Extension MEDIA

# Engineers' Guide to 8/16-bit Technologies

## Microcontrollers Make Waves in Automotive and Internet of Things

### Microcontroller and Connectivity Options for the Smart Home

### Mixed Signal and Microcontrollers Enable IoT

EECatalog

www.eecatalog.com/8bit

*Diamond Sponsor*

MICROCHIP

*Gold Sponsors*

CAST
IP Cores & Subsystems

zilog Embedded in Life
An IXYS Company

# Intelligent Analog

## PIC® Microcontrollers Lower BOM Cost, Reduce Noise, Increase Throughput


**Analog design is difficult and consumes precious development time. Microchip's intelligent PIC MCUs integrate analog functions such as high performance Analog-to-Digital Converters (ADCs), Digital-to-Analog Converters (DACs) and operational amplifiers (op amps) providing simple-to-use interfaces that ease analog design. This single-chip solution enables reduced system noise and provides higher throughput, while dramatically reducing design time and cost.**

### Applications

This flexibility and efficiency benefit multiple applications:

- Environmental quality sensors
- Portable medical equipment (glucose meters, portable ECGs, pulse oximeters, blood pressure meters)
- Industrial equipment (gas sensors, handheld multi-meters, lab instrumentation, e-meters, sensor arrays)
- Power conversion
- Efficient motor control
- Lighting
- Power measurement and monitoring
- Energy harvesting equipment
- Solar inverters

### GETTING STARTED IS EASY

www.microchip.com/intelligentanalog
for more information.

PIC24F Starter Kit for Intelligent Analog
(DM240015)

MICROCHIP

Microcontrollers • Digital Signal Controllers • Analog • Memory • Wireless

The Microchip name and logo, the Microchip logo and PIC are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries. All other trademarks are the property of their registered owners.
©2014 Microchip Technology Inc. All rights reserved. 03/14

# Zilog's S3 8-Bit Microcontroller Family

zilog
Embedded in Life
An IXYS Company

## Fast and Efficient Processing, Flash Memory, a Wide Range of Integrated Peripherals, and Efficient Register-Oriented Architectures

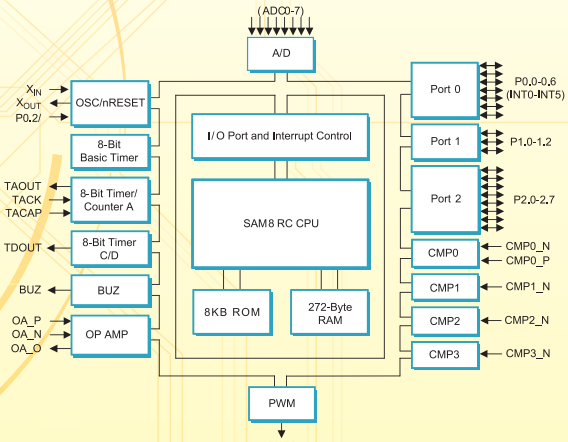
| S3 8-BIT MICROCONTROLLER FAMILY | |
|---|---|
| S3F80P5 | S3F8S19 |
| S3F80P9 | S3F8S24 |
| S3F80PB | S3F8S28 |
| S3F82NB | S3F8S35 |
| S3F84B8 | S3F8S39 |
| S3F8S15 | S3F94C4 |
| S3F94C8 | |

**APPLICATIONS:**

- Induction Heating Cookers
- Small Kitchen/Home Appliances
  - Boilers
  - Rice Cookers
  - Pressure Cookers
  - Induction Heaters
  - Air Conditioners
  - Washing Machines
  - Dryer Controller
  - Oven Controller
- Vending Machines
- IR Remote Controls with LCD
- Fan Control
- Smoke Detectors
- Cordless Tools & Battery Chargers
- PIR Motion Detectors
- Ambient Light Sensors
- Humidity Detectors
- LED Lighting Control
- System Board Management

**FEATURES:**

- SAM8 & SAM88 Z8-Compatible CPU Cores
- Flash Memory: 4, 8, 16, and 32 KB
- RAM: 208, 272, 1040, 2086 bytes
- CISC Instructions: 41, 78
- Interrupts: 4, 17, 26
- And many more!




**S3F84B8 Block Diagram**

Design With Freedom

For more information about our S3 Product Family, please visit **www.zilog.com/S3**

# Zilog's Z16FMC Series of Flash Microcontrollers

Z Flash MC Microcontrollers

Zilog's Z16FMC Series of Flash microcontrollers are ideal for 3-phase and single-phase AC induction, permanent magnet synchronous motors (PMSMs), and brushless DC motor control. These motors are typically used in industrial variable frequency drives (VFDs), elevators, fans and pumps, compressors, and large appliances.

The sixteen 32-bit general-purpose registers support complex CISC addressing modes and a single-cycle instruction set that includes capabilities needed to compile compact, efficient machine code. Four channels of linked list DMA ensure the CPU is free to perform additional system level tasks while also controlling the motor.

| Part Number | Flash (KB) | RAM (KB) | I/O | Multi-Channel Timers with PWM | Standard Timers with PWM | ADC Inputs | UARTs w/ LIN/IrDA | $I^2C$ Master/ Slave | ESPI |
|---|---|---|---|---|---|---|---|---|---|
| Z16FMC28 | 128 | 4 | 46 | 1 | 3 | 12 | 2 | 1 | 1 |
| Z16FMC32 | 32 | 2 | 46 | 1 | 3 | 12 | 2 | 1 | 1 |
| Z16FMC64 | 64 | 4 | 46 | 1 | 3 | 12 | 2 | 1 | 1 |

*Build your Motor Control applications with the Z16FMC Series Motor Control Development Kit (Z16FMC28200KITG).*

The Z16FMC Series Development Kit includes everything you need to start working with the Z16FMC family of devices.

