10/100 Ethernet RJ-45, 2 MB SDRAM/512 KB Flash, three UARTs, address/data bus, QSPI, I²C, CS, GPIO

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF5206e

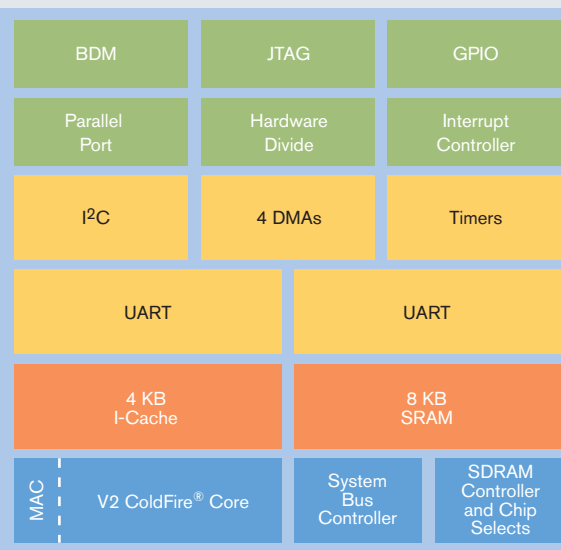
A High-Performance, Cost-Effective Solution

Freescale's ColdFire MCF5206e 32-bit integrated microprocessor, an enhanced version of the popular MCF5206, combines a Version 2 (V2) ColdFire core with peripheral functions such as a dynamic random access memory (DRAM) controller, timers, parallel and serial interfaces and system integration. These features on the MCF5206e provide ease of use through integration on a single chip, reducing overall design time. Enhancements from the MCF5206 version include 4 KB I-Cache and 8 KB SRAM, increased frequency, a Multiply-Accumulate (MAC) unit, hardware divide and a two-channel DMA controller. What's the bottom line? The MCF5206e is engineered to deliver enhanced system performance without impacting the low overall system costs or rapid development times you've come to expect from the ColdFire family.

Applications

The MCF5206e is designed for embedded control applications such as electronic point-of-sale (EPOS) terminals, vacuum system controllers, I/O controllers for gaming machines, local area network (LAN) interfaces, I/O cards or closed-circuit television (CCTV) cameras. The MCF5206e is a cost-effective, high-performance 54 MHz solution that is engineered to help designers get to market fast.

MCF5206e BLOCK DIAGRAM



MCF5206e Features

- > Version 2 (V2) ColdFire core
- > MAC module and hardware divide unit
- > 4 KB direct-mapped I-Cache
- > Industry-leading debug module offering both background and real-time capability
- > 8 KB on-chip SRAM
- > DRAM controller; supports Extended Data Out (EDO) DRAM and page mode DRAM
- > Two-channel DMA controller
- > Two UARTs
- > Dual 16-bit general-purpose multimode timers

- > I²C interface

- > 8-bit general-purpose parallel I/O port

MCF5206e Product Specifications

- > 50 (Dhrystone 2.1) MIPS @ 54 MHz
- > Available at 40 MHz and 54 MHz
- > 0°C to +70°C operating temperature
- > -40°C to +85°C operating temperature (40 MHz)
- > Implemented in 0.35 µm Triple Layer Metal (TLM)
- > 3.3V supply/5.0V-tolerant I/O
- > 160-pin QFP package
- > Pin-compatible with MCF5206

COLDFIRE® SELECTOR GUIDE

Part Number	Temp. Ranges	Features	Package	Speed
MCF5206E	-40°C to +85°C 0°C to +70°C	2 UARTS, 2 ch. DMA, Dual 16-bit timer, MAC, HW divide, BDM, I ² C, 5V tolerant I/O	160 QFP	40 MHz 54 MHz

DEVELOPMENT TOOLS

Part Number	Description	Pricing
M5206EC3	The M5206EC3 evaluation board provides 4 MB of ADAM, 1 MB of Flash, ethernet connectivity, two serial ports, available expansion of 512 KB SRAM for high-speed critical code or benchmarking, and access to the ColdFire debug module. An on-board ROM monitor provides capability to read and write registers and memory, disassemble assembly code, as well as write assembly code using the built-in ColdFire processor in-line assembler. To automate the porting of 68K family assembly code to ColdFire processors, PortASM/68K is provided free of charge.**	\$549*

*Manufacturer Suggested Resale Price

DOCUMENTATION

Freescale Document Number	Title	Description
CFPRM Rev 3	ColdFire Family Programmer's Reference Manual	Detailed information about the instruction set architecture (ISA) for ColdFire embedded controllers
M5206EPB/D Rev 2.1	MCF5206E ColdFire Product Brief	Overview of MCF5206e and on-chip peripherals
AN2981 Rev 0	Migrating from the MCF5206e to the ColdFire MCF5208	Engineering considerations when migrating from the MCF5206E to the MCF5208 ColdFire family

The ColdFire family offers unparalleled integration and debugging capabilities across a wide range of performance and price options. Variable-length RISC architecture gives designers greater flexibility and exceptional code density, and efficient use of on-chip memory means designers don't have to sacrifice performance to keep system costs in line. Plus, ColdFire product development tools—compilers, assemblers, linkers,

debuggers, code converters, simulators and evaluation kits—help accelerate design cycles to help you get your application to market quickly. Whatever your system performance and integration requirements may be, the ColdFire family has a solution to meet your needs.

Increased System Performance

The MCF5206e offers memory and peripheral integration that drives a dramatic reduction in time to market and system costs. The additional MAC module and hardware divide help to significantly increase performance of complex arithmetic functions common to DSP applications. On-chip instruction cache and SRAM with one-cycle access to critical code and data help further accelerate program performance, plus glueless interfaces to 8-bit, 16-bit and 32-bit DRAM, eliminating external logic. For 68K users, the MCF5206e offers more than six times the performance of the MC68340 with a similar peripheral set and up to 15 times the performance of the MC68306. The MCF5206e's package, pinout and integration mix also create a fully compatible upgrade path for current MCF5206 designs and result in an almost threefold improvement in performance.

Leverage Your Technology Investment

By leveraging your existing development tools and software, the MCF5206e helps protect the resources you've already invested in 68K and ColdFire microprocessor technology and training. Customers migrating from 68K to ColdFire microprocessors can access code translation and emulation tools, free of charge** to registered users, to modify and reuse 68K assembly code. The 100-percent synthesizable ColdFire family helps to protect your investment in technology and training well into the future.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

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Document Number: MCF5206EFACT

REV 4

MCF520x Family

Overview

The marketplace for lower-end connectivity and control applications is at a crossroads. The demand for improved performance is pushing developers to the 32-bit microprocessor, while the stringent low power and low cost restrictions remain paramount in the development process. Freescale Semiconductor gives the product designer the opportunity to drive straight-ahead with the next generation MCF520x ColdFire® embedded controllers. The MCF5207 and MCF5208 embedded controllers combine exceptional performance and integration with low power characteristics and system cost efficiencies. Built with the Version 2 ColdFire core, these two embedded controllers deliver 159 MIPS (Dhrystone 2.1) at 166 MHz and include the enhanced multiply-accumulate (eMAC) unit, resulting in DSP-like functionality. Furthermore, these devices are optimized for low power applications with several low power modes and a low frequency clock divider.

Big Punch, Small Cost

Answering the call for low system cost, the MCF5207 and MCF5208 feature a flexible memory controller, allowing the options of attaching a combination of external SRAM, Flash memory, and a choice of single-data rate (SDR), double-data rate (DDR) or mobile-double-data rate (M-DDR) SDRAM memory. The MCF5207 and MCF5208 embedded controllers integrate the standard ColdFire communications peripherals, including three universal asynchronous receiver/transmitters (UARTs) for medium and long distance connections, an inter-integrated circuit (I²C) and queued serial peripheral interface (QSPI) for in-system communication to connected peripherals. In addition, the MCF5208 embedded controller features a 10/100 Fast Ethernet Controller.



Delivering ColdFire to Volume-Driven Markets

The MCF520x family of ColdFire embedded controllers extends the long and distinguished line of 68K and ColdFire-based processors that dates back to the introduction of the MC68000 in 1979. With the introduction of the MCF5207 and MCF5208 embedded controllers, Freescale enables a new customer community to design volume applications affordably and attractively with 32-bit performance and integration. Moreover, the seamless ColdFire roadmap to the high end means customers can continue to rely on the Freescale ColdFire Family across their entire product offerings. Freescale's dedication to the ColdFire family of processors for control applications means customers can feel secure that they are designing in quality with a long product lifetime.

Easy-to-Use Product Development System

The cost-effective, fully functional and easy-to-use M5208EVB development kit simplifies MCF5207 and MCF5208 embedded controllers product development and speeds customers to market. Each kit includes open source software and a CodeWarrior™ Special Edition suite for ColdFire. The MCF5207 and MCF5208 embedded controllers also benefit from extensive software support from Freescale's leading third party tools partners. With a suggested resale price of US\$349, the M5208EVB features full access to the 196-pin fully-integrated MCF5208 embedded controller and integrates the MC13192 ZigBee™-ready transceiver with integrated antenna.

MCF520x Family

Part Number	Temperature Range	Key Features	Package	Speed
MCF5208	-40°C to 85°C	3 UARTs, EMAC, QSPI, I ² C, 10/100 FEC, DDR/SDR SDRAM, 16 KB SRAM, 8 KB C-Cache	196 MAPBGA 160 QFP	166 MHz 166 MHz
MCF5207	-40°C to 85°C	3 UARTs, EMAC, QSPI, I ² C, DDR/SDR SDRAM, 16 KB SRAM, 8 KB C-Cache	144 LQFP 144 MAPBGA	166 MHz 166 MHz
MCF5206E	-40°C to 85°C	2 UARTs, MAC, I ² C, EDO/FPM SDRAM, 8 KB SRAM, 4 KB I-Cache	160 QFP	54 MHz 40 MHz
MCF5206	-40°C to 85°C	2 UARTs, MAC, I ² C, EDO/FPM SDRAM, 512B SRAM, 512B I-Cache	160 QFP	33 MHz 25 MHz 16 MHz
M5208EVB	MCF5207/08 Development Kit \$349*			
M5206EC3	MCF5206E Development Kit \$549*			

*Manufacturer Suggested Resale Price

MCF5207 and MCF5208 Specifications

> ColdFire V2 Core

- Up to 159 (Dhrystone 2.1) MIPS @ 166 MHz
- Enhanced MAC Module and HW Divide
- Low-Power Optimization

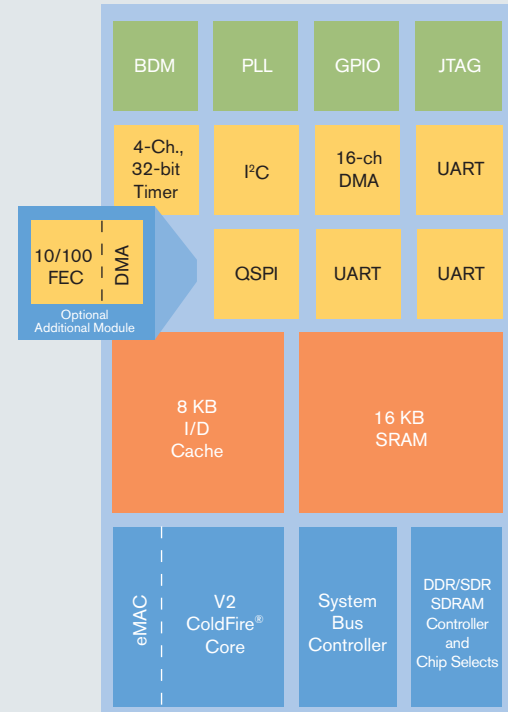
> Integration

- 8K bytes I/D-Cache
- 16K bytes SRAM
- Optional 10/100 Ethernet MAC (MCF5208 only)
- 3 UARTs
- Queued Serial Peripheral Interface (QSPI)
- I²C bus interface
- 4 ch. 32-bit timers with DMA support
- 16 ch. DMA controller
- 16-bit DDR / 32-bit SDR SDRAM controller
- Up to 50 General-Purpose I/O
- System Integration (PLL, SW Watchdog)
- 1.5V core, 2.5V DDR, 3.3V I/O voltages

> Availability

- Temperature Range: -40°C to +85°C
- Package Options:
 - MCF5208: 196-ball MAPBGA and 160-pin QFP
 - MCF5207: 144-ball MAPBGA and 144-pin LQFP

MCF5207 and MCF5208 Block Diagram



MCF5207 and MCF5208 Key Features

- > Fast Ethernet Controller
- > Low power modes and low-frequency clock divider
- > Memory Flexibility: Supports SDR, DDR, Mobile-DDR SDRAM
- > Upward-compatible ColdFire Roadmap
- > Big Punch, Small Cost: 166 MHz with eMAC for DSP-like functionality
- > Long Product Lifetime

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF521x Family

Overview

Pressing its leadership in 32-bit processing into new territory, Freescale Semiconductor introduces a single-chip solution to address the need for a cost-sensitive, low-power, 32-bit microcontroller that fills the gap between existing 16-bit and 32-bit products. Applications requiring traditional general purpose microcontroller functionality have rising computational performance and memory requirements. The challenge is to provide a microcontroller that offers it all—low power operation in small footprint configurations with options for computational-intensive tasks. There is also a requirement for a roadmap with seamless migration that includes robust full-featured embedded controllers. Freescale's MCF521x embedded controller family encompasses all this and more. It features power management options and low power modes along with right-sized feature sets offering a host of peripherals commonly used in microcontroller applications.

Trends

As a competitive advantage in the embedded marketplace becomes harder to secure, protecting a company's intellectual property (IP) becomes more critical. The robust and secure flash technology offered by the MCF521x family of embedded controllers gives designers a tool for protecting intellectual property. For applications requiring code security, the MCF521x family of embedded controllers offers a single-chip solution with up to 256 KB of high performance, near-single access, interleaved and securable embedded Flash memory. Moreover, the MCF521x embedded controller communication peripherals provide easy connection to other systems. Three universal asynchronous receiver/transmitters (UARTs) enable medium to long distance communication



to other control systems or computers. An inter-integrated circuit (I²C) and queued serial peripheral interface (QSPI) enable in-system communication to connected peripherals and systems, including LCDs and keyboards. All this is offered along with the high performance V2 ColdFire core that even incorporates a multiply and accumulate module (MAC) for DSP-like operation.

Building on years of experience in industrial control and communications, the MCF521x embedded controller family adds to a portfolio that today includes 32-bit embedded controllers with Flash memory and on-chip Ethernet and CAN networking interfaces as well as 16-bit microcontrollers that offer optimized system solutions with Ethernet and physical interfaces for complete networking solutions. The MCF521x family of embedded controllers offers

designers a powerful, cost-effective solution with a variety of supporting software and development tools that ease the transition into 32-bit technology.

Tools and Support

The ColdFire embedded controller family benefits from extensive support by a world-class development tools suites offered through leading third party tools developers. The M5213EVB development system includes, at no extra cost, CodeWarrior Special Edition software in each kit and professional tools and systems from such partners as Green Hills, Wind River Systems, Accelerated Technology, ARC and others. The open source software and graphical initialization tools used in the M5213EVB system make no-cost development easy to get and easy to use.

Part Number	Flash/ SRAM	Key Features	Package	Speed
MCF5211	128 KB/ 16 KB	3 UARTs, I ² C, QSPI, 16-bit, 32-bit, PWM timers, ADC	64-pin LQFP 81-ball MAPBGA	66 80
MCF5212	256 KB/ 32 KB	3 UARTs, I ² C, QSPI, 16-bit, 32-bit, PWM timers, ADC	64-pin LQFP 81-ball MAPBGA	66 80
MCF5213	256 KB/ 32 KB	3 UARTs, I ² C, QSPI, 16-bit, 32-bit, PWM timers, ADC, CAN	81-ball MAPBGA, 100-pin LQFP	80 80
MCF5214	256 KB/ 64 KB	3 UARTs, I ² C, QSPI, 16-bit, 32-bit, PWM Timers, DMA, ADC, CAN	256-ball MAPBGA	66
MCF5216	512 KB/ 64 KB	3 UARTs, I ² C, QSPI, 16-bit, 32-bit, PWM Timers, DMA, ADC, CAN	256-ball MAPBGA	66
M5213EVb	MCF5213/12/11 Eval Board \$299*			

*Manufacturer Suggested Resale Price

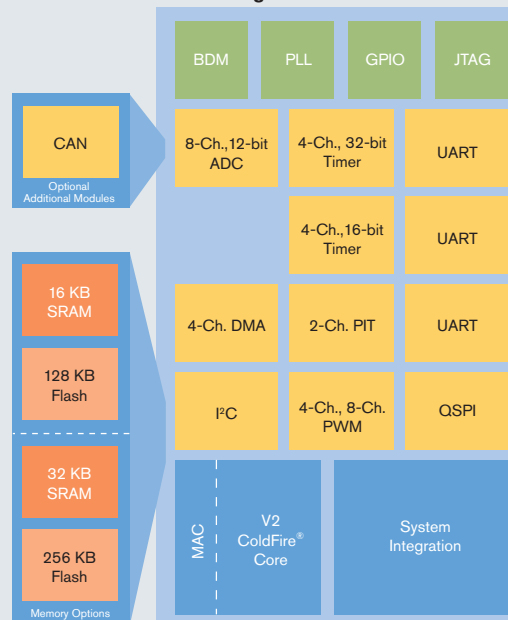
MCF521x Specifications

- > ColdFire® V2 Core
- > Temperature range: -40°C to +85°C
- > Up to 76 Dhrystone 2.1 MIPS @ 80 MHz
- > MAC Module and HW Divide
- > Low-power optimization
- > No external bus

Integration

- > Up to 32 KB SRAM
- > Up to 256 KB Flash: 100K W/E cycles, 10 years data retention
- > Enhanced CAN 2.0B controller (FlexCAN) interface with 16 message buffers (5213 Only)
- > Three UARTs with DMA capability
- > Queued serial peripheral interface (QSPI) with four peripheral chip selects
- > Inter-integrated circuit (I²C) bus controller
- > Four 32-bit timer channels with DMA capability
- > Four 16-bit timer channels for capture, compare and pulse width modulation (PWM)
- > 4-channel 16-bit/8-channel 8-bit PWM generator
- > Two periodic interrupt timers (PITs) for alarm and countdown timing
- > 4-channel DMA controller
- > 8-channel 12-bit ADC
- > Up to 55 general-purpose I/O
- > System integration (PLL, SW watchdog)
- > Single 3.3V supply

MCF5211/12/13 Block Diagram



MCF5213 Features

- > 256 KB of Embedded Flash memory
- > 32 KB of static RAM
- > CAN 2.0B Controller
- > 14 mm x 14 mm x 1.4 mm (0.5 mm pitch)
100-pin LQFP package
- > 10 mm x 10 mm x 1.6 mm (1 mm pitch)
81-ball MAPBGA package

MCF5212 Features

- > 256 KB of Embedded Flash memory
- > 32 KB of static RAM
- > 10 mm x 10 mm x 1.6 mm (1 mm pitch)
81-ball MAPBGA package
- > 10 mm x 10 mm x 1.4 mm (0.5 mm pitch)
64-pin LQFP package

MCF5211 Features

- > 128 KB Embedded Flash memory
- > 16 KB of static RAM
- > 10 mm x 10 mm x 1.6 mm (1 mm pitch)
81-ball MAPBGA package
- > 10 mm x 10 mm x 1.4 mm (0.5 mm pitch)
64-pin LQFP package

Learn More: For more information about ColdFire Family products, please visit www.freescale.com/coldfire.



MCF5214 and MCF5216

Overview

Further expanding Freescale's offering of 32-bit flash-based microcontrollers based on the ColdFire® architecture, the MCF5214 and MCF5216 combine a popular set of control peripherals with a selection of communications interfaces. The control peripherals include a 10-bit analog-to-digital converter (ADC) for interfacing to various sensors and several timer modules for external event measurement, control of drivers and actuators, generation of analog outputs, and internal software timing. The communications peripherals enable easy connection to other systems. Three universal asynchronous receiver/transmitters (UARTs) enable medium to long distance communication to other control systems or computers. An inter-integrated circuit (I²C) and serial peripheral interface (SPI) enable in-system communication to additional peripherals and systems such as LCD displays and keyboards. The controller area network (CAN) interface supports industrial and medical control buses and protocols such as DeviceNet and CANopen.

ColdFire Answers New Market Trends

Designers have indicated that component availability with the right level of integration is one of the most critical design challenges causing changes in processor selection today. Freescale Semiconductor continues to anticipate market demands with its ColdFire architecture by offering a family of integrated solutions. This family offers built-in versatility to address a variety of new and emerging markets that are driving the growth of low-cost, high-volume embedded control.

Tools Support for Fast Development

The ColdFire family benefits from extensive support by a world-class development tools suite through leading third-party tools developers.

The CodeWarrior™ for ColdFire development tools suite from Freescale includes a compiler, assembler, debugger, project manager and build system. A trial version of the tools is provided with the development kit.