With Zilog products, your possibilities are endless!


zilog Embedded in Life
An IXYS Company
To learn more visit **www.zilog.com**

# Welcome to the 2014 Engineers' Guide to 8/16-bit Technologies

The microcontroller (MCU) market just keeps on keepin'-on. Even as the high end of the market begins to blur the lines between MCUs and SoCs, innovative lower-end devices at 8 and 16 bit continue to add support for new, interconnected peripherals and other functionality. So while costs continue to drop, bringing overall revenue projections down, unit sales forecasts through 2018 for 8-bit units remain strong, according to IC Insights research. Senior Market Research Analyst Rob Lineback provides in-depth responses in "Microcontrollers Make Waves in Automotive and Internet of Things," and more detail is available in the 2014 edition of The McClean Report at http://www.icinsights.com/services/mcclean-report.

Microchip's Jason Tollefson provides additional insight in "Advanced Process Nodes Transform MCU Market," telling us that, "Innovation in 8- and 16-bit microcontrollers is occurring on several fronts, with the primary objective being increased system capability while reducing power consumption, cost and physical footprint." Jason addresses how MCUs are meeting the requirements of wearable and other ultra-mobile devices—as well as what embedded developers need to consider in these designs.

And there's plenty more news, product details and application information in our 8- and 16-bit digital edition and online technology channel at www.eecatalog.com/8bit. We hope you'll check in regularly!

***Cheryl Berglund Coupé***
Editor

P.S. To subscribe to our series of Engineers' Guide for embedded developers, engineers, designers and managers visit:

**www.eecatalog.com/subscribe**

EECatalog

Extension MEDIA


## Engineers' Guide to 8/16-bit Technologies 2014

**www.eecatalog.com/8bit**

**Vice President & Publisher**
Clair Bright
cbright@extensionmedia.com
(415) 255-0390 ext. 15

**Editorial**
**Editorial Director**
John Blyler
jblyler@extensionmedia.com
(503) 614-1082

**Editor**
Cheryl Berglund Coupé
ccoupe@extensionmedia.com

**Senior Editor**
Chris A. Ciufo
cciufo@extensionmedia.com

**Creative/Production**
**Production Manager**
Spryte Heithecker

**Media Coordinator**
Jenn Burkhardt

**Graphic Designers**
Nicky Jacobson
Jacob Ewing

**Senior Web Developer**
Mariam Moattari

**Advertising/Reprint Sales**
**Vice President & Publisher**
Embedded Electronics Media Group
Clair Bright
cbright@extensionmedia.com
(415) 255-0390 ext. 15

**Sales Manager**
Michael Cloward
mcloward@extensionmedia.com
(415) 255-0390 ext. 17

**Marketing/Circulation**
Jenna Johnson

**To Subscribe**
www.eecatalog.com/subscribe

Extension MEDIA

**Extension Media, LLC**
**Corporate Office**
(415)255-0390

**President and Group Publisher**
Vince Ridley
vridley@extensionmedia.com

**Vice President, Sales**
Embedded Electronics Media Group
Clair Bright
cbright@extensionmedia.com

**Vice President, Business Development**
Melissa Sterling
msterling@extensionmedia.com
(415)-970-19100

**Special Thanks to Our Sponsors**

MICROCHIP CAST IP Cores & Subsystems zilog Embedded in Life An IXYS Company



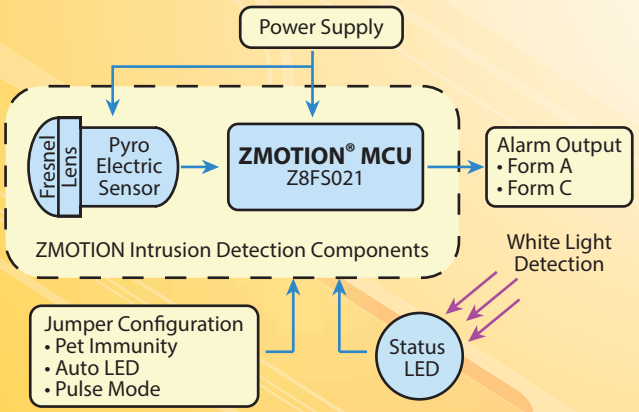
*The Engineers' Guide to 8-bit & 16-bit Technologies 2014 is published by Extension Media LLC. Extension Media makes no warranty for the use of its products and assumes no responsibility for any errors which may appear in this Catalog nor does it make a commitment to update the information contained herein. Engineers' Guide to 8-bit & 16-bit Technologies 2014 is Copyright ©2014 Extension Media LLC. No information in this Catalog may be reproduced without expressed written permission from Extension Media @ 1786 18th Street, San Francisco, CA 94107-2343.*

*All registered trademarks and trademarks included in this Catalog are held by their respective companies. Every attempt was made to include all trademarks and registered trademarks where indicated by their companies.*

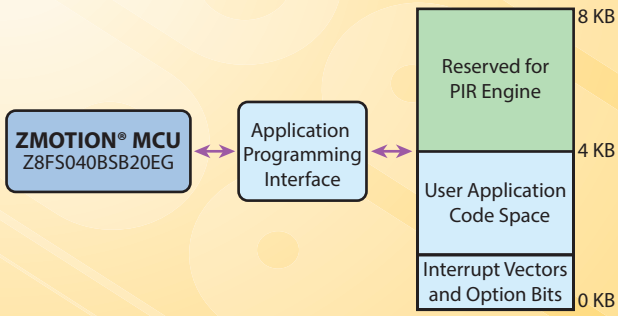
Zilog
Embedded in Life
An IXYS Company

# Go with the Best in Motion Detection Technology
# Zilog's ZMOTION® PIR-Based Motion Detection Solutions

### ZMOTION Intrusion Detection Block Diagram




### ZMOTION Occupancy Detection Block Diagram




## Intrusion Applications
## Z8FS021

- Wide-area intrusion detector
- Corridor, curtain & vertical barrier motion detectors
- Dual mode lighting/intrusion detector
- Secure access control
- Stand-alone alarm systems

## Occupancy Applications
## Z8FS040

- Lighting control
- Access control
- Customer sensing
- HVAC control
- Occupancy sensing
- Vending applications
- Automatic displays
- Proximity
- Power management

## ZMOTION Development Kits

| | |
|---|---|
| **ZMOTIONL100ZCOG** | ZMOTION Detection and Control Development Kit |
| **ZMOTIONL200ZCOG** | ZMOTION 20-pin Detection and Control Development Kit |
| **ZMOTIONS200ZCOG** | ZMOTION Intrusion Detection Development Kit |

**Zilog offers a wide selection of lens and pyroelectric sensor bundled options to fit your application needs.**

For more information or documentation about Zilog's ZMOTION products, please visit **www.zilog.com/ZMOTION.**

Design With Freedom

# Contents



## Products and Services

### *Microcontrollers and Cores*

#### *Microcontrollers and Cores*

# Adding Connectivity to Your Design


**Microchip offers support for a variety of wired and wireless communication protocols, including peripheral devices and solutions that are integrated with a PIC® Microcontroller (MCU) or dsPIC® Digital Signal Controller (DSC). Microchip's Solutions include:**

### USB

8-, 16- and 32-bit USB MCUs for basic, low-cost applications to complex and highly integrated systems along with free license software libraries including support for USB device, host, and On-The-Go.

### Ethernet

PIC MCUs with integrated 10/100 Ethernet MAC, standalone Ethernet controllers and EUI-48™/EUI-64™ enabled MAC address chips.

### CAN

8-, 16- and 32-bit MCUs and 16-bit DSCs with integrated CAN, stand-alone CAN controllers, CAN I/O expanders and CAN transceivers.

### LIN

LIN Bus Master Nodes as well as LIN Bus Slave Nodes for 8-, 16- and 32-bit PIC MCUs and 16-bit dsPIC DSCs. The physical layer connection is supported by CAN and LIN transceivers.

### Wi-Fi®

Innovative wireless chips and modules allowing a wide range of devices to connect to the Internet. Embedded IEEE Std 802.11 Wi-Fi transceiver modules and free TCP/IP stacks.

### ZigBee®

Certified ZigBee Compliant Platform (ZCP) for the ZigBee PRO, ZigBee RF4CE and ZigBee 2006 protocol stacks. Microchip's solutions consist of transceiver products, PIC18, PIC24 and PIC32 MCU and dsPIC DSC families, and certified firmware protocol stacks.

### MiWi™

MiWi and MiWi P2P are free proprietary protocol stacks developed by Microchip for short-range wireless networking applications based on the IEEE 802.15.4™ WPAN specification.

## BEFORE YOUR NEXT WIRED OR WIRELESS DESIGN:

1. Download free software libraries
2. Find a low-cost development tool
3. Order samples

www.microchip.com/usb
www.microchip.com/ethernet
www.microchip.com/can
www.microchip.com/lin
www.microchip.com/wireless

Wi-Fi G Demo Board
(DV102412)

MICROCHIP

Microcontrollers • Digital Signal Controllers • Analog • Memory • Wireless

The Microchip name and logo, the Microchip logo, dsPIC, MPLAB and PIC are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries. All other trademarks are the property of their registered owners.
©2013 Microchip Technology Inc. All rights reserved. 03/13

# Microcontrollers Make Waves in Automotive and Internet of Things

## Market analyst sees a blurring of the lines between microcontrollers and microprocessors, including the move to multicore and systems-on-chip

*By Cheryl Coupé, Managing Editor*

Semiconductor market research company IC Insights has released the 2014 edition of The McClean Report (http://www.icinsights.com/services/mcclean-report). We talked to Senior Market Research Analyst Rob Lineback to get his views on microcontroller trends (responses edited for clarity and space).

---

***EECatalog:*** Your report shows a downward or flat trend in low-end controllers. Overall in microcontroller trends, is the change due to the need for higher performance in more applications?

***Lineback:*** It's getting to the point where with chip integration and architecture, suppliers are able to deliver 32-bit, RISC-based microcontrollers at almost the same price and sometimes slightly less than even 8-bit designs. So from a cost point of view, the 32-bit doesn't really have any penalty. It's not any more expensive. The issue is always—in microcontrollers as well as microprocessors—the programming and how much has been done in converting that over. There is an effort by a lot of companies to build a migration path for 8-bit designs to move to 32-bit, especially with the types of legacy architectures that are not ARM-based. Companies that have been leaders for a long time have built migration paths from their 8-bit families to new 32-bit architectures. That's been one attempt to try to maintain market share. Of course, ARM-based microcontrollers have really hit the market in a big way, with a lot of companies licensing the architecture and most major suppliers have an ARM-based offering. ARM has changed the marketplace quite a bit.