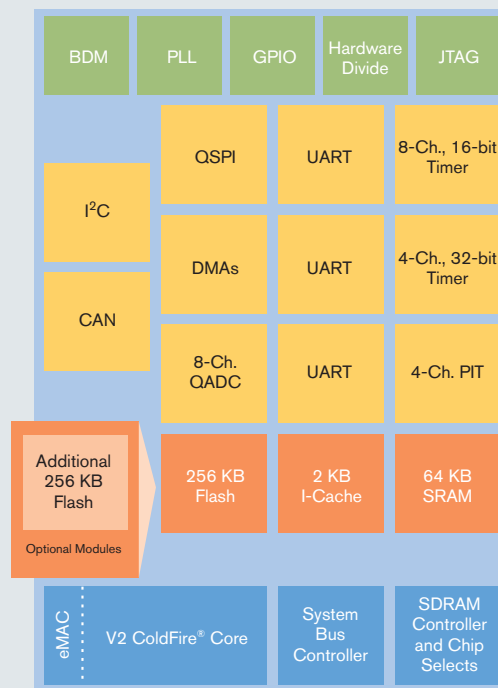
MCF5214/MCF5216 Features

- > Version 2 (V2) ColdFire core
- > 256 KB embedded flash memory (MCF5214)
- > 512 KB embedded flash memory (MCF5216)
- > 64 KB of static RAM
- > 2 KB I-Cache
- > SDRAM controller
- > Enhanced CAN 2.0B controller interface with 16 message buffers
- > Three UARTs with direct memory access (DMA) capability
- > Queued serial peripheral interface (QSPI) with four peripheral chip selects
- > I²C bus controller
- > 8-channel, 10-bit queued ADC (QADC)
- > Four 32-bit timer channels with DMA capability
- > Eight 16-bit timer channels for capture, compare and pulse-width modulation (PWM)
- > Four periodic interrupt timers (PITs) for alarm and countdown timing

Product Specifications

- > Up to 76 (Dhrystone 2.1) at 80 MHz; MIPS at 66 MHz (executing from internal flash)
- > -40°C to +85°C ambient operating temperature
- > 80 and 66 MHz available
- > 3.3V, 5V-tolerant I/O
- > 17 mm x 17 mm x 1.6 mm 256-ball (1 mm pitch) mold array process ball grid array (MAPBGA) package

MCF5214 AND MCF5216 BLOCK DIAGRAM



COLDFIRE MCF521x FAMILY SELECTOR GUIDE

Part Number	Speed	Flash	SRAM	Key Features
MCF5214	66 MHZ Up to 63 MIPS	256 KB	64 KB	CAN, 3 UARTs, I ² C, QSPI DMA, Timers, ADC
MCF5216	66 MHz Up to 63 MIPS	512 KB	64 KB	CAN, 3 UARTs, I ² C, QSPI, DMA, Timers, ADC

M5282EVB

MCF5282/81/80/16/14 Evaluation Board \$649*

*Manufacturer Suggested Resale Price

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF5222x Family

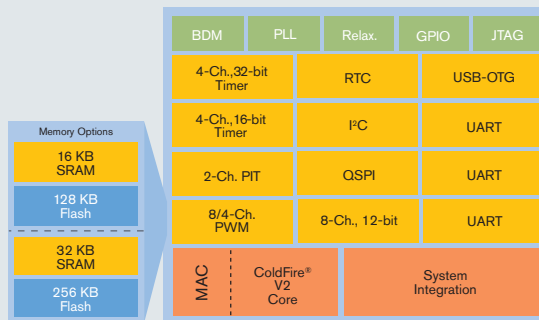
Overview

Connecting 32-bit controlled applications in the industrial, commercial and even consumer markets is fast becoming a necessity rather than an option. Freescale Semiconductor gives design engineers the flexibility to choose the right microcontroller from a broad portfolio of ColdFire® embedded controllers. The MCF5222x family offers a highly integrated system solution that addresses the need for cost-effective flexible connectivity options with 32-bit performance and memory requirements on a single chip.

Built using the popular Version 2 ColdFire core, the MCF5222x family offers up to 76 MIPS (Dhrystone 2.1) at 80 MHz. It builds upon the successful MCF5213 family by integrating a USB On-The-Go (OTG) controller, making it ideal for applications requiring device or host connectivity functionality. The MCF5222x microcontrollers are aimed at designers who want the power and flexibility of a 32-bit microcontroller plus a rich set of on-chip connectivity peripherals at a low cost. These small, highly integrated microcontrollers open the door to expanding application capabilities while driving down total system costs.

The MCF5222x family is ideal for embedded control applications such as home/factory automation, point-of-sale, health care, testing equipment and consumer applications.

**MCF5222X
BLOCK DIAGRAM**



Full Featured, Cost Effective

In today's increasingly competitive embedded marketplace, the importance of keeping system costs down is of increasing concern. The MCF5222x gives product designers a cost-effective, full-featured solution with USB-OTG that allows them to create next-generation systems quickly and efficiently. In addition to the USB-OTG, the MCF5222x has the advanced features that the ColdFire family has been known for, including 32 KB SRAM, 256 KB flash, an 8-channel, 12-bit analog-to-digital converter (ADC), various 32-bit timers and advanced pulse-width-modulation (PWM) channels.

The MCF222x family provides a migration path for existing 8/16-bit designers looking to incorporate flexible connectivity into their designs. The family integrates the standard ColdFire communication peripherals, including three universal asynchronous receiver/transmitters (UARTs) for medium to long distance connections, an inter-integrated circuit (I²C) and a queued serial peripheral

interface (QSPI) for in-system communication to connected peripherals. These features are built around the high-performance ColdFire V2 core that incorporates a multiply-accumulate (MAC) module that allows for DSP-like operation.

Tools and Support

The ColdFire embedded controller family is supported by world-class development tool suites offered through leading third-party tools developers. Each kit includes the CodeWarrior™ Special Edition software tools and professional tools from Freescale partners, such as Green Hills Software, Wind River Systems, Accelerated Technology, MQXEmbedded and others. The M52223EVB development kit is an easy to use, yet cost-effective, solution that simplifies product development and speeds customer time to market. Further development assistance is available through Freescale's web-based Fast Track™ support resources, including online training and technical support.



DEVICE MATRIX

Part Number	Flash/SRAM	Key Features	Package	Speed
MCF52221	128 KB/16 KB	USB-OTG, USB transceiver, 3 UARTs, I ² C, QSPI, 16-bit/32-bit/PWM timers, DMA, A/D	64 LQFP 81 MAPBGA	66 MHz 80 MHz
MCF52223	256 KB/32 KB	USB-OTG, USB transceiver, 3 UARTs, I ² C, QSPI, 16-bit/32-bit/PWM timers, DMA, A/D	100 LQFP 81 MAPBGA	66 MHz 80 MHz
M52223EVB		Development Kit \$299*		
M52221DEMO		Cost-Effective Board \$99*		

*Manufacturer Suggested Resale Price

MCF5222x ColdFire V2 Core Features

- > Up to 76 Dhrystone 2.1 MIPS at 80 MHz
- > MAC module and hardware divide
- > Up to 32 KB SRAM
- > Up to 256 KB flash
- > 100 KB write/erase cycles, 10 year data retention
- > USB 2.0 full-speed Host/Device/OTG controller
- > Three UARTs
- > QSPI
- > I²C bus interface
- > 4-channel, 32-bit timers
- > 4-channel, 16-bit capture/compare/PWM timers

- > 2-channel periodic interrupt timer
- > 8-channel, 8-bit PWM timer or 4-channel, 16-bit PWM timer
- > 8-channel, 12-bit ADC with simultaneous sampling
- > Real-time clock
- > Up to 56 general-purpose input/outputs (GPIOs)
- > System integration (phase-locked loop and software watchdog)
- > Relaxation oscillator
- > Single 3.3-volt supply
- > Temperature ranges from -40°C to +85°C
- > Available speeds—66 MHz and 80 MHz
- > Pin-compatible with MCF5211/12/13

Target Applications

- > ZigBee™ control nodes
- > Security/access control panels
- > Health care-related pumps and monitors
- > Lighting control nodes
- > Home/industrial automation
- > Point-of-sale terminals
- > Factory service and maintenance systems

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF5223x Family

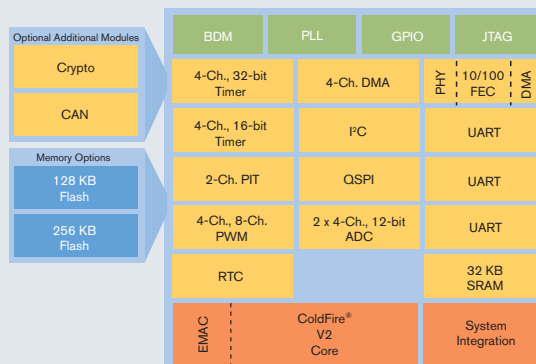
Overview

Connecting 32-bit controlled applications in the industrial, commercial and consumer markets is fast becoming a necessity rather than an option. Many new applications, such as remote data collection, home automation and networked appliances, require secure, high-performance connectivity at an economical price. Freescale Semiconductor gives design engineers the flexibility to choose the right 32-bit microcontroller from a broad portfolio of ColdFire® embedded controllers.

To help ensure secure connectivity, the MCF5223x family of ColdFire devices are single-chip solutions that provide 32-bit control with an Ethernet interface. It combines a 10/100 Fast Ethernet controller (FEC), Ethernet Physical Layer (EPHY), CAN 2.0B and a Cryptographic Acceleration Unit (CAU) for secure hardware encryption with the Version 2 ColdFire core to provide exceptional performance at a reasonable cost. The MCF5223x embedded controller family provides designers with the right set of peripherals and memory sizes for a compact Ethernet-enabled platform that cuts development time and cost to help your products get to market quicker.

The MCF5223x family integrates standard ColdFire peripherals, including three universal asynchronous receiver/transmitters (UARTs) for medium and long distance connections, an inter-integrated circuit (I²C) and a queued serial peripheral interface (QSPI) for in-system communications to connected peripherals.

MCF5223X BLOCK DIAGRAM



Delivering Cost-Effective ColdFire Solutions

The MCF5223x family expands the entry-level to 32-bit performance and supports standard protocols for applications that need connectivity options with security encryption. Industrial and commercial applications typically have long lifetimes, and Freescale has demonstrated a commitment to long-term support.

A natural migration for current MCF521x customers looking to integrate Ethernet into their applications, the MCF5223x family delivers cost-effective, feature-rich microcontrollers with industry-standard connectivity. These devices widen the migration bridge for existing 8- and 16-bit users who need a low-cost, entry-level 32-bit solution that incorporates 32-bit performance, Fast Ethernet features and comprehensive tools support. The Freescale ColdFire roadmap to high-end

32-bit performance and connectivity will allow customers to migrate their applications easily and quickly.

Developing with the MCF5223x Family

The easy to use and fully functional M52235EVB development kit simplifies MCF5223x product development, which helps customers reach their markets quickly with a new generation of products. Each kit includes open source software and CodeWarrior™ Development Studio for ColdFire Architectures, Special Edition. Further development assistance is available through Freescale's web-based Fast Track™ support resources, including online training and tech support. In addition, the MCF5223x family of embedded controllers benefits from the support of a number of world-class third-party tool vendors.

**MCF5223X FAMILY DEVICE MATRIX**

Part Number	Flash/SRAM	Key Features	Package	Speed
MCF52230	128 KB/32 KB	FEC, EPHY, 3 UARTs, I ² C, QSPI, A/D, 16-bit/32-bit/PWM timers, DMA	80/112 LQFP	60 MHz
MCF52231	128 KB/32 KB	FEC, EPHY, 3 UARTs, I ² C, QSPI, A/D, 16-bit/32-bit/PWM timers, DMA, CAN	80/112 LQFP	60 MHz
MCF52233	256 KB/32 KB	FEC, EPHY, 3 UARTs, I ² C, QSPI, A/D, 16-bit/32-bit/PWM timers, DMA	80/112 LQFP	60 MHz
MCF52234	256 KB/32 KB	FEC, EPHY, 3 UARTs, I ² C, QSPI, A/D, 16-bit/32-bit/PWM timers, DMA, CAN	112 LQFP 121 MAPBGA	60 MHz
MCF52235	256 KB/32 KB	FEC, EPHY, 3 UARTs, I ² C, QSPI, A/D, 16-bit/32-bit/PWM timers, CAN, DMA, Crypto	112 LQFP 121 MAPBGA	60 MHz
M52235EVB	Development Kit \$299*			
M52233DEMO	Cost-Effective Board \$99*			

*Manufacturer Suggested Resale Price

Integration

- > Up to 32 KB SRAM
- > Up to 256 KB flash: 100 KB W/E cycles, 10 years data retention
- > 10/100 Fast Ethernet controller (FEC) with PHY
- > Ethernet media access controller (EMAC) module
- > Cryptographic accelerator unit with random number generator
- > CAN 2.0B controller
- > Three UARTs
- > Queued serial peripheral interface (QSPI)
- > Inter-integrated circuit (I²C) bus interface
- > Four 32-bit timer channels with DMA capability
- > 4-channel, 16-bit timer for capture, compare and pulse width modulation (PWM)
- > 2-channel periodic interrupt timer
- > 4-channel, 16-bit or 8-channel, 8-bit PWM generator
- > Two 4-channel, 12-bit analog-to-digital (ADC) converters
- > 4-channel DMA controller
- > Up to 73 general-purpose I/Os
- > System integration (PLL, SW watchdog)
- > Single 3.3-volt supply

MCF5223x Specifications

- > 10/100 Fast Ethernet controller (FEC)
- > Ethernet Physical Layer (EPHY)
- > Up to 57 Dhrystone 2.1 MIPS @ 60 MHz
- > EMAC module and HW divide
- > Optional CAN 2.0
- > Optional Crypto
- > Real-time clock

MCF52230/1 Features

- > 128 KB of embedded flash memory
- > 32 KB of SRAM
- > 80 LQFP
- > 112 LQFP

MCF52233 Features

- > 256 KB of embedded flash memory
- > 32 KB of SRAM
- > 80 LQFP
- > 112 LQFP

MCF52234/5 Features

- > 256 KB of embedded flash memory
- > 32 KB of SRAM
- > 112 LQFP
- > 121 MAPBGA

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF523x Family

Overview

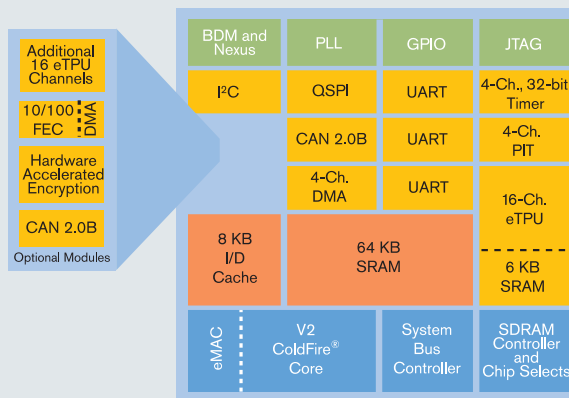
Offering the first ever combination of an enhanced Time Processing Unit (eTPU) and 10/100 Ethernet MAC on the popular Version 2 ColdFire® core, the MCF523x family addresses increasing application complexity requiring more system throughput as well as networked applications that require a high level of communications security. This family provides cost-effective controllers for networked and stand-alone, complex, real-time control applications, such as industrial control, manufacturing equipment and robotics.

This combination of features also provides a natural migration path for current MC68332 family users requiring higher performance and/or networking support. The MCF523x family enables a new generation of products with more complex, higher functionality at a similar price point to more mature generations.

The integrated networking support with optional hardware encryption/decryption accelerator on the MCF523x family allows for easy networking of the system with other applications and increased system security with little impact on performance.

With constant changes in the marketplace, customers need flexible and adaptable systems, particularly for serial protocols. The MCF523x devices are capable of supporting legacy and proprietary serial protocols as functions on the eTPU.

MCF523x BLOCK DIAGRAM



The eTPU is a configurable I/O controller with its own core and memory system, allowing it to perform complex timing and I/O management independently of the CPU. The eTPU is essentially a microcontroller all by itself. Since it was designed for the complex I/O management required in automotive engines, it can handle many of the most demanding timing applications. The embedded eTPU module on the MCF523x processor enables increased system performance and control of complex systems with a single controller rather than with multiple controllers. Some key features of the eTPU include:

- > Optimized for timing tasks to reduce service time
- > Operates independently from the MCU
- > Flexible and configurable. Any channel can run any function

- > Easy to configure—graphical tools and pre-programmed functions makes the eTPU simple to use

Applications for the eTPU

The eTPU is being used in a wide variety of industrial control applications including timing, measurement, automation, motor control and engine control. The eTPU is also being used to run standard and proprietary serial communications.

- > Serial communications: UART, SPI, I²C
- > Timing and automation: pulse/period accumulate, PWM, GPIO, input capture/output compare
- > Motor control: stepper motor systems, brushless DC motors, 3-phase induction motors, permanent magnet synchronous motors
- > Engine control: spark timing, fuel injection

ETPU LIBRARY OVERVIEW

Timing	Serial	Automotive	Motor Control	
Pulse Width Modulation	UART (Universal Asynchronous Receiver/Transmitter)	Angle Clock	Stepper Motor	DC Bus Break Control
Synchronized PWM	UART with Flow Control	Cam Decode	Speed Controller	Hall Controller
Input Capture	Synchronous Peripheral Interface (SPI)	Fuel Control	Quadrature Controller	Current Controller
Output Compare		Spark Control	Analog Sensing for DC Motors	Analog Sensing for AC Motors
Pulse & Freq. Measurement		Angle Pulse	DC Motor Control PWM	AC Motor Control PWM
Pulse/ Period Accumulate			Full Range PWM	Commutation Capable PWM
Queued Output Match			ACIM V/Hz Control	ACIM Vector Control
General Purpose I/O			PMSM Vector Control	

MOTOR CONTROL ETPU FUNCTIONS

Motor Control Functions work together to drive the following motors:	
DC Open Loop	ACIM V/Hz Open Loop with Sine Wave Drive
DC Speed Loop with QD	ACIM V/Hz Open Loop with SVM Drive
DC Speed Loop with HD	ACIM V/Hz Speed Loop with Sine Wave Drive
DC Speed & Current Loop	ACIM V/Hz Speed Loop with SVM Drive
BLCD with HD Open Loop	ACIM Torque Vector Control
BLDC with HD Speed Loop	ACIM Vector Control with Speed Loop
BLDC with HD Speed and Current Loop	PMSM Torque Vector Control
BLDC with QD Open Loop	PMSM Vector Control with Speed Loop
BLDC with QD Speed Loop	Stepper Motor
BLDC with QD Speed and Current Loop	

Key Features

- > v2 ColdFire core with enhanced multiply accumulate (eMAC) module with performance up to 144 (Dhrystone 2.1) MIPS @ 150 MHz
- > 32-bit non-multiplexed bus with up to eight chip selects (chip select support for paged mode Flash memories)
- > 64 KB of internal SRAM
- > 8 KB of configurable I/D-Cache
- > Two-bank SDRAM controller
- > 16- or 32-channel eTPU with 6 KB of SRAM
- > 10/100 Mbps bus-mastering Ethernet controller
- > CAN 2.0 B, optional second CAN 2.0B (muxed with UART3)
- > Three UARTs
- > Queued serial peripheral interface (QSPI)
- > I²C bus interface
- > System integration (PLL, SW watchdog)
- > Four-channel, 32-bit timers with DMA
- > Four-channel DMA controller
- > Optional hardware cryptography accelerator
 - Random-number generator
 - DES, 3DES, AES, block cipher engine
 - MD5, SHA-1, HMAC, hash accelerator

ORDERING INFORMATION

Part Number	Speed	Features	Package	Temp. Ranges
MCF5235	100, 150 MHz	3 UARTs, 2 CAN, 16-ch. eTPU, 10/100 Ethernet MAC, Encryption	256 MAPBGA	-40°C to +85°C
MCF5234	100, 150 MHz	3 UARTs, CAN, 16-ch. eTPU, 10/100 Ethernet MAC	256 MAPBGA	-40°C to +85°C
MCF5233	100, 150 MHz	3 UARTs, 2 CAN, 32-ch. eTPU	256 MAPBGA	-40°C to +85°C
MCF5232	80, 100, 150 MHz	3 UARTs, CAN, 16-ch. eTPU	196 MAPBGA 160 QFP	-40°C to +85°C
M523XEVB	Evaluation and Development System \$695**			
M5235BC	Business Card Computer \$180**			
M5235BCCKIT	Business Card Computer Kit \$250**			

**Manufacturer Suggested Resale Price

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

Tools Support for Fast Development

The MCF523x family of microprocessors benefits from extensive support by a world-class development tools suite from Freescale Semiconductor, Green Hills Software, Wind River Systems, as well as other leading third-party tools developers. An extensive migration support plan is also available for current MC68332 customers ready to take advantage of the enhanced performance on the MCF523x products. Freescale also provides an eTPU graphical configuration tool that supports the easy configuration of the eTPU module.

The MCF523x also comes with support from a number of our third-party tool vendors and ships with a brushless DC motor and a motor driver card to evaluate the enhanced time processing unit. The M5235BCC Business Card Computer is a cost-effective evaluation module for the MCF5235 microprocessor. The M5235BCC ships with an available RTOS, along with open source GNU tools and an open source TCP/IP stack. The M5235BCCKIT adds the power supply, BDM and other cabling necessary to run out of the box.

*Subject to license agreement and registration

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MCF523XFAMFS

REV 3

MCF5249

New Trends Call for New Technology

While sales of consumer electronics and home audio devices are growing, and the popularity of the cost-effective, high-capacity MP3 format is increasing, Freescale Semiconductor is keeping pace with innovative devices that address these trends. The MCF5249 ColdFire® microprocessor has entered the market at a time when a convergence is taking place between home audio electronics and computer technologies. At the same time, Freescale has positioned this advanced ColdFire device for many other growing markets such as point-of-sale, voice-over Internet Protocol (VoIP) and biometrics for fingerprint recognition and iris scanning applications.

Enhanced Features Open the Door to New Possibilities

Freescale's ColdFire MCF5249 32-bit embedded controller, based on the Version 2 (V2) ColdFire core, includes new features that are ideal for any application that requires significant control processing for file management, signal processing and data buffering. In fact, the MCF5249, with up to 125 Dhrystone 2.1 MIPS at 140 MHz, is diverse enough to drive a wide range of applications, everything from digital audio to VoIP, to point-of-sale to industrial control.

The MCF5249 is uniquely designed to enable fewer system components and, with low system power requirements, products with a longer battery life. Additionally, its integrated features keep development costs low and time to market short.

Price/Performance That's Hard to Beat

While the MCF5249 is well suited for the digital audio market, advanced features make it a good fit for many industrial control applications, such as information kiosks, security and biometrics. The advanced features include an enhanced Multiply-Accumulate (eMAC) unit, 96 KB of on-chip SRAM, 8 KB I-Cache, serial interfaces, a 12-bit analog-to-digital converter (ADC),

a four-channel direct memory access (DMA), timers, general-purpose input/output (GPIO) lines, system integration and a glueless SDRAM controller.

The MCF5249, our highest performing V2 yet, gives you flexibility to cost-effectively design the feature-rich products your customers demand in significantly less time.

New Features Give You More Design Options

The MCF5249 includes exciting enhancements—serial audio ports compatible with industry-standard formats, CD-ROM block decoder/encoder, SPDIF/EBU transmitter/receiver, Flash media interface, IDE master interface—that eliminate the need for additional audio interfaces. The innovative on-chip audio bus allows a direct connection between audio interfaces with no intervention from the CPU, adding even more intelligence to this smart device. The ColdFire family is designed to accelerate system design time and reduce development costs.