---

***EECatalog:*** Are there penalties for making the migration from 8-bit to 32-bit?

***Lineback:*** The one thing they have to do if they're using an 8-bit is to rework their code so that it can run on a 32-bit architecture. Some companies have built in compatibility of their 32-bit designs so that it can run recompiled code. They've already been trying to diminish the amount of work that an engineer might have to do to move a design from an 8-bit microcontroller to a 32-bit. But honestly, I think there are so many new applications and that's really driving the market; it's not so much taking something that existed and trying to upgrade it to 32-bit although that does happen. I think it's the appearance of a lot of new types of systems that are driving the growth.

---

***EECatalog:*** If we look back historically at where the large market segments were for low-end processors—white goods, automotive, etc.— is that still typical?

***Lineback:*** Home appliances are significant, but automotive is a major segment for microcontrollers. It's by far the biggest MCU application—in 2014, we think about 48% of overall microcontroller dollar sales will be in automotive.

---

***EECatalog:*** What about 8/16-bit specifically?

***Lineback:*** There are a lot of applications for 8/16-bit microcontrollers in automobiles. Actually quite a few specialized 16-bit microcontrollers are aimed specifically at automotive applications. 16-bit devices have digital signal processing type technologies (people call 16-bit microcontrollers digital signal controllers, or DSCs). They tend to be oriented toward more real-time and math-intensive type applications, so there are lots of automotive specialized microcontrollers that are 16-bit. 32-bit is certainly gaining share in the automotive segment as a lot of applications are moving to 32-bit in automotive.

One thing to make note of is that the 4/8-bit (mostly 8-bit) unit shipments will still be the largest volume in the microcontroller business even out to 2018. We know that 32-bit is on the verge of passing 8-bit unit shipments, and dollar-wise, of course, it's quite a bit more because 8-bit devices are being pressured to be lower and lower cost.

# Create Next-Generation Medical Devices with Microchip

## Industry-Leading Components Backed by World-Class Design Support


**Add next-generation capabilities such as touch-screen capacitive sensing, wireless connectivity and longer battery-life, while lowering your overall system cost and time to market. Our combination of innovative products, dependable delivery and years of experience in enabling embedded medical solutions for customers around the world makes Microchip Technology your partner of choice for medical designs.**

### Extend Battery Life with XLP Technology

- PIC® MCUs with nanoWatt eXtreme Low-Power (XLP) Technology
- Lowest-power consumption with sleep currents down to 9 nA

### Add Touch-Sensing with PIC MCUs

- mTouch™ capacitive touch-sensing for glass and plastic
- Waterproof Metal Over Cap touch technology for stainless steel and aluminium

### Add Connectivity

- Agency-certified Wi-Fi® and Bluetooth® modules
- PIC MCUs with on-board USB and enhanced CAN
- Proprietary low-cost wireless protocols (MiWi™)
- Free ready-to-use ZigBee® stack
- Embedded Ethernet controllers

### Increase Accuracy & Reliability

- Precision op amps
- Battery-management ICs
- Temperature sensor ICs
- Mixed-signal and interface ICs
- UNI/O® Serial EEPROM

### World-Class Support for Medical Designs

Microchip's dedicated Medical Design Center helps you to simplify analog design, software development, in-circuit emulation and system level evaluation.

- Low-cost development tools and evaluation boards
- Online reference designs and application notes for medical products
- Third-party Medical Design Partner Specialists

### GET STARTED IN 3 EASY STEPS

1. Get started with online medical reference designs: www.microchip.com/medical
2. Add capacitive touch-sensing with mTouch™ technology: www.microchip.com/mTouch
3. Extend battery life with XLP technology: www.microchip.com/XLP

MICROCHIP

**Microcontrollers • Digital Signal Controllers • Analog • Memory • Wireless**

The Microchip name and logo, the Microchip logo, UNI/O and PIC are registered trademarks and MiWi and mTouch are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries. All other trademarks are the property of their registered owners. ©2013 Microchip Technology Inc. All rights reserved. 09/13

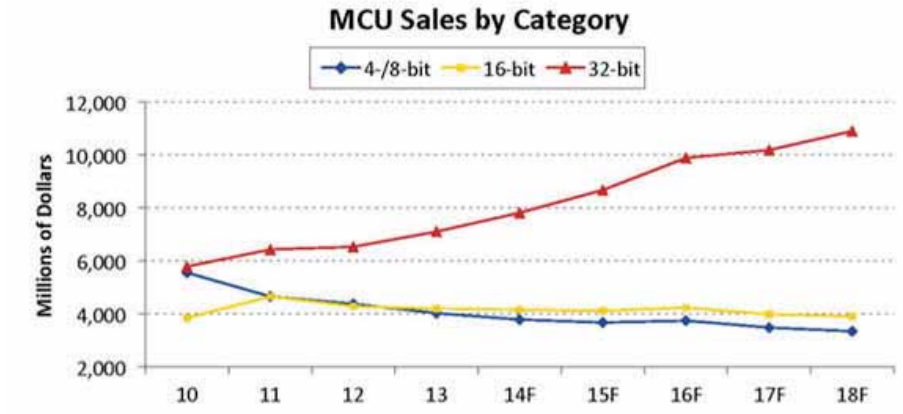



***Figure 1: Revenue growth in 32-bit microcontrollers will continue to outpace sales of 4/8-bit and 16-bit MCUs during the next five years. (Source: IC Insights' 2014 McClean Report)***

We're not splitting the two in forecasts yet, but it's something to be mindful of. It's going to get very blurry further out.

I guess we could see that Atom could end up coming back as a microcontroller type of device, as a system on chip. A lot of the applications they're going after are the same ones that are driving microcontrollers. We're seeing microcontrollers in SoCs as the processors serving a lot of the wearable stuff as well as medical. In teardowns, sometimes it's a microcontroller and sometimes it's an ARM-based processor. What's the difference between the two?