MCF5249 Features

- > V2 ColdFire processor core
- > 8 KB instruction cache
- > 96 KB SRAM
- > eMAC unit
- > Hardware integer divide unit
- > Industry-leading debug module offering both background and real-time capability
- > Integrated processor
 - SDRAM controller
 - Two independent universal asynchronous receiver/transmitters (UARTs)
 - Two I²C interfaces
 - Queued serial peripheral interface (QSPI)
 - Four-channel DMA (two internal/two external)
 - 12-bit ADC
 - Two independent 16-bit timers
 - Chip selects
 - 16-bit GPIOs
 - CD-ROM block decoder/encoder
 - CD text interface
 - Sony Phillips Digital Interface (SPDIF)/EBU transmitter/receiver

- Two I²C transmitter/receivers
- Hard disk drive interface
- Flash media interface

- > System integration (Phase-Lock Loop, software watchdog)
- > Doze mode and variable frequency operation

MCF5249 Product Specifications

- > Up to 125 (Dhrystone 2.1) MIPS at 140 MHz
- > -40°C to +85°C operating temperature
- > Requires 1.8V and 3.3V power supply
- > Package:
 - 160-pin MAPBGA package—MCF5249
 - 144-pin LQFP package—MCF5249L

MCF5249 Development Tools

M5249C3 Evaluation Board—\$649.10*

- > 8 MB SDRAM
- > 2 MB flash
- > 10/100 BaseT Ethernet connectivity
- > Two serial ports
- > Access to ColdFire debug module

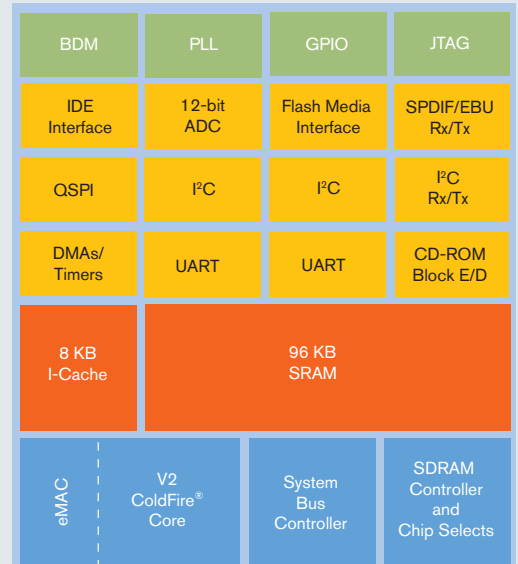
*Manufacturer Suggested Resale Price

Flexibility to Meet Your Customers' Needs

The MCF5249 incorporates advanced technologies that allow you to build greater performance into your products and get them to market faster.

The innovative ColdFire family has been a key member of Freescale's 32-bit family of products for more than eight years. And the ColdFire family product development roadmap helps ensure your creativity, time and resources are protected into the future.

MCF5249 BLOCK DIAGRAM



A Seamless Migration Path Protects Your Technology Investment

By leveraging your existing development tools and software, the MCF5249 protects the resources you've already invested in 68K and ColdFire microprocessor technology and training. For example, when you move from 68K to ColdFire microprocessors, you can use code translation and emulation tools, free of charge to registered users, to modify and reuse 68K assembly code.

Because ColdFire embedded controllers are 100 percent synthesizable, they are easily adaptable to new process technologies and easily integrated with memories, system modules and communications peripherals. With ColdFire, you don't have to sacrifice performance to keep system costs in line.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.



MCF527x Family

Overview

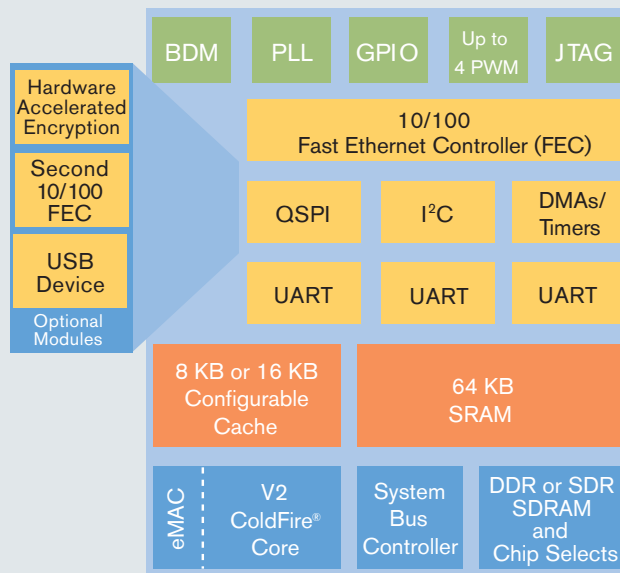
While the lower-end connectivity and networking market space requires solutions with the system performance and high integration benefits of a 32-bit microprocessor, it also brings more power and cost constraints. To meet those various needs, Freescale Semiconductor is expanding the MCF527x family of embedded controllers with a menu of devices that combine higher integration and lower cost options in addition to delivering a new level of performance on the Version 2 ColdFire® core with up to 159 MIPS (Dhrystone 2.1) at 166 MHz.

The advanced MCF527x family members are offered in low-power, high-performance 0.13µ technology and build upon the widely used peripheral mix of the popular MCF5272 by adding more connectivity options and encryption capability.

These highly integrated embedded controllers also feature an enhanced multiplier-accumulator (eMAC) unit and large on-chip memory with 64 KB SRAM and 8 KB or 16 KB configurable cache.

And because Freescale knows the importance of low system cost, several of the advanced MCF527x family members feature a DDR SDRAM memory controller, and offer a choice between MAPBGA and QFP package versions.

MCF527x BLOCK DIAGRAM



MCF527x Applications

The impressive combination of connection, protection and peripheral selection makes the MCF527x family ideal for power-conscious, cost-sensitive applications requiring significant control processing for file management, connectivity, data buffering, user interface and signal processing.

MCF527x target applications include remote monitoring, data security, voice-over-Internet Protocol (VoIP) phones, health care-related instrumentation, gaming equipment, Ethernet switches, server appliances, point-of-sale printers and home routers.

Extensive Connectivity Options

The MCF527x family offers a rich array of connectivity choices, including up to two 10/100 Ethernet controllers, USB, three UARTs, QSPI and I²C.

Connection with Protection

Today's embedded applications demand increased connectivity, requiring a higher level of data protection, with security at the node. The MCF527x family offers the encryption option (DES, AES, BCE, MD5, SHA-1, 3DES, HMAC, RNG) in hardware, and data can be encrypted from any interface on the processor.

Part Number	Temp. Ranges	Features	Package	Max Speed (MHz)	Memory
MCF5275	-40°C to +85°C	3 UARTs, USB device, encryption 2x10/100 FEC, DDR SDRAM	256 MAPBGA	166	16 KB C-Cache 64 KB SRAM
MCF5275L	-40°C to +85°C	3 UARTs, USB device, encryption 1x10/100 FEC, DDR SDRAM	196 MAPBGA	166	16 KB C-Cache 64 KB SRAM
MCF5274	0°C to +70°C	3 UARTs, USB device 2x10/100 FEC, DDR SDRAM	256 MAPBGA	166	16 KB C-Cache 64 KB SRAM
MCF5274L	0°C to +70°C	3 UARTs, USB device 1x10/100 FEC, DDR SDRAM	196 MAPBGA	166	16 KB C-Cache 64 KB SRAM
MCF5272	-40°C to +85°C	2 UARTs, USB device 1x10/100 FEC, SDR SDRAM	196 MAPBGA	66	1 KB I-Cache 4 KB SRAM
MCF5271	-40°C to +85°C	3 UARTs, encryption 1x10/100 FEC, SDR SDRAM	196 BGA 160 QFP	100	8 KB C-Cache 64 KB SRAM
MCF5270	0°C to +70°C	3 UARTs 1x10/100 FEC, SDR SDRAM	196 BGA 160 QFP	100	8 KB C-Cache 64 KB SRAM

Low System Cost with DDR SDRAM Controller

The MCF527x family offers a cost-effective, highly integrated solution. Taking advantage of current pricing trends in the memory space, most of the MCF527x family members feature a DDR SDRAM memory controller, which can be quite appealing to those on tight budgets. Potential cost savings can be realized with the DDR SDRAM memory controller by allowing users to attach up to 256 MB (1 Gbit) of DDR SDRAM to the processor.

Key Features

- > v2 ColdFire core with performance up to 159 (Dhrystone 2.1) MIPS @ 166 MHz
- > eMAC (32 x 32) module, hardware divide
- > 8 KB or 16 KB configurable I-/D-Cache
- > Integrated peripherals
 - Up to two 10/100 Fast Ethernet Controllers (FECs)
 - Optional USB 2.0 full-speed device
 - Three UARTs
 - QSPI
 - I²C

- Optional encryption—RNG, DES, 3DES, AES, BCE, MD5, SHA-1, HMAC, Hash Accelerator
- Up to four pulse-width modulators (PWMs)
- Four 32-bit timers
- Four programmable interrupt timers (PITs)
- Watchdog timer
- Four-channel DMA
- External DMA req/ack
- 64 KB SRAM
- DDR or SDR SDRAM memory controller
- Chip selects, GPIOs
- World-class BDM
- JTAG
- Technology: 0.13μ
- Temperature range: -40°C to +85°C or 0°C to 70°C
- 160-QFP, 196-MAPBGA and 256-MAPBGA options

Tools Support for Fast Development

The ColdFire family benefits from extensive support by a world-class development tools suite from Freescale, Green Hills Software, Wind River® Systems and other leading third-party tools developers.

M5271EVB Features

The M5271EVB evaluation board for the MCF5270 or MCF5271 ColdFire embedded controllers provides 16 MB of SDRAM, 2 MB of flash (upgradable to 4 MB), 10/100 BaseT Ethernet connectivity, three serial ports (two available to the user) and access to the ColdFire debug module.

M5275EVB Features

The M5275EVB evaluation board for the MCF5274 or MCF5275 ColdFire embedded controllers provides 16 MB of DDR SDRAM, 2 MB of flash (upgradable to 4 MB), dual 10/100 BaseT Ethernet connectivity, three serial ports (two available to the user) and access to the ColdFire debug module.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF5272

Today, the high performance of embedded processors is all around us. In fact, the average person encounters more than 350 microprocessors a day! These small machines have a major impact on our lives—from inside your car to the printers you use in your home or office to your cell phones and PDAs. A few years ago, the concept of networking within the home was unheard of, but today you can find Ethernet hubs and routers in homes around the world. The ColdFire® family has stepped up in the advancement of entry-level networking, offering a range of connectivity products for the 32-bit market.

More Reasons to Think Freescale

Freescale Semiconductor's ColdFire MCF5272 32-bit embedded controller is a springboard into the ColdFire family. It combines advanced communications peripherals, such as a 10/100 Fast Ethernet Controller (FEC) and a USB module, with standard ColdFire peripherals for maximum system performance and design flexibility. It features a Version 2 (V2) ColdFire core and offers a performance of 63 (Dhrystone 2.1) MIPS at 66 MHz.

An excellent complement to the MC68302 family because of a shared 68K programming model, the MCF5272 processor is a high-performance alternative for applications where communications peripherals are essential.

The MCF5272's expanded peripheral set and attractive price/performance ratio means it is a great fit for a broad range of embedded applications such as:

- > Imaging systems including laser printers, cameras and plotters
- > In-home applications such as set-top boxes, security systems and building room control
- > Telecommunications applications including PBX switches and Ethernet switches
- > Networking devices such as local area network (LAN) controllers, LAN boards or ATM switches

Connectivity Peripheral Set Offers New Capabilities

The connectivity peripheral set included on the MCF5272 allows you to design performance and capabilities into your products that will help put you far ahead of your competition.

- > Fast Ethernet Media Access Controller (eMAC) that supports 100 Mbps MII, 10 Mbps MII, and 10 Mbps 7-wire physical interfaces
- > USB 2.0 full-speed controller operating with either an internal or external transceiver
- > Time division multiplexing (TDM) controller for connecting your products at a physical level with external codes, ISDN transceivers and other peripheral devices that use either the General Circuit Interface (GCI) or Interchip Digital Link (IDL) serial interface protocols
- > Multichannel high-level data link controller (HDLC) software module
- > Queued serial peripheral interface (QSPI) module designed to provide a serial peripheral interface with queued transfer capability
- > Pulse-width modulation (PWM) units for use in control applications

In addition to the communications peripherals, the MCF5272 offers peripherals common to many embedded applications, such as a synchronous DRAM controller, direct memory access (DMA) controllers, timers, universal asynchronous receiver/transmitters (UARTs), chip selects, general-purpose input/outputs (GPIOs), on-chip memories and the world-class ColdFire background debug module (BDM). All ColdFire peripherals are cost-effectively integrated to help reduce system cost and accelerate system design time.

MCF5272 Features

- > Version 2 (V2) ColdFire processor core
- > 1 KB I-Cache
- > 4 KB SRAM
- > Multiply-Accumulate (MAC) unit
- > Hardware integer divide module
- > Industry-leading debug module offering both background and real-time capability
- > Integrated processor
 - IEEE® 802.3-compliant 10/100 Fast Ethernet controller (FEC) with dedicated DMA
 - USB 2.0 full-speed controller and transceiver
 - Four 2B+D TDM ports
 - HDLC software module
 - QSPI
 - SDRAM controller
 - Three PWM outputs
 - Two UARTs
 - Two-channel DMA
 - Eight chip selects provide external memory controller—glueless interfacing to volatile and nonvolatile memory-mapped I/O peripherals (i.e., ROM, flash, SRAM)

- Four 16-bit timers
- Software watchdog timer

- > Doze mode and variable frequency operation

Product Specifications

- > 63 (Dhrystone 2.1) MIPS at 66 MHz
- > 0° to +70°C operating temperature
- > -40° to +85°C extended temperature
- > Implemented in 0.35 µm Triple Layer Metal (TLM)
- > 3.3V supply/5V I/O-tolerant
- > 196-pin MAPBGA package

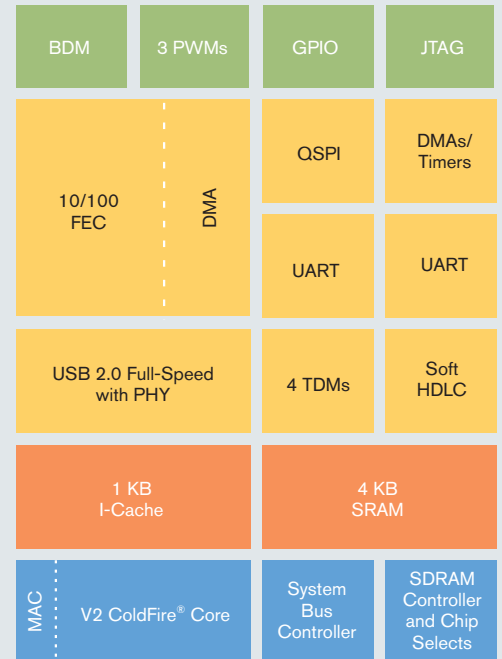
MCF5272 Development Tools

M5272C3 Evaluation Board—\$649.10*

- > 4 MB of SDRAM
- > 2 MB of flash
- > 10/100 BaseT Ethernet connectivity
- > Two serial ports
- > Available expansion of 512 KB SRAM for high-speed critical code or benchmarking
- > USB device port
- > Access to ColdFire debug module

*Manufacturer Suggested Resale Price

MCF5272 BLOCK DIAGRAM



We Take the Risk Out of Change

The MCF5272 incorporates advanced technologies that allow you to build greater performance into your products and get them to market faster. The innovative ColdFire family has been a key member of Freescale's 32-bit family of products for more than 14 years, and the ColdFire product development roadmap helps ensure your creativity, time and resources are protected into the future.

Tools Support for Fast Development

The ColdFire family benefits from extensive support by a world-class development tools suite through leading third-party tools developers. The CodeWarrior™ for ColdFire development tools suite from Freescale includes a compiler, assembler, debugger, project manager and build system. A trial version of the tools is provided with the development kit.

ColdFire Architecture Offers a Smooth Transition to Leverage Your Investment

The MCF5272 offers a seamless upgrade for existing 68K and ColdFire processor users, leveraging familiar development tools and software. For example, designers moving from 68K to ColdFire can use code translation and emulation tools, at no extra cost** to registered users, to modify

and reuse 68K assembly code. Because ColdFire embedded controllers are 100-percent synthesizable, they are easily adaptable to new process technologies and easily integrated with memories, system modules and communications peripherals. With ColdFire, you don't have to sacrifice performance to keep system costs in line.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

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Document Number: MCF5272FACT

REV 3



MCF528x Family

Overview

Building on years of experience in industrial control and networking communications, Freescale Semiconductor introduced the industry's first 32-bit microcontroller with integrated Fast Ethernet, Controller Area Network (CAN) and flash memory. Based on Freescale's ColdFire® architecture, the MCF528x family offers advanced communications features, a rich peripheral set and a variety of supporting software and development tools.

The MCF528x family helps simplify embedded Ethernet design and offers flexibility in embedded memory options, delivering up to 76 (Dhrystone 2.1) MIPS at 80 MHz when executing from internal flash.

ColdFire Architecture Answers New Market Trends

Designers have indicated that component availability with the right level of integration is one of the most critical design challenges causing changes in processor selection today. Freescale continues to meet market demands by offering integrated solutions with its ColdFire architecture. The MCF528x family offers built-in versatility to address a variety of new and emerging markets that are driving the growth of low-cost, high-volume embedded control.

More applications are being networked, requiring higher performance and integration with improved connectivity. The MCF528x family is designed to make this process easier. The on-chip connectivity modules on these ColdFire devices are creating excitement in the design community and inspiring creativity in emerging applications.

Growing Demand for Embedded Ethernet

Traditionally, MCU networks have used CAN and universal asynchronous receiver/transmitter (UART) serial interfaces that have distance and bandwidth limitations. Ethernet—the standard upon which the Internet is built—provides more bandwidth than common serial interfaces and can be used to connect devices over virtually unlimited distances. With its integrated 10/100 Mbps Ethernet Media Access Controller (eMAC) and network-ready applications software from Quadros Systems, OpenTCP™ and others, the MCF528x family is designed to bring standards-based networking to a variety of traditional MCU applications in markets as diverse as security systems, lighting control, home automation and enterprise networking.

These applications can expect to benefit from networking functions such as Web-based user interfaces, network time synchronization and router/gateway protocols.

MCF5280 Features

- > 63 (Dhrystone 2.1) MIPS at 80 MHz
- > No embedded flash memory
- > All other features identical to the MCF5282

MCF5281 Features

- > 256 KB embedded flash memory
- > All other features identical to the MCF5282

MCF5282 Features

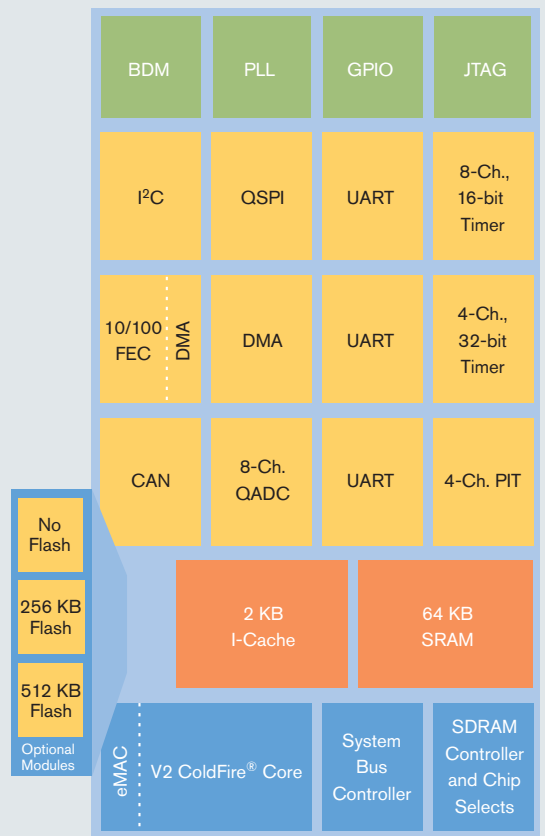
- > Version 2 (V2) ColdFire core
- > 512 KB embedded flash memory
- > 64 KB of static RAM
- > 2 KB I-Cache
- > SDRAM controller
- > 10/100 Ethernet MAC
- > Enhanced CAN 2.0B controller (FlexCAN) interface with 16 message buffers
- > Three UARTs with direct memory access (DMA) capability

- > Queued serial peripheral interface (QSPI) with four peripheral chip selects
- > Inter-integrated circuit (I²C) bus controller
- > 8-channel, 10-bit queued analog-to-digital converter (QADC)
- > Four 32-bit timer channels with DMA capability
- > Eight 16-bit timer channels for capture, compare and pulse-width modulation (PWM)
- > Four periodic interrupt timers (PITs) for alarm and countdown timing

Product Specifications

- > Up to 76 (Dhrystone 2.1) MIPS at 80 MHz (executing from internal flash)
- > -40°C to +85°C ambient operating temperature
- > 80 MHz and 66 MHz available
- > 3.3V, 5V tolerant I/O
- > 17 mm x 17 mm x 1.6 mm 256-ball (1 mm pitch) mold array process ball grid array (MAPBGA) package

MCF528x BLOCK DIAGRAM



Tools Support for Fast Development

The ColdFire family of microprocessors benefits from extensive support by a world-class development tools suite through leading third-party tools developers. In addition, Freescale and Quadros Systems have partnered to provide a comprehensive hardware/software solution for networked, embedded control solutions based on the ColdFire MCF528x family, OpenTCP stack, RTX[™] Quadros operating system and CodeWarrior[™] for ColdFire development tools suite.

RTXC Quadros for the MCF528x family includes a real-time operating system (RTOS) supporting both thread- and task-based kernels. It also includes extensive networking support—Ethernet driver; Internet protocols such as IP, UDP, TCP, ICMP, ARP and DHCP; and application-level protocols such as embedded Web server, Trivial FTP server for remote firmware download, SMTP to send e-mail alerts and SNMP to retrieve current-time information from a network NTP server. Three versions of the software are available at a range of prices and functionality.

The RTX[™] Quadros for the MCF528x Special Edition is available at no charge** and preloaded into the internal flash with the purchase of the M5282EVB or available for download for registered users of the Freescale website.

The CodeWarrior for ColdFire development tools suite from Freescale includes a compiler, assembler, debugger, project manager and build system. Trial versions of the tools are provided with the development kit.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

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MCF5307

ColdFire® embedded controllers are optimized for a new generation of advanced consumer electronics and business peripherals. With new process technology and a wide range of functionality, the ColdFire family delivers the performance levels required by low-end to high-end applications.

Highly Integrated for Cost Efficiency

The MCF5307 embedded controller combines a cost-effective peripheral set with the high performance of the 32-bit Version 3 (V3) ColdFire core.