***EECatalog:*** What do you expect from a market segment standpoint? Do you expect that automotive will continue to be the largest segment, or do you see growth coming from other areas?

***Lineback:*** Automotive will be a large market for the foreseeable future, so it's significant. Now whether it's something close to 50 percent... it definitely will be drifting down as we see more microcontrollers used in new things that are emerging like the Internet of Things. As that takes off, there's a lot of Internet connection being built into microcontrollers and that's driving 32-bit designs. Then you have the wearable medical type of devices and wearable electronics—the medical electronics segment is growing quite strong and using a lot of microcontrollers and we think that will be growing faster. We think home automation and you mentioned MEMS and sensors—anytime you have a sensor of any kind, a microcontroller is usually involved or connected. As those applications keep growing—as we have self-aware systems that either know there's movement or sense things around them— there's a microcontroller sitting there doing the work.

One thing that I think is going to be interesting to see out in the future—and this may have an impact on who's playing in this whole market—is I've always seen microcontrollers way back to the 1980s as being systems on chip, SoCs. And we're seeing SoCs in processors growing too. Now a lot of those are ARM-based, but Intel is definitely making a big push with its Atom SoC that's not just aimed at cell phones and tablets and even notebooks, but they're going after embedded applications in medical, television and such. I think there's going to be a point, probably by the latter part of this decade, where we might see SoCs—microprocessors and microcontrollers—being pretty much the same thing. It's going to be hard to differentiate between them because all the functions that are on a microcontroller are appearing on SoC designs, which has a little more on-chip.

***EECatalog:*** Are there viable options to ARM?

Intel would be an option. There are also the old MIPS cores which were acquired by Imagination Technologies, which is a competitor of ARM. They're known mostly for graphic cores but they said in June that they intended to use the MIPS core aimed at microcontrollers and try to go after that market. Probably the biggest user of the MIPS core is Microchip, which is ranked number four in overall MCU sales by revenue (2012 are most recent numbers). Renesas is the biggest by far still, even though they've had a pretty good decline in sales. They actually don't sell an ARM-based controller, so theirs is internal. Samsung we show as second, but they sold their 4/8-bit microcontroller business (they didn't have much of a 32-bit presence) to IXYS. Fujitsu sold its microcontroller business along with analog ICs to Spansion, which is known for its flash memory—they're trying to get into the microcontroller business because they see the microcontroller as basically a platform to put their flash technology on. There have been other acquisitions. As far as ranking, Samsung was number two, but that's mostly 8-bit. Freescale we have ranked third in 2012. They have their own internally designed 32-bit microcontrollers based on the Power architecture, but they also sell a line of ARM-based devices and they've been expanding that quite a bit. Microchip is number four, STMicroelectronics is fifth, Atmel sixth, Infinion seventh, TI is eighth, Fujitsu is nine (they sold their business to Spansion), and NXP, which used to be Phillips, is ten.

That's the overall ranking, but the ARM business is definitely reshaping the marketplace. They have four core architectures for 32-bit microcontrollers. One or two of them are aimed at the low-end, simple designs: the Cortex M0 and the Cortex M0+, which is the one being used for the Internet of Things and wireless systems. We don't have the 2013 numbers, but ARM estimated about 1.9 billion Cortex M-based microcontrollers were shipped in 2012, which is

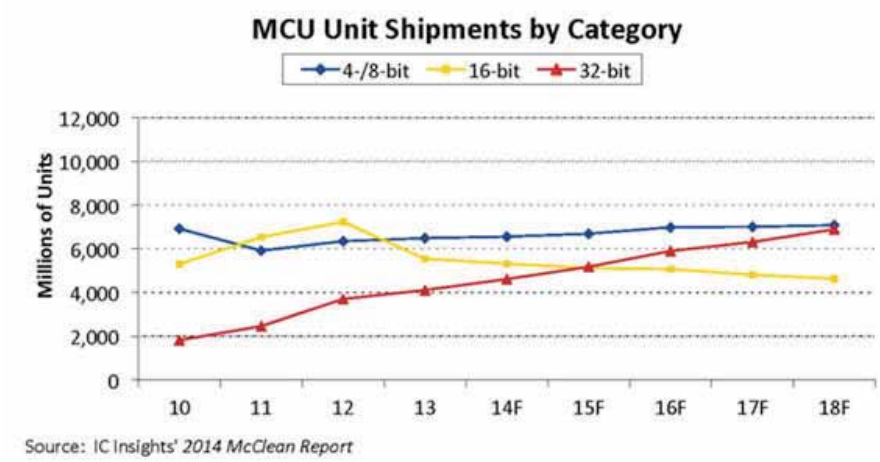



***Figure 2: In terms of device shipments, 4/8-bit MCUs overtook 16-bit devices in 2013 to regain their historic position as the largest unit-volume category in the market. The outlook shows 4/8-bit MCUs remaining the largest unit-volume category in microcontrollers during the next five years, but 32-bit shipments are expect to be on the verge of taking the lead in 2018.***

about a 73% increase from 2011. For 32-bit designs, the ARM-based microcontrollers had 31% market share in 2010, 45% in 2011 and 51% in 2012. That's pretty significant—a little more than half of all units shipped. You make the assumption that it's still going up so they're probably up around 55%, maybe even getting close to 60% this year.

---

***EECatalog:*** Are those mostly new designs?

Yes, lots of Internet of Things, there's a lot more automotive that's going 32-bit, and consumer. It ends up that 32-bit is going into a lot of new sockets, so that's one of the reasons it's growing so strong. The need for higher precision, more real-time and the Internet connection factor is playing a big role in driving 32-bit sales.

There always will be new things happening in 8-bit and 16-bit. In the 8-bit world the emphasis has been on being able to have high levels of code efficiency to be able to keep the memory requirements low and the programming simple. The 16-bit world is driven by being more specialized and more focused as far as an application-oriented or specific microcontroller. 16-bit is big in automotive and audio systems as well as motor control.

---

***EECatalog:*** Anything else of particular interest to you?

One new trend we've seen is multicore microcontrollers. We hear about multicore microprocessors in PCs and tablets and smartphones, but we're seeing some multicore microcontrollers in the market. Some units might have two 32-bit cores, there's been some mixing of 32-bit ARM—for instance, TI has a 32-bit ARM core mixed internally with a digital signal processing microcontroller core. We'll have to see how that plays out. There are a lot of parallels between microcontrollers and the microprocessor world so I think we're going to see some blurriness in definitions as we get further out.

***Editor's Note:*** in our discussion, Rob clarified that the graphs for unit and sales volume are somewhat skewed by the inclusion of smartcard microcontrollers along with mainstream MCUs. From a unit perspective, smartcards make up almost half of overall MCU unit shipments. In 2013, the smartcard business had a market correction based on delays in government and transportation programs worldwide and unit volumes fell after large volumes sales in 2011 and 2012. Because of the smartcard correction, IC Insights shows overall MCU unit sales declined 7% in 2013 to 16.1 billion from a record high of nearly 17.3 billion in 2012. Excluding smartcard units, shipments of mainstream, embedded microcontroller devices grew 11% to about 8.8 billion units from 7.9 billion in 2012. However, on the revenue side, the total smartcard sales volume in 2013 was $2.3 billion while total microcontroller sales in 2013 were $15.3 billion. This represents the dramatic difference in average selling price (ASP) of $.31 for smartcard microcontrollers in 2013 vs. $1.49 ASP for all mainstream microcontrollers.

---

*Cheryl Berglund Coupé is managing editor of EECatalog.com. Her articles have appeared in EE Times, Electronic Business, Microsoft Embedded Review and Windows Developer's Journal and she has developed presentations for the Embedded Systems Conference and ICSPAT. She has held a variety of production, technical marketing and writing positions within technology companies and agencies in the Northwest.*

# INTERNET OF THINGS DEVELOPERS CONFERENCE

May 7-8, 2014

Hyatt Regency Santa Clara, CA

## Resolving the Technical and Business Challenges of Getting Connected to the Internet of Things

**Two full days of keynotes, training sessions and panel discussions. Topics covered include:**

- Adopting legacy industrial connectivity solutions
- Communication gateways
- Differentiating Greenfield and Brownfield
- Embedded cloud computing
- Semiconductor technologies of the future for IoT
- Making money with the Internet of Things
- Networking, LTE equipment, and Femtocells
- Security
- Ultra-low power microcontrollers

**Supported by Industry leaders:**

PLATINUM SPONSORS

freescale · Imagination · WIND RIVER

INDUSTRY SPONSORS

EECatalog · EMBC · Embedded Intel® Solutions · Embedded Computing Design · Embedded Developer (Find. Compare. Buy.) · The Multicore Association

**Plan now.** Come to the **Internet of Things Developers Conference 2014!**

Register today at **IoT-devcon.com**

# Modernized 8051 IP Cores Provide a Superior MCU Solution for Internet of Things and Similar Applications

With some of the fastest and most mature 8051 cores available, CAST today offers the best high-performance, low-energy 8051 MCUs in its 16 years of 8051 IP experience

*By Dr. Nikos Zervas, CAST Inc.*

An 8051 IP pioneer going back to 1997, CAST today offers its best ever family of 8- and 16-bit MCS®51-compatible IP cores and related hardware and software solutions. These MCU IP cores for ASICs or FPGAs are also some of the best you'll find anywhere, and their royalty-free licensing and competitive pricing make them cost-effective solutions for a wide range of projects.

## Choose from Several Fast, Small, Efficient 8051s

CAST partners with 8051 development experts Silesia Devices to bring you the proven advantages of this venerable microcontroller—compactness, reliability, easy programming—but using modern processor design techniques that enable vastly superior performance and reduced energy consumption.

These modernized 8051s offer sufficient processing power for today's fastest growing applications—Internet of Things, wearable electronics, smart automobile systems—yet are smaller, use less power, and are more affordable than lower-end 32-bit processors.

The CAST 8051 product family includes the following.

**Super-Fast, Low-Power S8051XC3**
A sophisticated architecture makes this the fastest 8-bit 8051 available anywhere. It uses a single clock per machine cycle, executes instructions up to 26.85 times faster than the original, and can operate up to 500 MHz (65nm). Its interrupt latency is ultra low and nearly jitter-free.

The S8051XC3 is also very small—with a CPU size under 6,500 gates—and energy efficient, with CPU dynamic power down to 2.3µW/MHz (40nm).

**High-Performance, Configurable, Mature R8051XC2**
Built on 4th generation IP code and shipping in millions of customer devices, this mature 8051 core is extremely configurable and easy to integrate. It executes 12.1 times faster than the original, and ASIC implementations reach 430 MHz (90nm).

**Configurable Discrete Part Replacement L8051XC1**
Designers often need to update an existing system whose MCU chip is out of production, or wish to consolidate discrete chips into an ASIC or FPGA SoC.

This 8051 core is an excellent solution, built with the latest processor design techniques for maximum performance yet completely configurable to exactly match the functional and timing characteristics of existing chips (coming 3Q14).