The MCF5307 solution delivers impressive mathematical performance for basic digital signal processing capabilities and a comprehensive peripheral set that offers ease of use through integration on a single chip, reducing overall design time. In fact, the MCF5307's mid-range performance level, code compatibility and award-winning integration come at a performance/cost ratio that's hard to beat.

Ideal Performance for Embedded Applications

The MCF5307's 75 (Dhrystone 2.1) MIPS performance is ideal for embedded applications such as high-end control panels, digital set-top boxes, routers, digital video recorders, barcode printers, printer servers and gigabit switches. This product family and the applications it enables is an example of why Freescale is the world's most pervasive supplier of embedded processing solutions to the automotive, consumer, industrial, networking and wireless markets.

The V3 core boosts CPU performance while maintaining a low-frequency domain for on-chip peripherals and external interfaces. The result is simplified integration of on-chip functions and reduced overall power consumption. The V3 core architecture also includes enhancements, such as branch-acceleration capabilities that accelerate change-of-flow operations in the instruction execution stream, resulting in better performance efficiency of the pipeline.

For current 68K users, upgrading to the MCF5307 can result in significant improvements in performance. In fact, the MCF5307 offers more than 10 times the performance of the M68EC020, up to twice the performance of the M68EC040, up to

three times the performance of the MCF5206 and a comparable performance level with the MC68LC060, the highest-performance 68K device available. In addition, the MCF5307 includes a broad array of integrated peripherals at a fraction of the cost of these other microprocessors.

Integrated Peripherals Help Speed Time to Market

With the MCF5307 system, design time is accelerated by packaging common system features—a direct memory access (DMA) controller, timers, and parallel and serial interfaces—on-chip. The MCF5307 also provides glueless interfaces to 8-bit, 16-bit and 32-bit DRAM, thereby eliminating external logic, while internal SRAM offers very high-speed on-chip memory access, and additional general-purpose input/output (GPIO) pins give you more flexibility.



MCF5307 Features

- > V3 ColdFire processor core with clock-multiplied core and branch cache acceleration logic
- > Fully code-compatible with V2 ColdFire processor core
- > 8 KB unified cache
- > 4 KB SRAM
- > Multiply-Accumulate (MAC) unit
- > Industry-leading debug module offering both background and real-time capability
- > Hardware integer divide unit
- > Integrated processor
 - DRAM controller (glueless interface to SDRAM or ADRAM)
 - Two universal asynchronous receiver/transmitters (UARTs)
 - Four fully programmable DMA channels
 - Eight chip selects provide external memory controller—glueless interfacing to volatile and nonvolatile memory-mapped I/O peripherals (i.e., ROM, Flash, SRAM)
 - 16-bit GPIO
 - Dual 16-bit general-purpose multimode timers
 - I²C module
 - System integration (Phase-Lock Loop, software watchdog)

- User-defined bus speed at 1/2, 1/3 or 1/4 of processor clock
- > Doze mode and variable frequency operation

Product Specifications

- > 75 (Dhrystone 2.1) MIPS at 90 MHz
- > Available at 66 MHz and 90 MHz
- > 0° to +70°C operating temperature
- > -40° to +85°C operating temperature (66 MHz)
- > Implemented in 0.35 µm, Triple Layer Metal (TLM)
- > 3.3V supply/5.0V-tolerant I/O
- > 208-pin plastic QFP package
- > Pin-compatible with the MCF5407

MCF5307 Development Tools

M5307C3 Evaluation Board—\$539.10*

- > 8 MB SDRAM
- > 1 MB flash
- > 10/100 BaseT Ethernet connectivity
- > Two serial ports
- > Available expansion of 1 MB SRAM for high-speed critical code or benchmarking
- > Access to ColdFire debug module

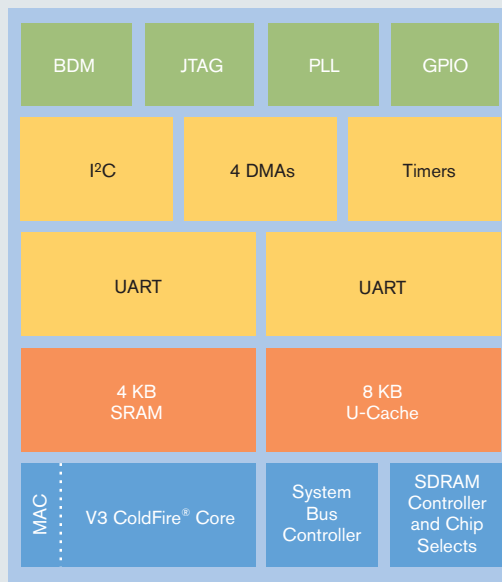
*Manufacturer Suggested Resale Price

Position Your Products for the Future

ColdFire embedded controllers can provide the optimum solution for virtually any embedded application, whether a design requires high performance at low cost or high levels of integration. The innovative ColdFire portfolio has been a

key member of Freescale's 32-bit family of products for more than 14 years, and the ColdFire product development roadmap helps ensure your creativity, time and resources are protected in the future.

MCF5307 BLOCK DIAGRAM



Your Technology Investment Works to Your Advantage

The MCF5307 provides a seamless, fully compatible upgrade path for existing users of 68K and ColdFire embedded controllers, leveraging the development tools and software you're already familiar with. For example, customers migrating from 68K to ColdFire embedded controllers can access code translation and emulation tools, free of charge to registered users, to facilitate, modify and reuse 68K assembly code.

Because ColdFire embedded controllers are 100 percent synthesizable, they are easily adaptable to new process technologies and easily integrated with memories, system modules and communications peripherals. With ColdFire, you don't have to sacrifice performance to keep system costs in line.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF532x Family

Control Efficiency

The MCF532x family takes industrial control efficiency to the next level with an integrated super video graphics adapter (SVGA) LCD controller that helps reduce overall system cost by supporting a variety of LCD panels from one single embedded controller chip. Building on the competitive high-performance legacy of the 68K/ColdFire family, these devices offer up to 211 (Dhrystone 2.1) MIPS at 240 MHz, placing them among the highest performing processors in their class. Advanced features include an enhanced multiply-accumulate (eMAC) unit, which handles DSP-like instructions, and an integrated SDRAM controller that supports either double data rate (DDR) or single data rate (SDR) memory.

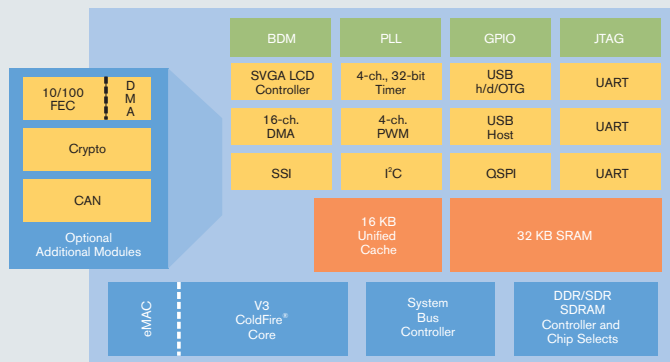
Connectivity

For applications requiring enhanced human-machine interfaces, the MCF532x family enables higher performance and increased flexibility for virtually any combination of system-to-system, in-system or networked communication. MCF532x embedded controllers offer both an integrated universal serial bus (USB) host and an integrated USB On-The-Go (OTG) module, as well as three on-chip universal asynchronous receiver/transmitters (UARTs) for direct communication between computers, terminals and other devices. The MCF532x family also features an integrated queued serial peripheral interface (QSPI) and an inter-integrated circuit (I²C) for in-system communication and supports networked communication via the integrated Fast Ethernet Controller (FEC) and controller area network (CAN) modules.

Security

Data protection is a critical requirement for connected embedded applications. The MCF532x family offers an optional on-chip hardware encryption module that is designed to support a variety of encryption algorithms and protocols while maintaining high overall system performance.

MCF532x BLOCK DIAGRAM



MCF532x Features

ColdFire V3 Core

- > Up to 211 (Dhrystone 2.1) MIPS @ 240 MHz
- > Enhanced MAC module and hardware divide

Integration

- > Integrated SVGA LCD controller
- > 16 KB I/D-Cache
- > 32 KB SRAM
- > USB 2.0 full-speed host controller
- > USB 2.0 full-speed/high-speed** On-The-Go controller
- > 10/100 Fast Ethernet Controller (FEC) (MCF5328 and MCF5329 only)
- > Hardware accelerated encryption (MCF5329 only)
- > Enhanced CAN 2.0B controller (MCF5329 only)
- > Three UARTs
- > Queued serial peripheral interface (QSPI)
- > Serial synchronous interface (SSI)

- > I²C bus interface
- > 4-channel, 32-bit timer with DMA support
- > 4-channel PWM timer
- > 16-channel DMA controller
- > 16-bit DDR/32-bit SDR SDRAM controller
- > Up to 94 general purpose I/O
- > System integration (PLL, software watchdog)
- > 1.5V core, 2.5V DDR, 3.3V I/O voltages

Availability

- > Temperature range: -40°C to 85°C
- > Package Options
 - MCF5329 and MCF5328: 256-ball MAPBGA
 - MCF5327: 196-ball MAPBGA

**High speed using external ULPI PHY

COLDFIRE® SELECTOR GUIDE

Part Number	Features	Package	Speed
MCF5329	LCD controller, USB host, USB-OTG 3 UARTs, SDR/DDR SDRAM, 4-ch. DMA 10/100 FEC, CAN Encryption (DES/3DES/AES)	256 MAPBGA	Up to 240 MHz
MCF5328	LCD controller, USB host, USB-OTG 3 UARTs, SDR/DDR SDRAM 4-ch. DMA, 10/100 FEC	256 MAPBGA	Up to 240 MHz
MCF5329	LCD controller, USB host, USB-OTG 3 UARTs, SDR/DDR SDRAM, 4-ch. DMA	196 MAPBGA	Up to 240 MHz

DEVELOPMENT TOOLS

Part Number	Description	Pricing
M5329EVB	Evaluation and development system for the MCF532x processor family. Development kit features the MCF5329-based Fire Engine, a plug-in system-on-module containing 32 MB of DDR-SDRAM, 16 MB of NAND flash, 2 MB of boot flash, an audio codec, a touch screen controller and other interfaces. Includes a complimentary Special Edition of CodeWarrior™ Development Studio for ColdFire Architectures.	\$699*

*Manufacturer Suggested Resale Price

DOCUMENTATION

Freescal Document Number	Title	Description
MCF5329PB	MCF532x Product Brief	Provides an overview of the MCF532x family, focusing on its highly diverse feature set.
MCF5329DS	MCF532x Data Sheet	Describes the functionality of the MCF532x family, including the electrical characteristics, packaging and signal connections.
MCF5329RM	MCF5329 Reference Manual	A comprehensive description of the structure and function of the MCF5329 (Also supports the MCF5327 and MCF5328).

The ColdFire portfolio offers unparalleled integration and debugging capabilities across a wide range of performance and price options. Variable-length RISC architecture gives designers greater flexibility and exceptional code density, and efficient use of on-chip memory means designers don't have to sacrifice performance to keep system costs in line. Plus, ColdFire product development

tools—compilers, assemblers, linkers, debuggers, code converters, simulators and evaluation kits—accelerate design cycles to help you get your application to market quickly. Whatever your system performance and integration requirements may be, the ColdFire family has a solution to meet your needs.

The Market Challenge

As the demands for integration and connectivity increase, designers are challenged to develop systems that share information in a connected environment while offering a rich set of human interface peripherals. Freescale's MCF532x embedded controller family provides integrated LCD, USB-OTG and fast Ethernet modules for single chip solutions that address the growing demand for human interface on machine and industrial control applications while still maintaining a rich level of connectivity and security integration.

68K/ColdFire Hardware and Software Tools Support

Because a number of Freescale and leading third-party development tools support the MCF532x family of embedded controllers supports, developers can easily migrate to other members of the portfolio without extensive new equipment purchases and training expenses. The Freescale M5329EVB evaluation and development system includes a complimentary** CodeWarrior™ Special Edition software. Professional tool support is also available through ColdFire third-party tool vendors. Open Source software is also available for the M5329EVB, including µCLinux and Nano-X, an open source graphical user interface (GUI) development platform.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

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Document Number: MFC532XFS

REV 4



MCF537x Family

The Market Challenge

The need for connectivity and system communication continues to be a steadily growing trend. However, the challenge most designers face is how to accommodate the different methods of connectivity within a system. There is a need to select an embedded controller with the right level of integration and performance enhancement features to accommodate system-to-system, in-system and secure networked communication. There is also a need for a roadmap with seamless migration that includes an entire portfolio of full-featured embedded controllers with an emphasis on connectivity. By introducing the integrated USB host and integrated USB On-The-Go (USB-OTG) modules to the 68K/ColdFire portfolio, the MCF537x family of embedded controllers offers a single chip solution to address the growing need for flexible communication within industrial control systems.

Connectivity

To address the growing need for system-to-system communications, the MCF537x adds an integrated USB host and integrated USB-OTG module to the 68K/ColdFire portfolio of features. These on-chip USB modules address the need for system flexibility and enables support for a rapidly growing number of applications where direct communication is required between USB devices such as printers, mass storage devices and input devices. The MCF537x also includes three on-chip universal asynchronous receiver/transmitters (UARTs), common on a majority of 68K/ColdFire devices, for direct communication between computers, terminals and other devices. Both the I²C and queued serial peripheral interface (QSPI) peripherals are ideal for supporting in-system communication to connected peripherals. The MCF537x family further accommodates flexibility in communication by supporting networked communication via the integrated 10/100 Ethernet controller. This integrated Fast Ethernet controller (FEC) in conjunction with the on-chip hardware encryption module ensures secure connectivity with no compromise to system performance.

Flexibility and Performance

The MCF537x offers many peripherals that give designers the flexibility they need to accommodate the multiple functions in their systems. The MCF537x features an integrated USB-OTG module that allows a system to serve as either the master or a device in a given application. The MCF537x also features an integrated SDRAM controller that supports either DDR or SDR memory for designers who wish to modify their designs to accommodate one or the other. Other advanced features include an enhanced multiply-accumulate (eMAC) unit, which handles DSP-like instructions. The MCF537x family of devices also builds upon the competitive

high-performance legacy of the 68K/ColdFire family, offering up to up to 211 Dhrystone 2.1 MIPS at 240 MHz of performance, making them one of the highest performing embedded controllers in its class.

Security

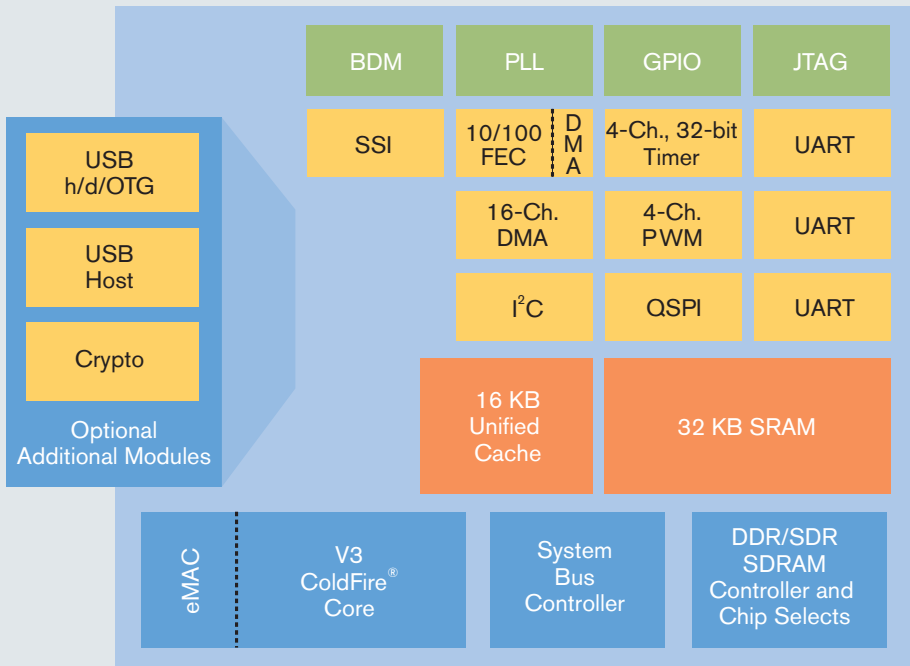
As the need for networked connectivity increases in embedded applications, a higher level of data protection is required. The MCF537x Family offers an optional on-chip hardware encryption module to address this need. The integrated hardware encryption module is designed to support a variety of encryption algorithms and protocols while maintaining overall system performance.

68K/ColdFire Hardware and Software Tools Support

The ColdFire® embedded controller family benefits from world-class support by several leading third-party developers. These developers support a wide variety of 68K/ColdFire devices, making it possible to use the same tool set across several devices in the ColdFire portfolio. In addition to maintaining this similar tool support across the entire ColdFire family, the MCF537x offers peripherals that are similar across several ColdFire devices, further enabling smooth migration within the ColdFire device portfolio. The Freescale M5373EVB evaluation and development system includes, at no extra cost*, CodeWarrior™ Special Edition software. Professional tool support is also available to ColdFire third-party tool vendors. Open source software is available for the MCF537x family of microcontrollers.

*Subject to license agreement and registration

MCF537x FAMILY BLOCK DIAGRAM



MCF537x Family

Part Number	Key Features	Package	Speed
MCF5373L	3 UARTs FEC, SDR/DDR SDRAM 32 KB SRAM, 16 KB C-Cache Encryption USB host, USB-OTG	196 MAPBGA	Up to 240 MHz
MCF5373	3 UARTs FEC, SDR/DDR SDRAM 32 KB SRAM 16 KB C-Cache Encryption	160 QFP	Up to 180 MHz
MCF5372L	3 UARTs FEC, SDR/DDR SDRAM 32 KB SRAM 16 KB C-Cache USB host, USB-OTG	196 MAPBGA	Up to 240 MHz
MCF5372	3 UARTs FEC, SDR/DDR SDRAM 32 KB SRAM 16 KB C-Cache	160 QFP	Up to 180 MHz
M5373EVB	Development Kit for the ColdFire MCF537x Microprocessor Family \$699.00**		

**Manufacturer Suggested Resale Price

MCF537x Features

ColdFire V3 Core

- > Up to 211 (Dhrystone 2.1) MIPS @ 240 MHz
- > Enhanced MAC module and hardware divide

Integration

- > 16 KB I/D-Cache
- > 32 KB SRAM
- > USB 2.0 full-speed host controller (MCF5373L and MCF5372L only)
- > USB 2.0 full-speed/high-speed* On-The-Go controller (MCF5373L and MCF5372L only)
- > 10/100 Fast Ethernet Controller (FEC)
- > Hardware accelerated encryption (MCF5373L and MCF5373 only)
- > Three UARTs
- > QSPI
- > Synchronous serial interface (SSI)
- > I²C bus interface
- > 4-channel, 32-bit timer with DMA support
- > 4-channel PWM timer
- > 16-channel DMA controller
- > 16-bit DDR/32-bit SDR SDRAM controller
- > System integration (PLL, software watchdog)
- > 1.5V core, 2.5V DDR, 3.3V I/O voltages

Availability

- > Temperature range: -40°C to +85°C
- > Package options:
 - MCF5373L and MCF5372L: 196-ball MAPBGA
 - MCF5273 and MCF5372: 160-pin QFP

*High speed using external ULPI PHY

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.



MCF5407

Performance of 32-bit ColdFire® Embedded Controllers Gain Success in the Market

Freescale Semiconductor is a leader in embedded processing, and our expansion of our ColdFire family will help ensure this success continues in the future. Freescale's 32-bit experience is defined by a broad array of customers and applications, which have provided a solid foundation for further development of intelligent products such as the ColdFire family. The performance level gains of the MCF5407 microprocessor over other ColdFire devices have provided entry points into new markets, thanks to outstanding price/performance, integration and time-to-market advantages.

Balanced for Improved System Performance

RISC architectures have traditionally embraced performance at the expense of code density. Despite front-end add-ons designed to support compressed instruction formats, performance generally suffered.

The superb code density of the MCF5407's Version 4 (V4) ColdFire core strikes a balance between reduced processor bus bandwidth requirements and the demand for improved system performance. For MC68EC040 and MC68EC060 users, the MCF5407 product offers more than twice the performance of the MC68EC060 at a fraction of the cost.

Advanced Technologies Equal Advanced Performance

Freescale's ColdFire MCF5407 32-bit embedded controller combines the best features of the award-winning MCF5307 with the high-performance V4 ColdFire core operating at an impressive 316 (Dhrystone 2.1) MIPS at 220 MHz. The MCF5407 features the industry-standard Harvard memory architecture, branch cache acceleration logic and limited superscalar dual-instruction issue capabilities. This combination of advanced technologies boosts the performance of this highly integrated device.

It is performance that sets the MCF5407 apart in the market. It offers the capabilities of a single pipeline at an amazingly efficient 1.4 MIPS/MHz without the additional cost of a second pipeline. With an outstanding price/performance ratio, code compatibility and a wide array of integrated peripherals, the MCF5407 helps you build maximum value into a broad range of embedded applications, such as mediaweb boxes, digital video recorders, Internet TV, set-top boxes and telecommunications cards.

A Seamless Migration Path Helps Protect Your Technology Investment

The MCF5407 provides a seamless, fully compatible upgrade path for 68K and ColdFire microprocessor users. For example, users moving from 68K to ColdFire can use code translation and emulation tools, free of charge to registered owners, to facilitate, modify and reuse 68K assembly code. The MCF5407 also leverages the development tools and software you're already familiar with so your time to market is not jeopardized.

Because ColdFire embedded controllers are 100 percent synthesizable, they are easily adaptable to new process technologies and easily integrated with memories, system modules and communications peripherals. With ColdFire, you don't have to sacrifice performance to keep system costs in line.



MCF5407 Features

- > V4 ColdFire processor core with Harvard memory architecture and branch cache acceleration logic
 - Limited superscalar design
 - Fully code-compatible with V2 and V3 ColdFire processor cores
 - Enhanced instruction set
- > 16 KB I-Cache, 8 KB D-Cache
- > 4 KB SRAM
- > Multiply-Accumulate (MAC) unit with integer and fractional capabilities
- > Industry-leading debug module offering both background and real-time capability
- > Hardware integer divide unit
- > Integrated processor
 - DRAM controller (glueless interface to SDRAM or ADAM)
 - One universal asynchronous receiver/transmitter (UART)
 - One universal synchronous/asynchronous receiver/transmitter (USART)
 - Four fully programmable direct memory access (DMA) channels
 - Eight chip selects provide external memory controller—glueless interfacing to volatile and nonvolatile memory-mapped I/O peripherals (i.e., ROM, flash, SRAM)
 - 16-bit general-purpose input/output (GPIO) pins
 - Two 16-bit timers
 - I²C module
 - System integration (Phase-Lock Loop, software watchdog)

- User-defined bus speed at 1/2, 1/3, 1/4, 1/5, 1/6 of processor clock
- > Doze mode and variable frequency operation

Product Specifications

- > 316 (Dhrystone 2.1) MIPS at 220 MHz
- > Available at 162 MHz and 220 MHz
- > 0°C to +70°C operating temperature
- > -40°C to +85°C operating temperature (162 MHz)
- > Implemented in .22 µm quad layer metal (QLM)
- > Requires a 1.8V core and 3.3V I/O power supply
- > 208-pin plastic quad flat package (QFP)
- > Pin-compatible with MCF5307

MCF5407 Development Tools

M5407C3 Evaluation Board—\$649.10*

- > 32 MB SDRAM
- > 2 MB flash
- > 10/100 BaseT Ethernet connectivity
- > Two serial ports
- > Available expansion of 1 MB SRAM for high-speed critical code or benchmarking
- > Access to ColdFire debug module

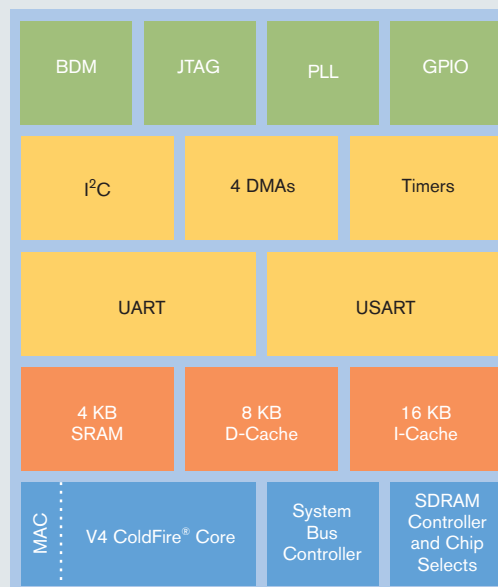
*Manufacturer Suggested Resale Price

The Road to Advanced Performance

The MCF5407 incorporates advanced technologies that allow you to build greater performance into your products and get them to market faster.

The innovative ColdFire family has been a key member of Freescale's 32-bit family of products for more than 14 years. And the ColdFire family product development roadmap helps ensure your creativity, time and resources are protected into the future.

MCF5407 BLOCK DIAGRAM



The Feature-Rich Solution That Makes Your Job Easier

The MCF5407 includes a rich array of memory and integrated peripheral features that help accelerate system design time and reduce system cost. For example, two programmable, full-duplex UARTs provide serial communications channels. Four channels of DMA enable fast data transfer using a programmable burst mode independent of processor execution. Two 16-bit multimode timers provide separate input and output signals. Other features include chip selects, interrupt control, bus arbitration, a background debug module (BDM) and an IEEE® 1149.1 JTAG module. Available in a 208-pin QFP, this device is pin-compatible with the MCF5307 and requires a 1.8-volt and 3.3-volt power supply. It's available right now, along with the recommended M5407C3 evaluation board.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF547x and MCF548x Families

Overview

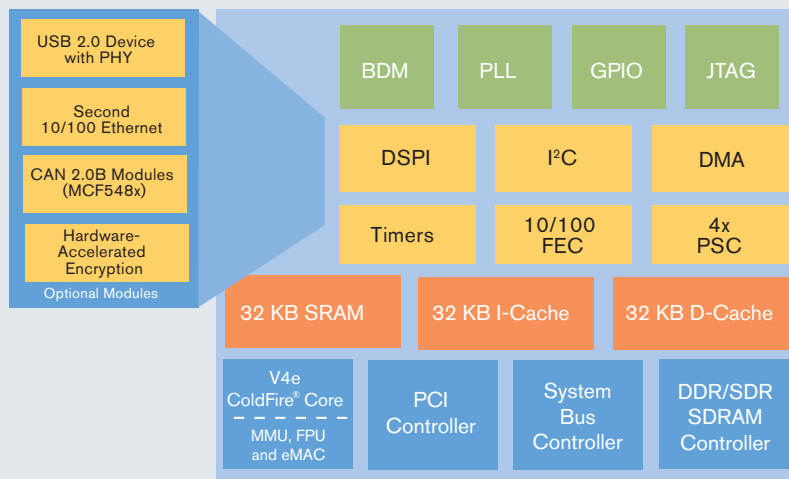
Increasingly complex embedded 32-bit applications demand higher system performance. To meet advanced performance requirements, Freescale Semiconductor designed the MCF547x and MCF548x families on the V4e ColdFire® core. The advanced V4e offers the highest level of integration of a ColdFire product to date. Features of the V4e core include the following:

- > Memory management unit (MMU) that enables process isolation for a high level of reliability and security; expanded use of protected-mode OS, such as Linux® OS
- > Floating point unit (FPU) for excellent performance levels on complex applications and algorithms
- > Enhanced Multiply-Accumulate (eMAC) unit, dual-ported processor RAMs and user-defined address permutation for DSP functionality on a microprocessor with a single, unified code stream
- > On-chip multiprocessing for improved throughput on numerically intensive algorithms as well as general-purpose control processing

Pin-Compatible Families

Pin-compatibility offers scalability and flexibility for embedded designs as needs evolve over time.

MCF547x AND MCF548x BLOCK DIAGRAM



MCF547x and MCF548x Applications

Both of these ColdFire families are well suited for network-connected control applications that require a broad range of communications peripherals and high performance to enable competitive and cost-effective system solutions. The MCF547x devices, operating at a 0°C to +70°C range, are targeted at applications such as point-of-sale systems, security systems, robotics and medical instrumentation.

The MCF548x devices, featuring two CAN modules and operating at -40°C to +85°C range, are better suited for embedded designs in factory and building automation systems, process control equipment, as well as other industrial control applications.

The combination of a performance level of up to 400+ MIPS, the DDR memory controller, and the communication peripherals onboard the MCF547x and MCF548x devices makes these families an ideal solution for flexible, connected control applications.

The addition of hardware-accelerated encryption helps to ensure that the communication enabled by these processors can be done safely and securely. Both families offer a broad range of choices for connectivity, a robust encryption solution and competitive system solution costs. These processor families also contain integrated general-purpose peripherals—including timers, I²C and DSPI—that are essential in order to function as the main control processor in an embedded system.



Part Number	Temperature Range	Features	Package	Speed
MCF5485	-40°C to +85°C	USB 2.0 device with PHY, 2 x FEC 2 x CAN, PCI, DDR, encryption	388 PBGA	200 MHz
MCF5484	-40°C to +85°C	USB 2.0 device with PHY, 2 x FEC, 2 x CAN, PCI, DDR	388 PBGA	200 MHz
MCF5483	-40°C to +85°C	USB 2.0 device with PHY, 2 x FEC 2 x CAN, PCI, DDR, encryption	388 PBGA	166 MHz
MCF5482	-40°C to +85°C	USB 2.0 device with PHY, 2 x FEC, 2 x CAN, PCI, DDR	388 PBGA	166 MHz
MCF5481	-40°C to +85°C	2 x FEC 2 x CAN, PCI, DDR, encryption	388 PBGA	166 MHz
MCF5480	-40°C to +85°C	2 x FEC, 2 x CAN, PCI, DDR	388 PBGA	166 MHz
MCF5475	0°C to +70°C	USB 2.0 device with PHY, 2 x FEC PCI, DDR, encryption	388 PBGA	266 MHz 200 MHz
MCF5474	0°C to +70°C	USB 2.0 device with PHY, 2 x FEC, PCI, DDR	388 PBGA	266 MHz 200 MHz
MCF5473	0°C to +70°C	USB 2.0 device with PHY, FEC, PCI, DDR, encryption	388 PBGA	200 MHz
MCF5472	0°C to +70°C	USB 2.0 device with PHY, FEC, PCI, DDR	388 PBGA	200 MHz
MCF5471	0°C to +70°C	2 x FEC, PCI, DDR, encryption	388 PBGA	200 MHz
MCF5470	0°C to +70°C	2 x FEC, PCI, DDR	388 PBGA	200 MHz
M5485EVB	Development System for the MCF548x Family \$850*			
M5484LITEKIT	Linux® Development Kit for the MCF548x Family \$350*			
M5475EVB	Development System for the MCF547x Family \$850*			
M5474LITEKIT	Linux Development Kit for the MCF547x Family \$350*			

*Manufacturer Suggested Resale Price

Rich Communications Peripherals Mix

The MCF547x and MCF548x families provide substantial communication functionality by integrating the following connectivity peripherals:

- > Up to two 10/100 Mbps Ethernet controllers
- > An optional USB 2.0 high-speed device (slave) module with seven endpoints and an integrated transceiver
- > Four UART/USART/IrDA/modem programmable serial controllers (PSCs)

- > 32-bit PCI interface, 33/66 MHz, five external masters
- > A DMA serial peripheral interface (DSPI)
- > An Inter-Integrated Circuit (I²C) bus controller

With on-chip support for multiple common communications interfaces, these devices require only the addition of memory and certain physical layer transceivers to be cost-effective system solutions for many applications.

Key Features

- > V4e ColdFire core with performance up to
 - 410 Dhrystone 2.1 MIPS @ 266 MHz (MCF547x)
 - 308 Dhrystone 2.1 MIPS @ 200 MHz (MCF548x)
- > 32 KB I-Cache, 32 KB D-Cache
- > MMU, FPU and eMAC
- > High level of integration
 - Up to two 10/100 Ethernet controllers
 - Optional USB 2.0 high-speed device with integrated PHY
 - 32-bit PCI interface, 33/66 MHz, five external masters
 - 32 KB on-chip SRAM
 - 16-channel direct memory access (DMA) controller
 - Four 32-bit timers, two 32-bit slice timers, one watchdog timer
 - Four programmable serial controllers (UART, USART, IrDA and modem capability)
 - Two CAN 2.0B (MCF548x)
 - Optional hardware-accelerated encryption (DES, 3DES, RC4, AES, MD5, SHA-1, RNG)
 - 32-bit 133 MHz DDR/SDR-SDRAM controller
 - 1.5V core, 2.5V DDR, 3.3V I/O

Tools Support for Fast Development

The ColdFire family is supported by an integrated development environment including our CodeWarrior™ Development Studio and our Fire Engine system-on-module development board, as well as extensive third-party support from ARC, Green Hills Software, Wind River Systems and other leading tools developers.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.



VirtuaLab Online Development Environment

Run Demos, Execute Code, Access Real Platforms

Our VirtuaLab for the ColdFire® family helps bring efficiencies and cost savings to the engineering community specifically in the concept, evaluation and decision stages of the design cycle. VirtuaLab allows technology that allows you to evaluate hardware and software tools using only your Web browser, providing you with information, training and resources to make more informed design decisions. And, it's available at no cost!**

The user accesses real development tools, not a simulation or emulation, and has LDAP protected network storage available as well as access to their local computer to upload files. Each VirtuaLab is delivered with a product tutorial or quick start script—enabling the novice looking for a step-by-step guide or the expert expecting a full featured experience.

Applications

- > Motor Control
- > Industrial Control
- > Networking
- > Security/Access Control
- > Point-of-Sale Terminals
- > Network-Attached Storage
- > Building and Factory Automation
- > Process Control Equipment

**Subject to license agreement and registration

Key Features

- > Web-based training for ColdFire embedded controllers at no cost
- > Online training environment allows you to take course at your own pace and on your own schedule
- > Access real hardware and fully-functional, pre-configured software
- > No unpacking and no installation allows you to start evaluating immediately from the comfort of your own desktop
- > VirtuaLab reservation system allows scheduling up to six months in advance

M523xEVB VirtuaLab

- > Access M523xEVB evaluation board for the MCF523x family of embedded controllers
- > M523xEVB VirtuaLab demonstrates the use of the MCF5235 enhanced Time Processing Unit (eTPU) in motor control applications
- > Webcam shows three-phase motor executing your instructions via the evaluation board
- > Includes CodeWarrior® Development Studio for ColdFire embedded controllers
- > Lab contains motor control demonstration QuickStart guide and FreeMaster Real-Time Control and Debugging Tool

M5282EVB VirtuaLab

- > Allows designers to experience the ColdFire MCF5282 microcontroller with CAN and Ethernet communication
- > Learn how to use the MCF5282 as a web server and embed your own web pages
- > Includes CodeWarrior Development Studio for ColdFire embedded controllers
- > Access embedded web server applications from ARC International, Quadros Systems and Interniche Technologies
- > View the execution of your code through a CAN analyzer, CPU meter and Dhrystone analyzer

M5485EVB VirtuaLab

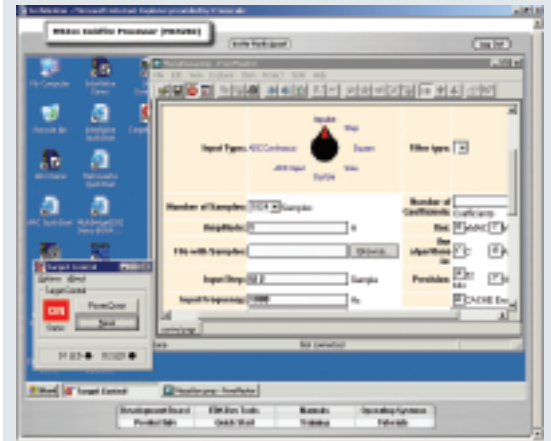
- > Test drive the M5485EVB development system featuring our Fire Engine system-on-module
- > Supports the MCF547x and MCF548x family of ColdFire embedded controllers with communication and connectivity peripherals
- > Write and debug code with a fully licensed CodeWarrior Development Studio for ColdFire
- > Write code to access Fire Engine module features such as a graphics controller
- > Access the debug ROM monitor through a serial connection



EMBEDDED CONTROLLERS SELECTOR GUIDE

VirtuaLab	Devices Supported	Device Features	Package Options	Speed
M5485EVB VirtuaLab	MCF547x MCF548x	V4e ColdFire core, USB 2.0 device with PHY, 2 x Ethernet MAC, 2 x CAN, PCI, DDR, Encryption	388 PBGA	Up to 200 MHz
M5282EVB VirtuaLab	MCF5282 MCF5281 MCF5280	V2 ColdFire core, 10/100 Ethernet MAC, enhanced CAN 2.0B controller, up to 512 KB flash, SDRAM controller, 3 x UARTS, QSPI, I ² C, QADC, 8 x 16-bit PWM	256 MAPBGA	Up to 80 MHz
M523xEVB VirtuaLab	MCF5235 MCF5234 MCF5233 MCF5232	V2 ColdFire core, enhanced TPU, 10/100 Ethernet MAC, CAN 2.0B, 3 x UARTS, QSPI, I ² C, Encryption	256 MAPBGA 196 MAPBGA 160 QFP	Up to 150 MHz

SCREEN SHOT FROM M5282EVB VIRTUALAB



DEVELOPMENT TOOLS

Part Number	Description	Pricing
M5485EVB	Development system provides essential tools required to quickly develop an embedded design with the MCF548x ColdFire family of embedded controllers. Kit contains a Fire Engine system-on-module containing 64 MB of DDR-SDRAM, 16 MB of flash memory, a graphics controller and a 4-port USB host. The Fire Engine module, with included Ethernet ports, PCI slots, CAN interfaces, serial interfaces and ColdFire debug module, provides a comprehensive development package.	\$850*
M5282EVB	Supports the evaluation of the MCF528x family and provides an excellent vehicle for embarking on high-performance embedded networking designs. With 8 MB of SDRAM, 10/100 BaseT Ethernet connectivity, and a best-in-class ColdFire debug module, this complete package includes all the components to enable quick design support.	\$650*
M523xEVB	Provides easy evaluation of the MCF523x family of ColdFire embedded controllers and facilitates hardware and software development. Enables cost-effective software testing with the use of a ROM-resident debug monitor programmed into the external flash device. Operation allows the user to load code in the onboard RAM, execute applications, set breakpoints, and display or modify registers or memory. The M523xEVB comes with a 3-phase Brushless DC Motor and daughter card for an out-of-box evaluation of the eTPU. No additional hardware or software is required for basic operation.	\$695*

*Manufacturer Suggested Resale Price

DOCUMENTATION

Freescal Document Number	Title	Description
USMCF5475548XFS	MCF547x and MCF548x Families Fact Sheet	An overview of key features and specifications. Includes typical applications and development tool support
MCF5282FACT	MCF528x Family Fact Sheet	An overview of key features and specifications. Includes typical applications and development tool support
MCF532XFS	MCF532x Family Fact Sheet	An overview of key features and specifications. Includes typical applications and development tool support

ColdFire Embedded Controllers

The ColdFire portfolio offers unparalleled integration and debugging capabilities across a wide range of performance and price options. Variable-length RISC architecture gives designers greater flexibility and exceptional code density, and efficient use of on-chip memory means designers don't have to sacrifice performance to keep system costs in line. Plus, ColdFire product development tools—compilers, assemblers, linkers, debuggers, code converters, simulators and evaluation kits—accelerate design cycles to help you get your application to market quickly. Whatever your system performance and integration requirements may be, the ColdFire portfolio has a solution to meet your needs.

Fast Track Technical Learning Center

Freescal online training offers a variety of free** resources, including courses and presentations on our products and technologies to help you get up to speed quickly and efficiently. Our product experts strive to provide the most accurate and complete information in formats that make learning convenient and effective. Freescal online development tools are full-featured evaluation boards and development software that are accessible via a standard web browser at no cost—24 hours a day, 7 days a week.

Learn More: For more information about ColdFire family products, please visit www.freescal.com/coldfire.

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Document Number: VIRTUALABODEFS

REV 0



MCF523x Robotic Control System

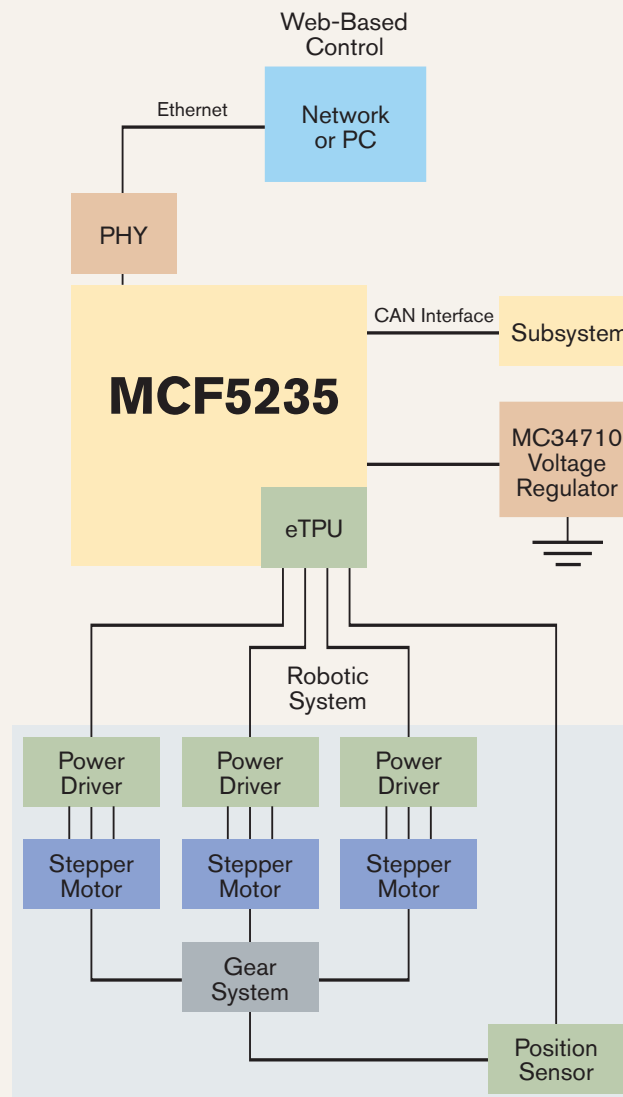
Overview

Robotic control systems are used in a wide variety of manufacturing assembly and industrial control operations, which are dedicated to performing highly repetitive tasks with a very high level of precision and accuracy.

Typical robotic control systems consist of segments that are manipulated by several individual stepper motors. These stepper motors are specifically coordinated to move in very precise increments, often using motion sensors to ensure precision movement. Robotic control systems are often connected to other subsystems, allowing for smarter control and task implementation.



MCF523x BLOCK DIAGRAM



Design Challenges

Demands on robotic control systems are increasing, requiring complex algorithms and more networked communication. Key requirements for a microprocessor in a robotic control system application center around connectivity, performance and price. The processor must maintain the precise motion control required in most robotic control applications while maintaining increasing levels of performance. The processor should be highly integrated, with the necessary connectivity and serial peripherals to enable communication with other subsystems. An integrated encryption module would enable secure communication between other systems.

Robotic control systems would also require the processor to have easy-to-program internal memory to maintain a simple and cost-effective design. Ideally, the processor would include an easy-to-program mechanism for handling complex motion control algorithms. The ability for the processor to handle complex timing and motion control is critical to the overall robotic system performance.

Key Features

- > V2 ColdFire core
- > Up to 144 MIPS (Dhrystone 2.1) at 150 MHz
- > eTPU
- > Connectivity options
 - Integrated CAN 2.0 device
 - Optional 10/100 Ethernet MAC
 - I²C module
 - Queued serial peripheral interface (QSPI)
 - Three universal asynchronous receiver/transmitters (UARTs)
- > 8 KB of configurable I-/D-Cache
- > 64 KB of internal SRAM
- > Dual-bank SDRAM controller
- > MAPBGA and QFP packages

Freescale Solution

The MCF523x family of microcontrollers provides the essential performance, integration and motion control requirements for robotic control applications. The Version 2 ColdFire® core on the MCF523x devices offers up to 144 MIPS at 150 MHz and has an enhanced MAC unit for DSP functions. The on-chip 64 KB SRAM can be used to store data and critical function routines, allowing for a more efficient system. The embedded connectivity peripherals, such as Fast Ethernet and CAN, combined with the on-chip hardware accelerated

encryption module, allow for secure connectivity to subsystems and other robotic control systems.