**16-bit, Higher Speed and Capacity S80251XC3**
Projects requiring 16-bit data handling and faster performance yet still wanting the simplicity and efficiency of an 8051 can find an excellent solution in this modernized 80251-compatible design (coming 2Q14).

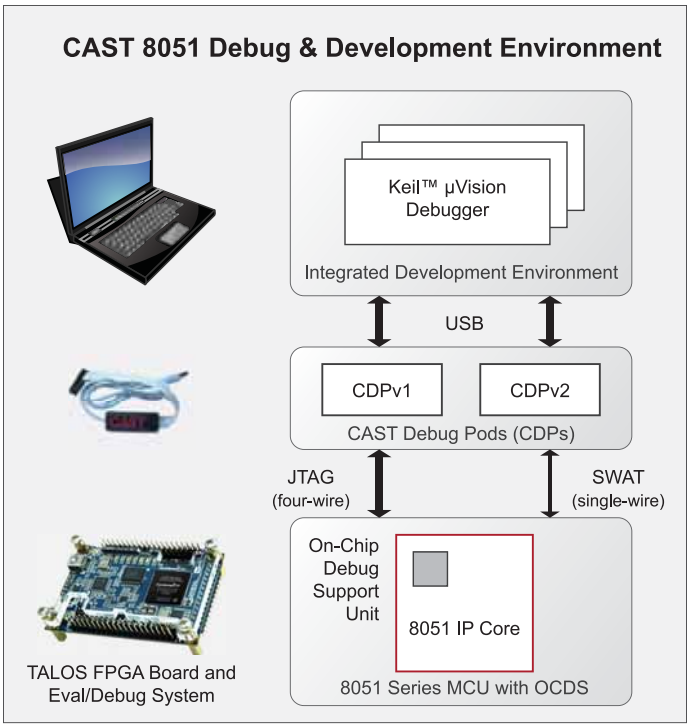
**8051 IP Subsystems**
Further reduce your development time with complete 8051 subsystems for sensor management, industrial control, machine vision, networking and more. Choose from our growing library of pre-integrated subsystems (available throughout 2014) or get exactly what you need for your system via our IP Integration Services.

## Configure and Integrate the Optimum MCU

Auto-configuration makes it easy to use MCU peripherals and interfaces from our large included library. Further configure the CPU and memory architecture to ideally support your particular application. Or use our available services to get the additional peripherals or features you need.

## Enjoy A Complete Development and Debug Environment

Develop software for your CAST 8051 with the powerful, familiar Integrated Design Environments available from Keil and other providers. Seamlessly integrate with these through our on-chip hardware debug block and either four-wire JTAG or our unique single-wire SWAT connection to our CAST Debug Pods. These efficient pods are designed for fast operation, speeding program uploading and practically




eliminating time lag in the interactive debug loop. Insert and monitor hardware or software breakpoints, trace elements, and more.

## Trust the 8051 IP Leader

Twenty-year-old IP provider CAST has delivered 8051 IP since 1997. We have over 200 customers, with 8051s shipping in hundreds of millions of devices around the world.

Our development, support, and sales teams are among the most experienced in the world, and we are ready to help you choose and use the ideal 8051 MCU for your next project.

Learn more by visiting www.cast-inc.com, email info@cast-inc.com, or call any time at +1 201.391.8300.

*"CAST's 8051 controller offered the best combination of features, performance, and terms that we could find. The proven track record of both the 8051 core and the support team at CAST give us great confidence as we pursue this next great engineering challenge."*

Emad Afifi, VP Engineering

Ensphere Solutions

## Ultra-Low Interrupt Latency in Modern 8051s

Internet of Things, smart automobile systems, wearable electronics; these fast-growth applications require a large number and variety of focused, inexpensive, low-energy subsystems. Their MCUs must meet real-time challenges, and this requires very low interrupt latency (the number of clock cycles between an interrupt making itself known and the processor starting to execute the appropriate response). Consistent latency is also important, as large differences or jitter lead to errors in applications like motor control or sound processing.

32-bit RISC MCU providers promote the interrupt latency of their processors as superior to that of 8-bit MCUs. But this turns out not to be true for modern 8051 architectures such as the S8051XC3 from CAST.

The 'XC3 needs just 3 cycles to respond to an interrupt request, plus an additional 7 to 12 cycles to save and restore what the processor was doing, for a best/worst-case real latency delay of 10 to 18 cycles. In contrast, the popular ARM® Cortex™-M0 needs 17 to 24 cycles. Jitter in the 'XC3 is never worse than I cycle, but in the 32-bit MCU can be 3 to perhaps 10 cycles. (See the 8051 Interrupt Delay white paper on the CAST site for details.)

Moreover, the Cortex series requires a relatively complex Nested Vectored Interrupt Controller (NVIC) even to compete, and that block can be as large as an entire CAST 8051.

When low interrupt latency really matters, look to 8051s first.

**CONTACT INFORMATION**

CAST
IP Cores & Subsystems

CAST, Inc.
11 Stonewall Court
Woodcliff Lake, NJ 07677 USA
201.381.8300
201.391.8694 fax
info@cast-inc.com
www.cast-inc.com

# Microcontroller and Connectivity Options for Smart Home and IoT Devices

IoT end nodes and gateways that offer the best combination of energy-efficiency, performance, cost effectiveness and appealing features—regardless of MCU bit size—will be in the driver's seat in the race to our IoT future.