The MCF523x devices also feature the enhanced Time Processing Unit (eTPU), a programmable I/O controller with its own core and memory system dedicated to performing serial communication, advanced timing and complex motion control algorithms. With the eTPU dedicated to handling most of the motion control in the system, the MCU is able to handle other tasks, allowing for an increase in overall system performance.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF5249

Biometrics Security

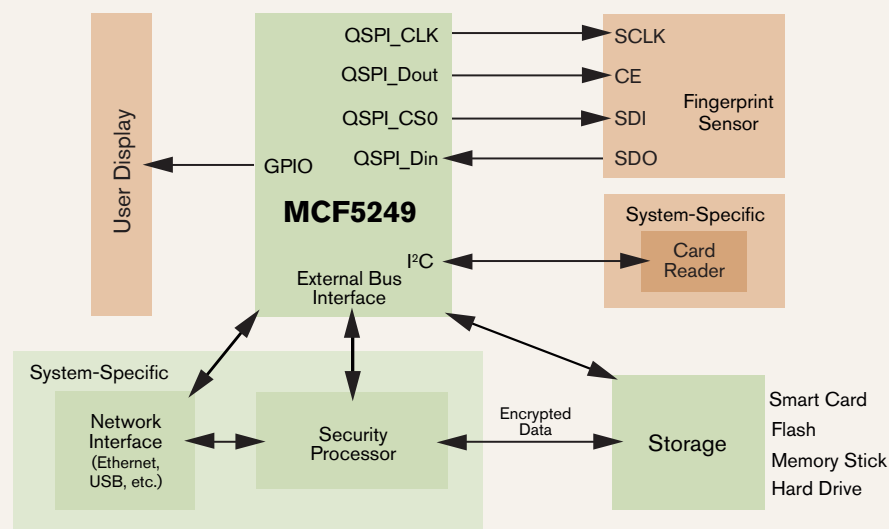
Overview

Biometric technologies automate the process of using a physiological or behavioral characteristic to prove someone's identity. The chance of two people—even identical twins—having the same fingerprint is less than one in a billion. Fingerprint comparison is the most widely used method of biometric authentication—and the most cost-effective.

Fingerprint recognition compares a user's fingerprint to a previously stored template and determines validity or authenticity based on this comparison. The template is created from tiny points called minutiae—based on the position of end points and junctions of print ridges—extracted from the fingerprint during enrollment, and comparison of attributes are carried out using complex algorithms during verification.

Total biometric revenues, including law enforcement and large-scale public sector usages, have grown rapidly, reaching an estimated one billion dollars in 2005. Much of this growth is attributable to PC/network access and e-commerce, although large-scale public sector deployments, such as airports, military installations and other secure facilities, continue to be an essential part of the industry. Biometrics has moved from unconventional specific technological applications to more mainstream applications.

MCF5249 BLOCK DIAGRAM



Design Challenges

Corporations and institutions considering biometric deployments must investigate a range of questions including costs, compatibility, scalability and user acceptance.

Using fingerprint biometrics can result in many variations in system design, ranging from the basic, stand-alone verification system used for restricted access areas, to the multi-unit networked system with a central hub and many remote scanning units, such as in an airport setting. The stand-alone system would consist of the fingerprint sensor, a microprocessor running the algorithms, a user interface and flash memory for the template storage.

An ATM-style system would incorporate a card reader, with the smart card becoming the storage for the fingerprint template. The networked remote scanning system would add a network interface such as USB or Ethernet to provide communication from the scanner to the central hub. A security device could be used by all these systems to encrypt the data before transmission or storage, allowing increased security levels. The challenge is to ensure that the basic solution is versatile enough to be incorporated into the more complex systems as well, with minimal modifications for enhancements.



Freescal Solution

The MCF5249 ColdFire device interfaces directly to the fingerprint sensor using the integrated queued serial peripheral interface (QSPI) module. Once the fingerprint scan is complete, the data is transferred from the sensor to the MCF5249 over the serial peripheral interface (SPI), before the algorithms are executed. The 96 KB of internal SRAM allows increased performance by running the algorithms in the internal memory, while the enhanced Multiply-Accumulate (eMAC) unit enables the algorithms to be executed efficiently and quickly. The MCF5249 supports external

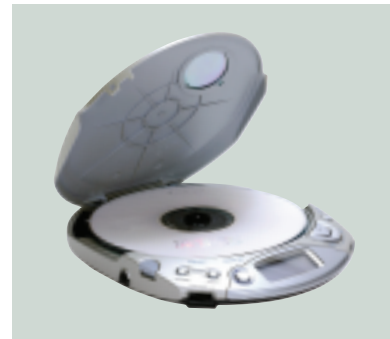
SDRAM and flash memory modules through a glueless interface. The flash memory is used to store the fingerprint templates after enrollment and is accessed for template retrieval during verification. The low power consumption of the MCF5249 allows it to fit into power-critical fields such as in battery-powered applications and does not significantly add to the battery drain of the product. The user display is based around an LCD panel. The general-purpose input/output (GPIO) available on the MCF5249 is used to control the generation of messages on the LCD. The display will inform the user that enrollment is complete as well as display a

verified fingerprint message and a rejected fingerprint message subsequent to enrollment. The I²C module on the MCF5249 provides a glueless interface to the card reader in an ATM-style system. This allows quick template retrieval from the smart card and reduces user delay. If enhanced data security is required, then a security processor can be attached via the bus interface providing data encryption for storage or transmission purposes. The network interface, i.e., Ethernet or USB, is also attached to the bus interfaces allowing communication between the remote unit and the central hub when this is required.

Learn More: For more information about ColdFire family products, please visit www.freescal.com/coldfire.

MCF5249

Portable Internet Audio Products



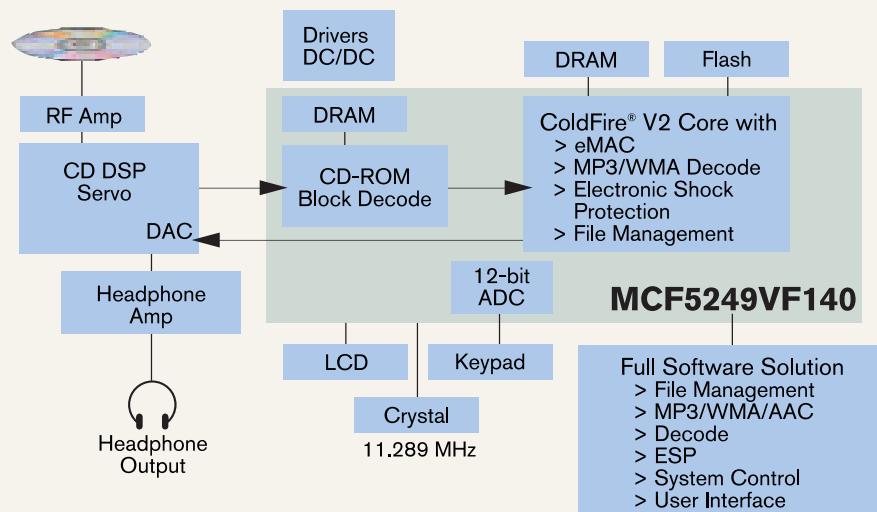
Overview

The portable Internet audio market has exploded with a wide range of products and formats. These products create a whole host of opportunities for consumers and challenges for designers. Freescale Semiconductor's comprehensive hardware and system solutions are engineered to help reduce overall system cost and speed time-to-market. The portable Internet audio devices vary widely depending on the storage format. The availability of recordable CD drives at consumer price points is giving a new lease on life for the compact disc format. The relatively low cost and high storage capacity of blank CD media, together with its compatibility with existing playback systems in use all over the world, may make the CD the ultimate MP3 music medium. A single read/write-able (R/W) CD typically costs less than US\$1 and can hold more than 10 hours of music in MP3 form. Compressed audio is written onto CDs as a file on a CD-ROM, so MP3 CD players must be able to read CD-R/W discs, perform CD-ROM decode and file management and decode MP3, Windows Media Audio (WMA), AAC and any new formats that are derived.

Design Challenges

Standard compact disc (CD-DA) and compressed audio (MP3, WMA, etc.) playback digital audio systems share the requirement for significant amounts of control processing as well as digital audio signal processing. Control processing includes file management, data

MCF5249 BLOCK DIAGRAM



buffering, system control and user interface control, while the MP3 decode algorithm itself involves approximately 50 percent control-type functions and approximately 50 percent signal processing. Other signal processing tasks include audio effects processing (e.g., dynamic bass boost) and digital volume control. Typically these systems use separate digital signal processor (DSP) and microcontroller devices to perform the signal processing and control tasks. Clearly a more efficient, cost-effective solution would be to implement both tasks on a single microprocessor. In addition, due to the portable nature of these devices, power consumption is a major issue. All devices

in the solution must have very low power consumption in order to maximize the battery life of the audio playback device. Finally, multimedia formats and products are evolving very quickly. Different digital audio formats are being used in different regions of the world and in different products. For example, while MP3 (MPEG-1 Audio, Layer 3) is the audio standard of the Internet, MPEG-4 AAC (MP4) and WMA are also growing in popularity. Due to these ever-changing formats, an ideal solution could be upgraded in the field.



Freescal Solution

Freescal's ColdFire 32-bit embedded controllers are designed to provide a compact engine for control code processing with its variable-length RISC architecture; with the addition of the enhanced Multiply-Accumulate (eMAC) unit, ColdFire also offers powerful digital signal processing ability.

With its 32-bit data paths and 48-bit accumulators, the ColdFire architecture with eMAC is capable of extremely efficient processing of certain audio algorithms.

For example, the MP3 decoder running on the MCF5249 has been tested as having 18 bits* of accuracy compared to the ISO floating point standard implementation, equivalent to a signal-to-noise ratio of 108 dB*. In addition, the MP3 decoder requires just 19 MHz* of CPU bandwidth on this device.

The MCF5249 has been designed with advanced ColdFire audio peripherals which include I²S-compatible serial ports and an IEC958/SPDIF transceiver. The on-chip

time-division multiplexing (TDM) bus is designed to allow signals to be routed easily between the peripherals and the CPU. Because external audio interface devices are not required, these audio peripherals help provide lower system costs. In addition, standard audio software modules, such as MP3 and WMA decoders, are available for customers with the proper licensing for a small fee.

*These numbers are for worst case data and assume single-cycle memory accesses.

Learn More: For more information about ColdFire family products, please visit www.freescal.com/coldfire.

MCF5272

Cost-Effective Virtual Private Network (VPN) Router

Overview

A VPN router securely connects a group of two or more computer systems to a private local area network (LAN) that communicates over the Internet. To ensure network privacy and data integrity, the router should support user authentication mechanisms, data encryption/decryption and firewall technologies. A VPN router may be used as a cost-effective network router for small office/home office (SOHO) applications, providing a gateway and firewall for dial-up, cable or asymmetrical digital subscriber line (ADSL) Internet connections.

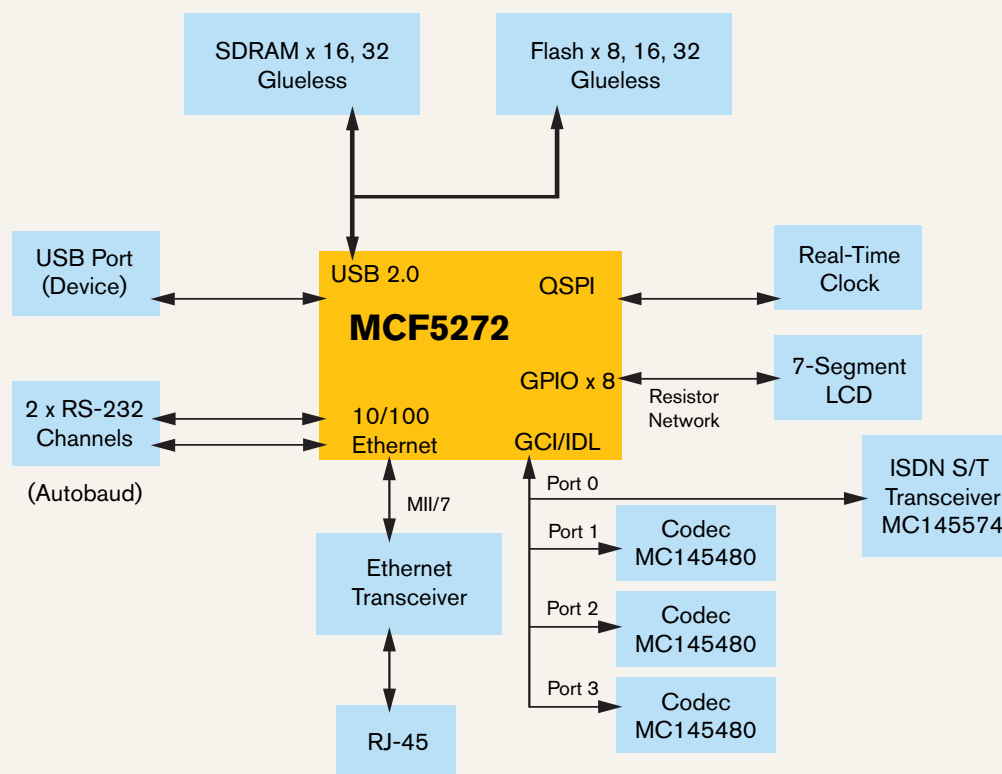


Design Challenges

Embedded network devices not only perform their own specific control functions; they also need to perform additional control functions by interacting over a network. Devices connected to the network, particularly the Internet, take on a range of functionality. For example, they should be capable of handling standard

protocols, such as TCP/IP and its associated application set, in addition to handling authorization and access issues. In the design of a network, systems must adhere to a set of protocols for addressing, identifying hosts, routing, establishing connections and contention on the network, and sending data.

MCF5272 BLOCK DIAGRAM



Freescal Solution

Freescal Semiconductor's family of ColdFire® embedded controllers provides an ideal networking solution. The MCF5272 embedded controller, based on a Version 2 (V2) ColdFire core, is designed with integrated peripherals widely used in communications applications.

The design is centered around the ability of the MCF5272 to handle 100 Base-T Ethernet, 12 Mbps Universal Serial Bus (USB), an Integrated Services Digital Network (ISDN) transceiver, three codec channels and

two serial ports, while leaving more than 50 percent of the CPU bandwidth to run user applications such as router software. In addition to using the communications interfaces on the MCF5272, general-purpose input/output (GPIO) is used to drive a seven-segment LCD display. The queued serial peripheral interface (QSPI) module is used to interface to a real-time clock to provide time stamping on the data as it is routed. Incoming serial data tends to vary in terms of data rate. The RS-232 channels are designed to lock to this data and to automatically track

and respond at the incoming data rate. HDLC firmware is provided in the on-chip ROM of the MCF5272. The user can use the HDLC protocol for virtually any of the communication channels in the router—particularly the codec and ISDN interfaces. The Ethernet Media Access Controller (MAC) designed into the MCF5272 requires an external transceiver and magnetics to provide 10 or 100 Base-T operation via the MII interface.

Learn More: For more information about ColdFire family products, please visit www.freescal.com/coldfire.

MCF5275

Local Medical Monitoring Gateway

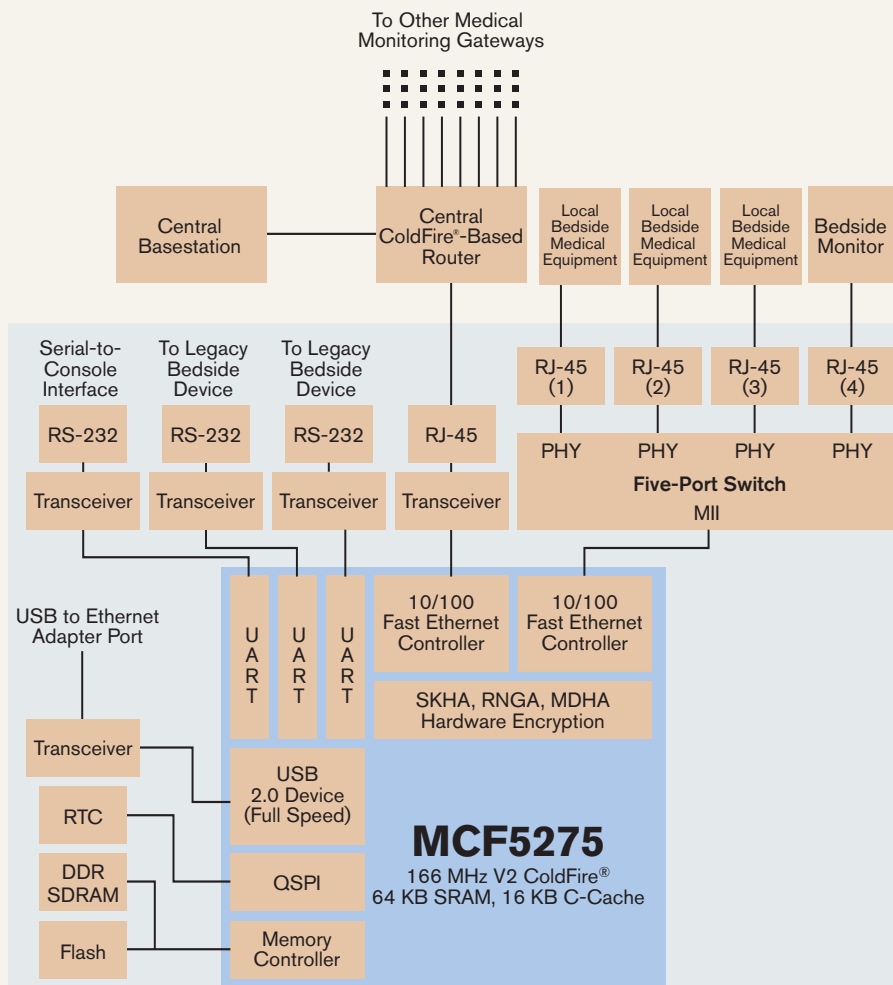
Overview

Medical personnel today have a wider variety of patient information sources than ever before, yet the volume of information can be an impediment if the data is not interconnected, analyzed, recorded and responded to—especially in the event of an emergency. Thus, a system becomes necessary to allow medical personnel to monitor and interface local frontier-connected equipment both locally and from a central basestation.

In this example, local bedside health care-related equipment, such as respirators, heart monitors and medicine dosage controllers, from several hospital rooms can be securely and remotely monitored by a central basestation. This is made possible by connecting the local bedside medical equipment to an MCF5275 ColdFire® controller-based local medical monitoring gateway via Ethernet or, in the case of a legacy medical device that is not equipped with Ethernet, via a serial RS-232 port. The gateway in each room is wired to a central router, which is connected to the central basestation.



MCF5275 BLOCK DIAGRAM



Design Challenges

An embedded controller for a medical gateway application must offer connectivity, security and product lifetime longevity. The MCF5275 family integrates dual Ethernet, USB, universal asynchronous receiver/transmitters (UARTs), DDR SDRAM memory control and hardware encryption into one cost-effective chip, thus streamlining design and reducing component count costs and space.

Due to the sensitive nature of the data in transit, this solution must help ensure that data cannot be accessed inappropriately. Hardware encryption onboard the MCF5275 device helps provide secure transmission of sensitive personal information over a potentially exposed network. The MCF5275 embedded controller in the gateway encrypts the data received from the bedside equipment before the data is transmitted by Ethernet to the central basestation, where the data is decrypted and interpreted.

In addition to the ability to monitor bedside medical equipment in a given room from the remote central basestation, medical personnel need access to the same data while in the patient's room. This has customarily been accomplished with a bedside monitor. Alternatively, a 12 Mbps USB device on the MCF5275 embedded controller allows the possibility of a doctor or attendant accessing the system through the gateway's USB-to-Ethernet adapter port. A doctor could use a PDA with a USB On-The-Go (OTG) port, keeping track of patients' conditions at every visit.

Furthermore, Freescale develops the ColdFire family with commitment to long-term availability and continued innovation. The ColdFire Family's focus on the industrial market helps ensure your product will have the support it needs throughout its lifetime.

Freescale Solution

While the lower-end industrial connectivity and networking market space requires solutions with the system performance and integration benefits of a 32-bit microprocessor, it also brings more power and cost constraints. To meet these needs, Freescale expands the MCF527x family of microprocessors with an array of devices that combine high integration and cost-effective options.

This impressive combination of connection, protection and peripheral

selection makes the MCF527x family ideal for power-conscious, cost-sensitive applications requiring significant control processing for file management, connectivity, data buffering, user interface and signal processing. MCF527x target applications include remote monitoring, data security, voice-over-Internet Protocol (VoIP) phones, health care-related instrumentation, gaming equipment, Ethernet switches, server appliances, point-of-sale printers and home routers.

Key Features

- > Version 2 ColdFire core
- > Up to 159 MIPS (Dhrystone 2.1) at 166 MHz
- > Low-power, high-performance 0.13μ technology
- > Connectivity options
 - Up to two 10/100 Fast Ethernet controllers
 - USB
 - Queued serial peripheral interface (QSPI)
 - I²C
 - Three UARTs
- > Hardware encryption capability
- > Enhanced Multiply-Accumulate (eMAC)
- > 64 KB SRAM
- > Up to 16 KB configurable cache
- > DDR SDRAM memory controller
- > MAPBGA and QFP packages
- > 10K suggested resale prices starting at US\$7.75

Support

With every MCF5274/75 embedded controller, users can benefit from extensive support by a world-class development tools suite from Freescale, ARC, Green Hills Software, Wind River and other leading tool developers.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF5282

HVAC and Security Control Panel

Overview

A heating, ventilation and air conditioning (HVAC) and security control panel is the central control hub of the home's heating and cooling functions and home security functions. With it, users can remotely control the temperature, furnace, compressor and air duct valves using ZigBee™ technology based on the IEEE® 802.15.4 standard, which is a low-data-rate, low-complexity solution with multimonth to multiyear battery life ideal for applications such as sensors, interactive toys, smart badges, remote controls, home automation and portable electronics.

Security enhancing features such as window and door sensors, motion sensors and keycode verification are handled by processing simple wireless packets or simple communication with the keypad that is mounted in the home. The remote sensors are efficiently managed through ZigBee wireless communication optimized for low power, short distance control and remote monitoring networking applications, which require infrequent, low-rate and small packet data. The Ethernet connection enables Web-based local and

remote control. The analog-to-digital converter (ADC) provides interfaces to analog components used to control the home environment.

The HVAC security control system conveniently brings remote manipulation and wireless communication into the hands of the resident with the flexible ability to network and control various elements in the home—while at home or away.

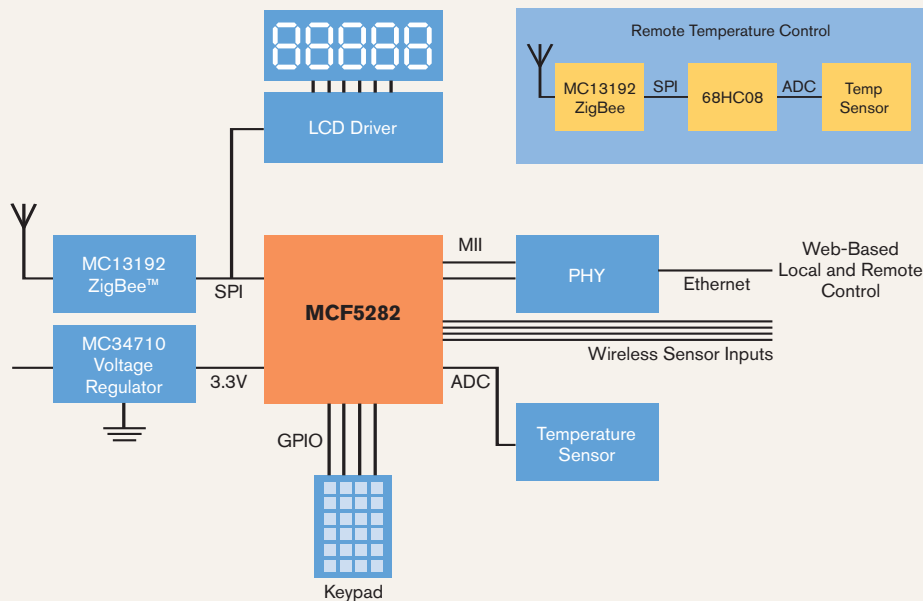
Design Challenges

Microcontrollers that enable an HVAC and security control panel require connectivity and integration. They require a means to interface to wireless nodes within the home such as an LCD display, keypads and sensors. In order to capitalize on the controllability of the wireless network, the interface to Ethernet enables remote monitoring and control.

Because the HVAC and security control panel is always powered and expected to run for years, it is necessary to use low-power devices with low standby current.



MCF5282 BLOCK DIAGRAM



Key Benefits

- > On-chip peripherals on the MCF5282 device are engineered to allow straightforward implementation of an HVAC and/or security system including the ability to remotely access the components of the network using the TCP/IP protocol over wired 10/100 Ethernet or IEEE 802.11 wireless local area networks (LANs).
- > Large securable flash memory integrated on the MCF5282 provides a means to use and update any necessary firmware for the initialization and control of the home network.
- > Connectivity such as a controller area network (CAN) and even numerous general-purpose input/outputs (GPIOs) enable interfaces to various hardware devices.

Freescal Solution

The MCF5282 offers a highly integrated solution for an HVAC and security control system. The 512 KB of onboard securable Flash provides a system solution that enables firmware for initialization and control of the connected devices. The 10/100 Ethernet Media Access Controller (MAC) offers the ability to serve up Web pages and enables local and remote control of this system. The ADC provides the interface to local temperature sensors.

The 64 KB of onboard SRAM and the enhanced Multiply-Accumulate (eMAC) offer the option of running algorithms used by the security system as well as other computation-intensive tasks. The MCF5282 includes the integration required for the HVAC and security system central controller.

Learn More: For more information about ColdFire family products, please visit www.freescal.com/coldfire.

MCF5307

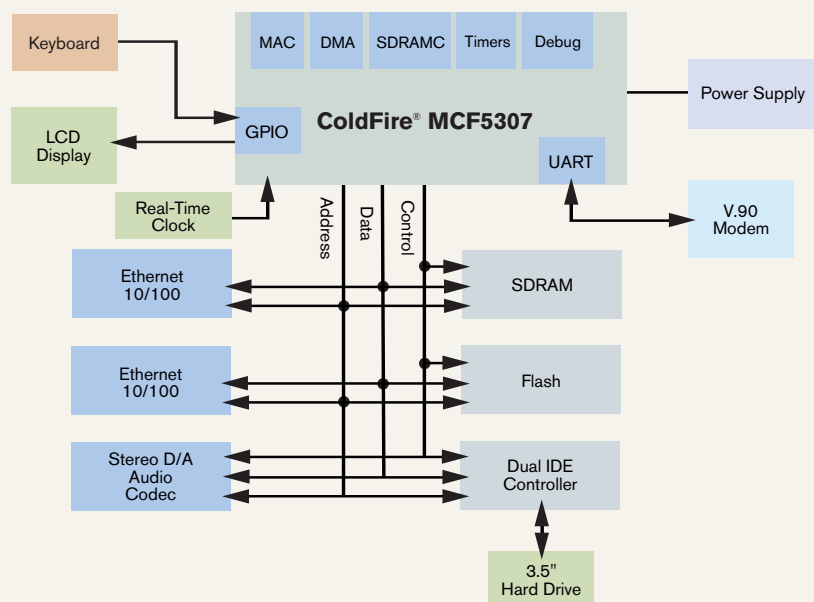
Music Media Player

Overview

SnapGear Inc. supplies a platform for the next-generation Business Music Media Player (BMMP) from MP3.com. The BMMP is a hardware component responsible for the delivery of playlists scheduled through the Music Manager software application. The BMMP essentially acts as a virtual jukebox where music schedules are downloaded and stored. The server's plug-and-play design requires minimal installation time and little to no maintenance. MP3.com provides the necessary technical support to ensure that the player is set up properly and functions smoothly.



MCF5307 BLOCK DIAGRAM



Design Challenges

The design challenge was to create a platform to handle the complex integration of hardware and software while maintaining a reduced bill of materials. SnapGear's SecureEdge Internet appliance platform, which runs SnapGear's implementation of the μ Clinux operating system, is a version of a Linux[®] operating system for processors without memory management units (MMUs). This application needed a microprocessor that had a low price, as well as the performance, integration and debugging

capabilities that meet the consumer's end requirements along with speeding time to market. Freescale Semiconductor's ColdFire® MCF5307 embedded controller met all of these challenges. The BMMP generates two channels of monaural sound which are fed to an external amplifier, thereby supporting two independent music zones simultaneously, including the possibility of providing background audio for a business phone system while customers are on hold.



Freescale Solution

Freescale offers an ideal embedded architecture for this application—the ColdFire embedded controller family. In particular, the MCF5307 ColdFire microprocessor has a version 3 (V3) ColdFire core along with the following peripherals:

- > 4 KB SRAM, Multiply-Accumulate (MAC) unit and divide unit, 8 KB unified cache
- > Four-channel direct memory access (DMA) controller, DRAM controller; supports SDRAM, EDO and page mode DRAM

- > Two universal synchronous/asynchronous receiver/transmitters (USARTs), dual 16-bit general-purpose multimode timers, Philips Semiconductor I²C-compatible bus, system interface
- > System debug support, clock-multiplied Phase-Lock Loop (PLL), 16-bit general-purpose parallel I/O port
- > 70 MIPS at 90 MHz; available at 66 and 90 MHz

Key Features

- > The 20 GB hard drive is designed to hold up to 10,000 songs; MP3 tracks used by

MP3.com are typically MONO @ 64 kbps, resulting in 2 MB per track or 10,000 tracks in 20 GB

- > “Dual zone” capability is designed to allow for two channels of audio to be delivered to customer locations
- > Plug-and-play simplicity requires little to no maintenance at the retail store level
- > Applications such as music-on-hold and message-on-hold features are designed to provide additional messaging opportunities and are alternate applications for the BMMP

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF532x

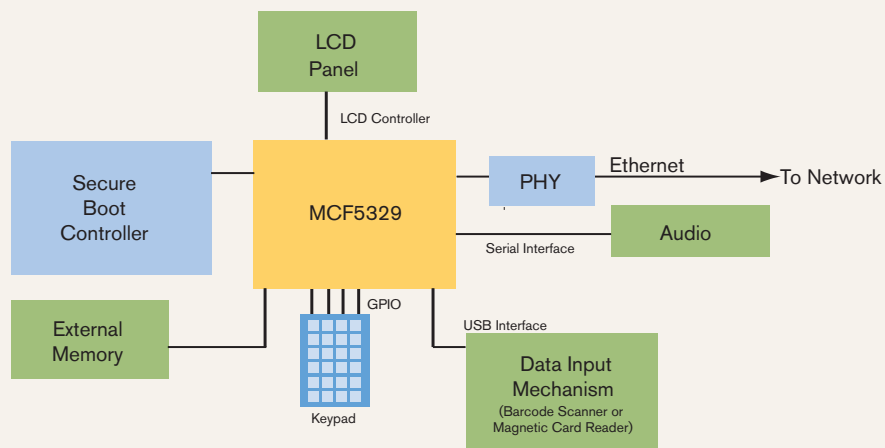
Point-of-Sale Terminal

Overview

Original point-of-sale (POS) terminals were first considered to be electronic replacements for mechanical cash registers. Today, however, POS terminals are taking on expanded functionality and flexibility, making management of global operations faster and more accurate with increased efficiency. POS terminals are becoming a standard in the commercial industry and are growing in popularity as the trends in networked communications increase over time. In addition to processing credit card transactions, POS terminals have the ability to track customer orders and connect to other systems to manage inventory. More and more POS terminals are connecting to global networks, enabling secure communication with financial institutions around the world. Future POS terminals must not only maintain fast and secure communication, but must also accommodate the high-performance needs of a flexible and multifunctional system.



POS TERMINAL





Freescale Solution

The ColdFire® MCF5329 embedded controller offers a full solution for POS applications. A performance speed of up to 240 MHz enables the processor to handle the increased level of data transmission typically required in POS applications without compromising the overall system performance.

The MCF5329 is the first 68K/ColdFire device to integrate an LCD controller for on-chip support of display interfaces for POS terminals. The processor is equipped with an integrated Fast Ethernet controller along with a hardware

encryption module to ensure the secure transmission of data. The MCF5329 processor also features an integrated synchronous serial interface (SSI) to support on-chip audio functionality. The integrated USB host and USB On-The-Go modules provide support for a number of POS input devices such as bar code scanners and smart card readers.

Design Challenges

Integration and performance are among the key criteria that designers should consider when selecting a processor to design POS applications. The processor must be capable of handling the secure transmission of data over a network while simultaneously maintaining a high level of system performance for the user interface. Equally important is a high level of peripheral integration to support the varying methods of conducting financial transactions.

On-Chip Features

- > High-performance v3 ColdFire Core offering up to 211 MIPS and 240 MHz of performance
- > LCD controller for graphical user interface
- > Fast Ethernet controller and hardware encryption unit for secure transmission of data
- > USB host and On-The-Go modules to support a variety of data input mechanisms
- > SSI to enable support for audio functionality or interface with data codecs

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF5407

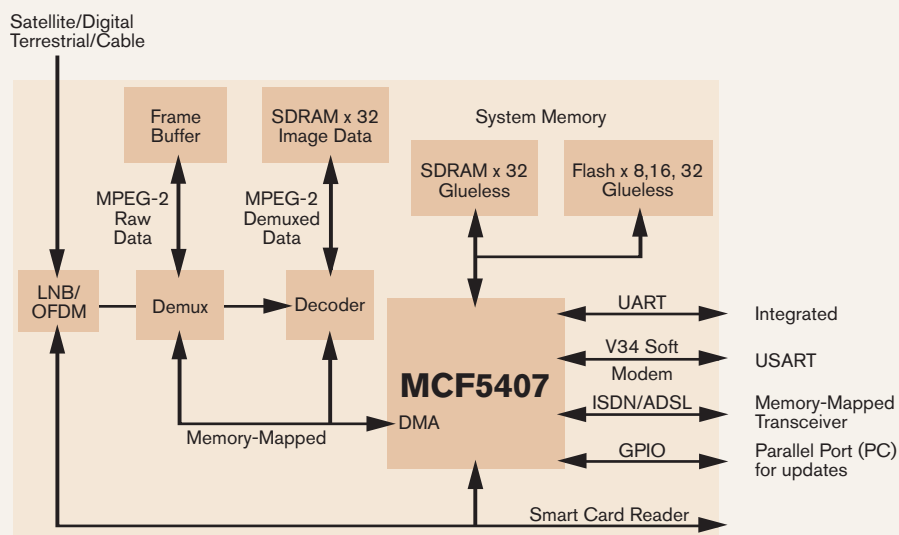
Digital Set-Top Box

Overview

The function of a digital set-top box (DSTB) is to decode an MPEG-2 video/audio stream. This stream can be transmitted either by satellite or terrestrial broadcast. For each transmission method, only the circuitry required to demodulate the incoming signal is different. More recently, there has been a revolution in home entertainment and personal communication. Internet access and e-mail are now consumer products delivered via set-top boxes in the home. To deliver this functionality, DSTBs run Web browsing and e-mail client software. Consequently, additional processing capability within the DSTB is necessary to handle both the MPEG-2 content and an embedded operating system.



MCF5407 BLOCK DIAGRAM



Design Challenges

In the race for service providers to offer greater functionality, the latest DSTBs must be able to interface to hard disk drives or DVD R/W units. And to provide the latest technology, the DSTB must also be capable of field upgrades. To this end, the communication channel must be capable of supporting at least V90 data rates. Future developments in the set-top box market will integrate xDSL as a part of the basic function. The challenge for designers is to ensure that MPEG decoding is never compromised.

To prevent bottlenecks from disrupting the data stream, multiple processor platforms are required. A dedicated processor decodes the MPEG-2 stream and handles the interface to storage devices. A second processor runs an embedded operating system enabling user interaction in the form of channel selection, e-mail, Web browsing and communications.



Freescale Solution

This multiple processor platform requires a separate CPU and MPEG-2 demux/decoder combination. In many of the high-performance DSTB designs, the CPU + demux/decoder functionality is integrated on one device. This integration limits the amount of bandwidth available on the shared address/data buses and reduces the scope for additional functionality. With its bus arbitration and built-in direct memory access (DMA) functionality, Freescale's MCF5407 ColdFire

embedded controller is engineered to be used with the MPEG-2 decoder to allow block transfers of decoded image data to the rest of the system. The integrated I²C module on the MCF5407 connects to the low-noise block (LNB) demodulator to help with control of the tuner front-end and also connects to the smart card reader in the set-top box.

Soft modem functionality helps save manufacturing costs by eliminating the need for a memory-mapped data pump.

The modem interface consists of a codec/DAA combination with the data pump software and protocol stacks running in software on the MCF5407. General-purpose input/outputs (GPIOs) can be used to drive a simple seven-segment front-panel LCD display. The ISDN/ADSL interface would require a memory-mapped ISDN/ADSL controller. The SDRAM and flash interfaces are glueless with the exception of series termination on the control signals.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF547x

Automated Gas Pumping Station and Automatic Teller Machine (ATM)

Overview

Gasoline pumps have become information appliances. In addition to allowing customers to fuel their cars and pay for gasoline at the pump, gasoline pumps now offer merchandising opportunities for the station owners and function as Web-based information portals. Competitive pressures are requiring stations to monitor and control their gas pumps remotely, instead of having personnel on-site. Pumps now contain touch screens or LCD displays with keypads, and they also feature speakers, barcode scanners, radio frequency identification (RFID) systems, cash acceptors and receipt-printing equipment.



Key Benefits

- > The MCF547x processor family delivers comprehensive, high-level control for a next-generation automated gas pump/ATM with a single device.
- > There is significant design flexibility offered by the multiple communications interfaces featured on the MCF547x devices.
- > The optional encryption accelerator within the MCF547x devices allows financial information and customer-specific marketing data to be collected with enhanced security and distributed via any personal area network (PAN), local area network (LAN) or wide area network (WAN) interface, without significantly degrading system performance.

Design Challenges

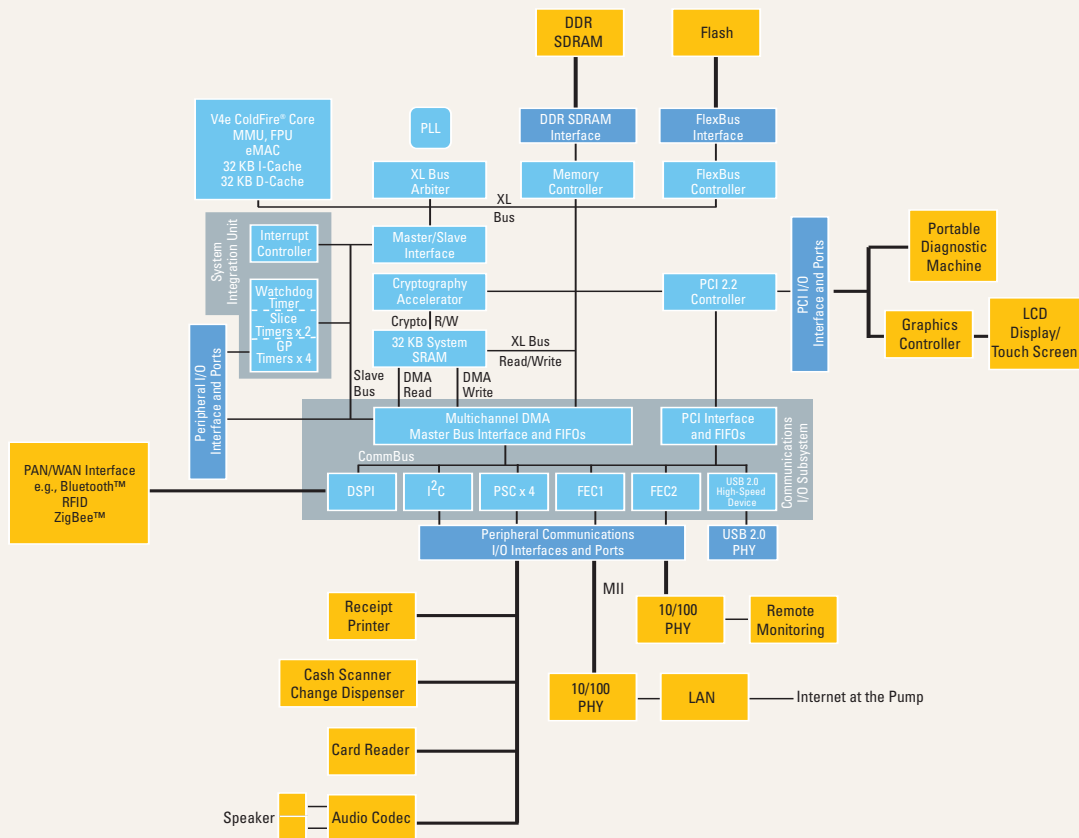
A typical gas pump/ATM has several I/O systems, including card readers, cash-collection equipment, barcode scanners, speakers, pump electronics and a touch-screen interface. A control chip for this application requires many connectivity interfaces to control the system without having to add significant amounts of external logic.

A number of different network connections are required. First, a LAN is typically offered for remotely monitoring the pump, printer paper and cash-acceptor levels; collecting diagnostic information; and

performing system software upgrades.

It is also useful to have a separate LAN interface to connect the fueling station to the Internet and to allow direct Web interaction with the customer. Many next-generation pumps include a WAN or PAN interface to collect user payment information or to communicate directly between the pump and the vehicle. Because financial and personal data may be collected at the pump, it is essential that this information be transmitted securely without slowing the transaction.

MCF547x BLOCK DIAGRAM



Freescal Semiconductor Solution

Freescale's MCF547x ColdFire® family is well suited to be the main control processor in next-generation information appliances, including automated gas fueling stations. The on-chip PCI interface offers straightforward control of LCD and touch-screen systems, and enables the use of different screen sizes and technologies. The wide range of connectivity peripherals on the MCF547x device—including four programmable serial controllers, two 10/100 Ethernet interfaces and the direct memory access—serial peripheral interface (DMA-SPI)—allows

design flexibility. Multiple 10/100 Ethernet connections mean the gas pump can easily separate remote monitoring and diagnostic information gathering from the customer Web interface, and the DMA-SPI can interface with next-generation WAN and PAN technologies such as RFID and ZigBee™ protocol devices, as well as devices enabled by Bluetooth™ wireless technology. The hardware-accelerated encryption of the MCF547x devices allows customer transactions to be quickly and securely stored and transmitted via any of the communications peripherals in the system.

ColdFire Embedded Controllers

Freescale offers user's manuals, product briefs and application notes for its ColdFire embedded controllers. In addition, local support is also provided for these products.

Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

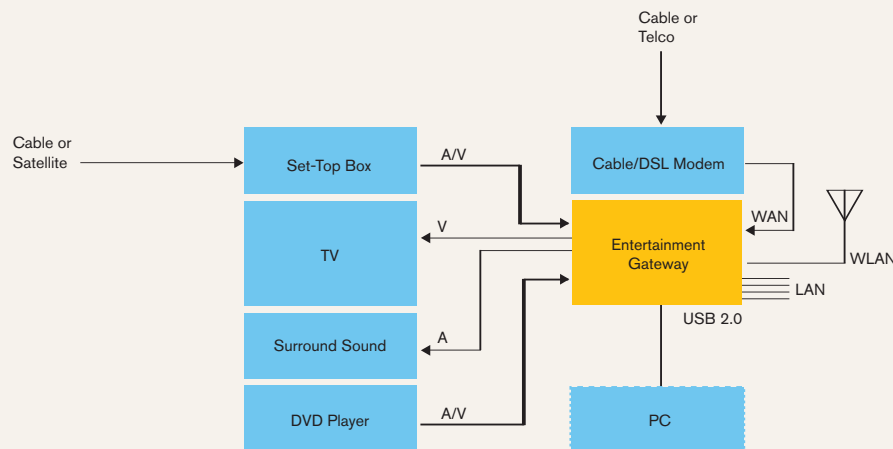
MCF547x

Home Entertainment Gateway

Overview

A home entertainment gateway is a communication and storage hub in the home that functions as a secure audio, video and file server; wireless router and firewall; and a personal video recorder. With it, consumers can listen to stored music or live Internet radio; watch live, stored or on DVD video; and access/store documents wirelessly. They can also record broadcast video and play it back on multiple TVs at different times. In addition, an optional DVD writer allows consumers to record or transfer to a DVD+/-R/W for mastering a disk to archive or distribute home movies to family and friends. They can even transfer digital video from a camcorder to a hard disk or DVD using an IEEE® 1394 link.

In addition to a typical wireless router implementation, the recording function involves decoding/digitizing/compressing video and audio inputs, and then transferring the audio and video data to a hard drive. Audio or video playback functions in reverse and can happen simultaneously with the recording function. The hard drive also serves as a network-attached storage (NAS) device and a USB 2.0 storage device.



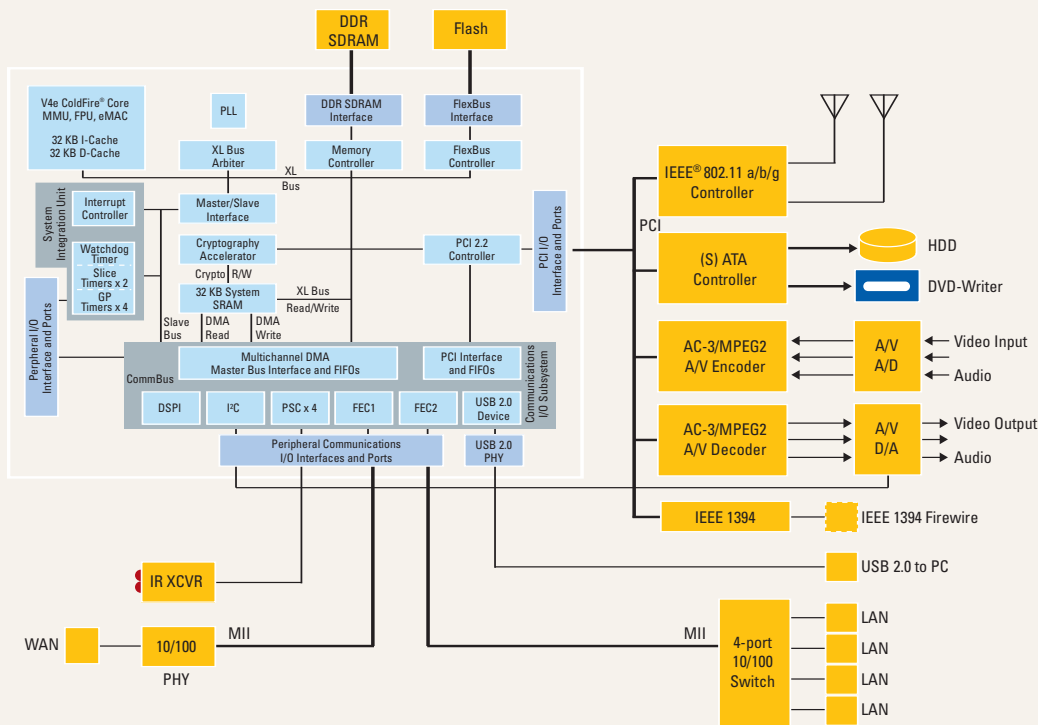
Key Benefits

- > A wide range of home entertainment gateway products can be developed based on the same core design using the MCF547x devices with different PCI peripherals.
- > The MCF547x device's system architecture enables high data throughput for communications-intensive peripherals included in a gateway application.
- > Hardware-accelerated encryption within the MCF547x devices helps to ensure secure transmission of data through the gateway.

Design Challenges

The key requirements of a microprocessor for the home entertainment gateway application are connectivity and price/performance. Processors for this application require dual Fast Ethernet interfaces for routing; a USB 2.0 device controller; and a PCI bridge to interface to the IEEE 802.11 a/b/g radios, (serial) ATA storage controller, MPEG-2/AC3 video/audio processor and optional IEEE 1394 controller. In addition, they require an I²C bus for controlling the video

MCF547x BLOCK DIAGRAM



components and an infrared-capable serial port for IR remote control. The processor must have sufficient performance and memory bandwidth to handle simultaneous A/V recording and playback, routing and file serving. A crypto engine is also required in order to accelerate encryption for the wireless link and to encrypt files stored on the hard disk.

Because the home entertainment gateway application is an embedded, always-on device that requires a reliable real-time operating system (RTOS) or Linux® operating system, full memory management capability is an asset.

Freemscale Semiconductor Solution

The MCF547x family provides the essential connectivity requirements for a home

entertainment gateway. It features a V4e ColdFire® core with large dual 32 KB caches that deliver 410 MIPS (Dhrystone 2.1) of performance at 266 MHz. The memory management unit (MMU) allows a full protected-mode OS, such as standard Linux OS, to be used. The 32-bit wide DDR SDRAM controller provides high-memory bandwidth for A/V, storage and network data. The on-chip 32 KB SRAM can be used to store critical routines and data, in addition to keys and initialization vectors for the on-chip crypto engine.

The serial peripherals (dual Fast Ethernet, USB 2.0 device, I²C and four programmable serial ports) are supported by direct memory access (DMA) channels to minimize CPU overhead. The integrated peripheral

component interconnect (PCI) bridge supports bus mastering for direct transfers to and from memory.

With the required key functionalities integrated into the MCF547x Family, a range of home entertainment gateway products can be developed based on the same core design, but with different PCI peripherals and software.

ColdFire Embedded Controllers

Freemscale offers user's manuals, product briefs and application notes for its ColdFire embedded controllers. In addition, local support is also provided for these products.

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MCF547x

Security-Enhanced Internet Protocol Camera

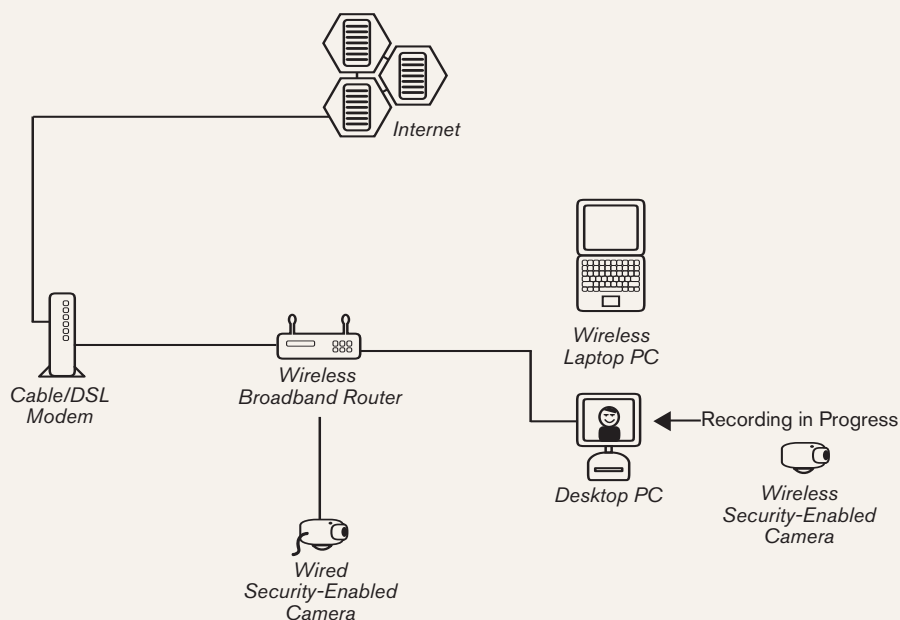
Overview

A security-enhanced Internet Protocol (IP) camera provides streaming video over the Internet via a Fast Ethernet or wireless local area network (LAN) link. Camera input can be either from an integrated CMOS/CCD digital image sensor or from an external camera. The security-enhanced IP camera first decodes and digitizes the analog camera input into standard digital video format. It then compresses the digital video into motion-JPEG, MPEG-2 or MPEG-4 format, and transfers it by direct memory access (DMA) into the processor's memory.

Input from a microphone or external audio input is digitized and compressed by a software encoder. The security-enhanced IP camera can also implement audio output for intercom applications.

Compressed audio and video streams are packetized, optionally encrypted and sent using TCP/IP protocol over wired 10/100 Ethernet or IEEE® 802.11 wireless LANs.

The camera is configured using a Web interface and can support remote pan and tilt control. Power can be supplied using an external adapter for wireless applications, or over Ethernet cable for wired installations.



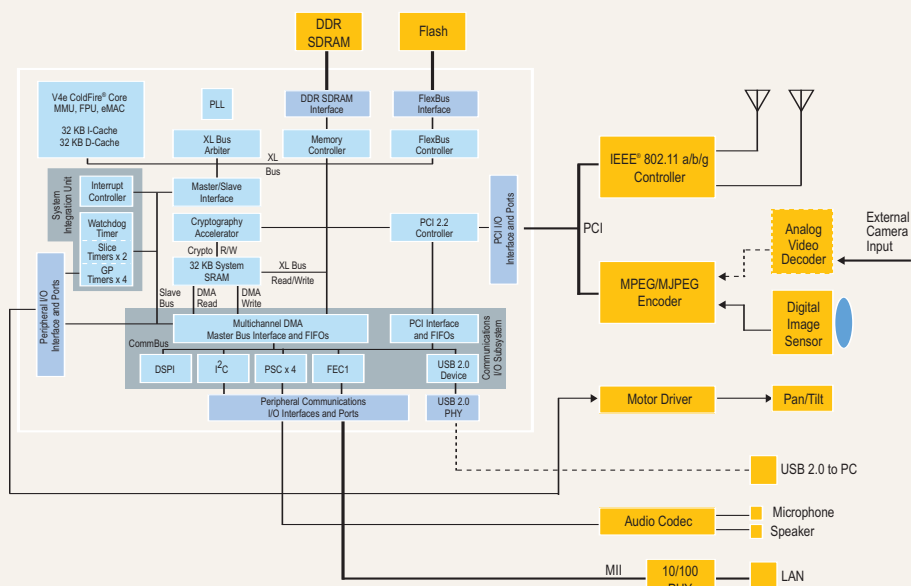
Key Benefits

- > Hardware-accelerated encryption onboard the MCF547x devices helps provide secure transmission of potentially sensitive video information over public interfaces without impacting system performance.
- > On-chip peripherals on the MCF547x devices allow straightforward implementation of a security-enhanced

IP camera, including the ability to set up the camera as a PC peripheral via the on-chip USB 2.0 high-speed device interface.

- > The memory management unit (MMU) contained within the V4e ColdFire® core allows the security-enhanced camera system to run protected-mode operating systems such as standard embedded Linux® OS.

MCF547x BLOCK DIAGRAM



Design Challenges

One of the most important Internet camera requirements is security. Because video streams can be transported over unprotected public networks, sensitive video streams need to be encrypted to ensure that only authorized viewers are allowed to see the images or control the camera. This encryption should be based on proven standards such as DES, 3DES or AES, and must be accelerated to satisfy real-time requirements with minimal CPU overhead.

A second requirement is high memory bandwidth. Image information is transferred into memory, passed to an encryption engine and back, then packetized and sent to 10/100 Ethernet or IEEE 802.11 Media Access Controller (MAC). A high-speed, wide memory bus and large CPU cache that reduces bus usage are also required.

Other requirements include a PCI bus bridge to interface to the standard IEEE 802.11

a/b/g radio chipset and MPEG encoder; integrated 10/100 Ethernet MAC; enhanced Multiply-Accumulate (eMAC) math capability for executing audio compression/decompression algorithms; and a CPU with full memory management to take advantage of standard Linux OS distributions.

Freescal Semiconductor Solution

The MCF547x family offers an integrated and balanced solution for a security-enhanced IP camera processor. The on-chip crypto engine supports DES, 3DES and AES private key algorithms as well as hardware random number generation. The bus mastering capability uses the external 32-bit-wide, high-speed DDR SDRAM directly for fetching clear-text image and storing encrypted image output. The large on-chip dual 32 KB caches minimize CPU bus usage, while the 32 KB SRAM can be used to store encryption keys, initialization vectors and audio compression/decompression data.

MCF547x on-chip peripherals include the PCI bridge; dual Fast Ethernet controllers; programmable serial controllers that interface gluelessly to audio codecs; timers for generating PWMs for pan and tilt motor control; and a USB 2.0 high-speed device interface that allows the camera to be used as a PC peripheral.

The V4e ColdFire® core on the MCF547x devices offers up to 410 MIPS at 266 MHz and has an enhanced MAC unit for DSP functions. The full MMU capability supports protected-mode operating systems such as standard Linux OS.

ColdFire Embedded Controllers

Freescal offers user's manuals, product briefs and application notes for its ColdFire embedded controllers. In addition, local support is also provided for these products.

Learn More: For more information about ColdFire family products, please visit www.freescal.com/coldfire.

MCF548x Fieldbus Controller/Gateway

Overview

Fieldbus controllers take the measurements and perform the actions critical to manufacturing and materials processing. A fieldbus gateway provides communication to factory floor and process control devices that are connected via a large variety of popular protocols. Ethernet is making rapid inroads into areas formerly covered by older serial protocols.

Along with this physical layer change, access via TCP/IP has become increasingly important to enable enterprise-wide integration. Controllers are evolving as well, taking over central control room tasks through distributed processing schemes. All of these changes are driving a new level of integration in microprocessors for industrial applications.



Key Benefits

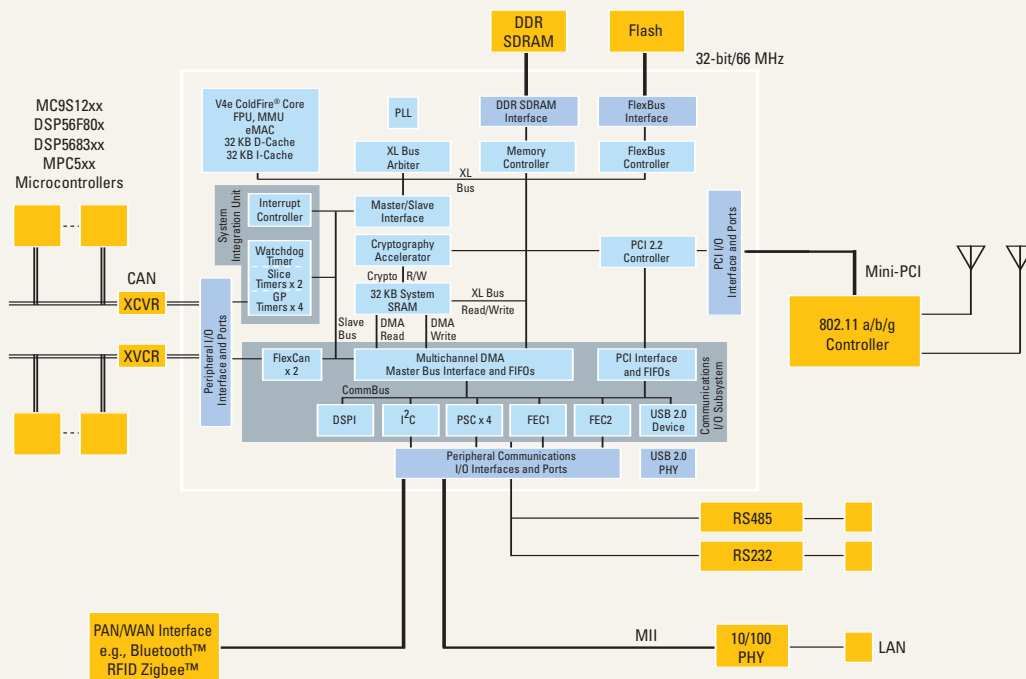
- > The MCF548x devices are particularly well suited for interfacing legacy fieldbuses such as CAN, MODBUS and PROFIBUS with newer technologies such as wired and wireless Ethernet.
- > Multiple Ethernet interfaces on the MCF548x devices allow straightforward separation of public and private data streams for an industrial application.
- > The MCF548x devices offer straightforward interfacing to Freescale's chipset based on ZigBee™ technology.

Design Challenges

The trend toward distributed control places increased computational demands on fieldbus controllers. Sensing, actuator and closed loop process control, data logging and diagnostics must all be performed in real time. Increasingly sophisticated operating systems are required to effectively schedule and dispatch these tasks. Added to this load is a rapidly growing communications throughput.

Older serial protocols are being encapsulated and transported over Ethernet on private local area networks (LANs), while information critical to productivity and efficient materials management must travel over the public Internet. Controllers must be able to be reprogrammed remotely. This means gateways must be able to connect legacy fieldbuses such as CAN, MODBUS and PROFIBUS with newer technologies such as 100 Mbps or wireless Ethernet.

MCF548x BLOCK DIAGRAM



Rapid reconfiguration is also an issue because controllers can be very installation-specific, leading to a mix of many low-volume configurations. The challenge to designers is to meet these needs in a rugged industrial environment and in a form factor that may be restricted to a DIN rail-mounted module.

Freescal Semiconductor Solution

The need for high-performance control and secure enterprise communications requires a high level of integration for industrial microprocessors. The MCF548x family of ColdFire embedded controllers addresses these needs with the V4e ColdFire core and integrated communication peripherals. Onboard data and instruction caches provide efficient execution of control algorithms and communication protocols. Signal processing tasks, such as control loop filters, are handled

by an enhanced Multiply-Accumulate (eMAC) unit and a floating point unit (FPU).

The memory management unit (MMU) provides the type of memory protection required by real-time and Linux® operating systems. Connectivity to serial fieldbuses is accomplished through multiple CAN and programmable serial controllers (PSCs). Dual Fast Ethernet controllers (FECs) give true gateway functionality to both LAN and wide area network (WAN) connections.

Secure communication, such as IPsec, can be implemented easily with the optional cryptography acceleration unit. Onboard multichannel direct memory access (DMA) transfers communications packets, which offload the CPU. External buses provide glueless interfaces to SDRAM and flash.

The PCI bus can be used for custom options requiring wireless communications or other specialized subsystems.

Finally, Freescale's chipset based on ZigBee technology interfaces to the MCF548x devices in a straightforward fashion via the DSPI interface, allowing the MCF548x processor to become a main control node in a star or mesh personal area network (PAN) topology in an industrial setting.

ColdFire Embedded Controllers

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Learn More: For more information about ColdFire family products, please visit www.freescale.com/coldfire.

MCF548x

Integrated Operating Theater

Overview

The complexity of components that operating theaters require continues to increase due to the development of minimally invasive techniques in surgery. This complexity has dramatically increased the need for a centralized management unit that can control all of the mechanical and electrical systems within the operating room, and also connect all of these components with the larger network within the building for monitoring, data collection and data backup. An integrated operating room control system allows for improved workflow and greater efficiency in surgery.



Key Benefits

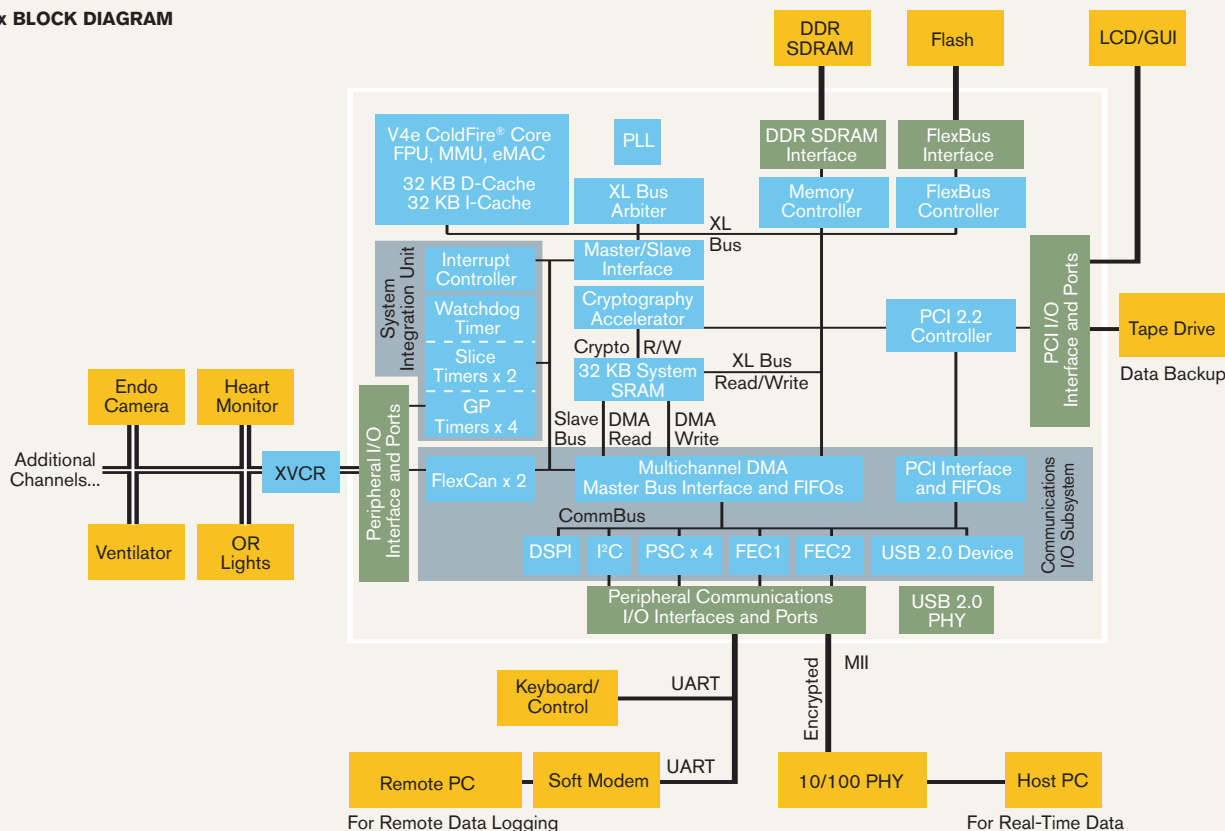
- > The MCF548x family provides customers with the option of building an integrated operating theater using a single piece of silicon.
- > The MCF548x family features a broad range of communication interfaces that enable straightforward connection to the hospital's local area network (LAN), along with on-chip encryption acceleration to help make this connection secure.
- > The on-chip controller area network (CAN) controller is designed to allow for secure data transfer between the operating room's components and the central control unit.

Design Challenges

Increasing operating efficiency and quality are the key drivers for implementing an integrated operating room system. There are a number of simultaneous activities within a modern operating room that require an integrated system to coordinate and control all of the data collection from operating room systems and equipment. Typical requirements are the networking and control of endoscopic and surgical components; control of the operating room table, lighting and temperature; connection to colleagues via phone or video conference; interfacing of image and video communication; and direct electronic access to patient information.

All patient information, including images from endoscopic, X-ray or ultrasound equipment, must be easily accessible. In addition, all relevant data collected during the operating process (patient monitoring data, video records of the operating procedure, equipment diagnostic information, etc.) must be saved and backed up for future reference. All of this information must be transmitted and stored in a secure fashion to protect the privacy of the patient.

MCF548x BLOCK DIAGRAM



Freescal Semiconductor Solution

Freescal's MCF548x family provides the performance and integration required to be the main controller within an integrated operating theater application. Specifically, the on-chip CAN controller is designed to allow customers to integrate a fault-tolerant communications protocol into their system that would help to ensure secure data transfers between the central control unit and the specified components of the system, such as blood pressure monitors or the operating theater's lighting system.

The MCF548x devices feature multiple Ethernet controllers that are engineered to allow the control system to be connected via a network to a host computer for real-time data logging. The additional communication interfaces on the MCF548x devices allow for flexibility in design: The ColdFire® FlexBus could be used to connect to an LCD or touch screen system for output monitoring, data input and video/graphic image viewing. The on-chip PCI controller allows straightforward interfacing to data storage and backup systems, while also generating flexibility for adding additional connectivity, audio or video

features in a modular fashion in the future. Finally, the hardware encryption module on the MCF548x devices is engineered to facilitate secure data collection and transfer between the integrated operating theater and the LAN or WAN.

ColdFire Embedded Controllers

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