*By Greg Hodgson, Silicon Labs*

We're at the dawn of a new era in connectivity and convenience unlike anything we've experienced before. The Internet of Things (IoT) promises to deliver on the vision of anywhere/anytime knowledge and control of our home and work environments, and depending on the side of Geoffrey Moore's "chasm" you sit, the IoT may already be here. Today I can monitor my connected home and ensure my family is safe, optimize my home energy usage and check on my pets, all while at home or on the road. There will be a tipping point; a handful of innovative consumer products and services that even the late adopters won't be able to ignore, after which there will be little question that the IoT has arrived.

If it hasn't already happened, soon your company's management team will propose products to participate in the IoT. How will you respond? The good news is that many of the application building blocks for the IoT are available today, just waiting for you and your team to add your creative genius. In this article we'll examine common architectures for the connected home and technology considerations to help navigate the IoT.

We all want to be in control of the security of our home and family, and it only takes a fire or burglary to remind ourselves of this need. A number of upstarts and cable operators have introduced products for the connected home that provide fire, security and convenience services. A typical connected home system architecture comprises a number of sensor nodes ranging from simple to complex, a wireless network featuring a gateway to connect to the Internet wirelessly and potentially provide localized system intelligence, and cloud services to connect to mobile devices. Figure 1 shows such a connected home architecture.

Embedded systems designers must consider a number of competing requirements in designing a gateway or sensor nodes, such as processing speed, memory size, regulatory considerations, energy consumption, system latency, connectivity options, system segmentation, security requirements, interoperability, future migration and system cost, to name a few.


***Figure 1: The Connected Home***

The system gateway might be a cable set-top box or a standalone system. See Figure 2 for an example of a typical gateway architecture. The gateway microcontroller (MCU) is most likely based on an ARM Cortex-M or Cortex-A class processor combined with connectivity options such as Ethernet, Wi-Fi, ZigBee and sub-GHz/ISM wireless. Considerations for selecting the optimal MCU include memory size and processing requirements for the communications stacks and gateway services, system latency requirements for "real-time" or offline operation, and connectivity. Considerations for selecting the RF subsystem include local regulations (FCC, ETSI, etc.), whether connection to a broader ecosystem is desired (which requires a standard) or if the system will be self-contained (a proprietary stack can be used), protocol stack requirements, link budget (which translates into RF range) and system cost. Wireless transceiver energy consumption is relevant to the system architecture since it affects sensor node range and battery lifetime.

A "thin" gateway that only passes sensor and environmental data via Ethernet or an RF subsystem to the cloud could suffice with a smaller, less -xpensive Cortex-M class MCU, particularly if the communications stack requirements are kept minimal. The advantage of a thin gateway is that intelligence and interoperability between nodes can be managed by cloud services, but the disadvantage is the potential for roundtrip while waiting for cloud services to process and

# The Most Popular 8-bit Microcontrollers


**See what makes Microchip the most popular choice for embedded designers:**

- Broad portfolio of more than 325 8-bit PIC® microcontrollers
- Easy migration with pin and code compatibility
- Industry's lowest active and sleep power consumption
- Integrated peripherals for USB, CAN and Ethernet with free software
- Interface to the world with LCD drivers and capacitive touch
- Continuous innovation with 70 new 8-bit MCUs in the last two years
- MPLAB® IDE is free, and supports ALL of Microchip's microcontrollers
- Low-cost development tools help speed up prototyping efforts
- Comprehensive technical documentation, app notes and code examples
- World-class 24/7 technical support and training

## GET STARTED IN 3 EASY STEPS

1. Purchase the XLP 8-bit Development Board
2. Download free MPLAB® IDE
3. Order samples and start designing!
   www.microchip.com/8bit

XLP 8-bit Development Board (DM240313)

MICROCHIP

Microcontrollers • Digital Signal Controllers • Analog • Memory • Wireless

The Microchip name and logo, the Microchip logo, dsPIC, MPLAB and PIC are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries. All other trademarks are the property of their registered owners.
©2012 Microchip Technology Inc. All rights reserved. 3/12

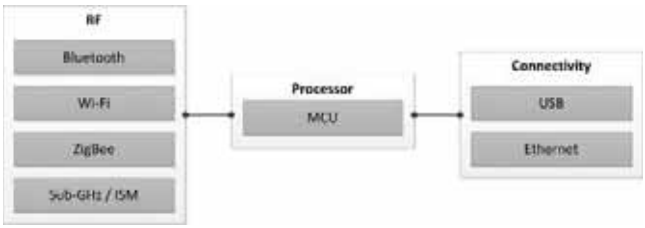



*Figure 2: Example of Connected Home Gateway Architecture*


*Figure 3: Basic Sensor Node Architecture*

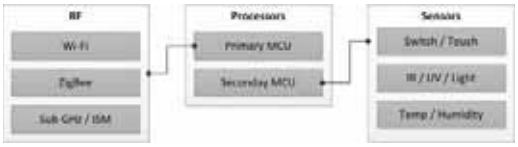



*Figure 4: Advanced Sensor Node Architecture*

return command and control data. At the other extreme, a "smart" gateway provides the command and control intelligence onboard and has the advantage of minimal latency and full functionality if the cloud connection is lost. However, smart gateway applications must manage the business logic and must be future-proofed to support system upgrades. Nobody wants to buy a wireless lighting control system today that requires a new gateway tomorrow.

The basic connected home node might be a door sensor, wireless light or a smoke detector, as shown in Figure 3. The MCU is likely to be a low-energy 8-bit device or a 32-bit ARM Cortex-M class device. Considerations for selecting the optimal MCU include memory and processing requirements for the RF stack and sensor management, energy consumption, device footprint and cost. Considerations for selecting the RF protocol include energy consumption, link budget and cost. Typical wireless connectivity options include a proprietary sub-GHz/ISM stack, ZigBee, Bluetooth or Wi-Fi. Of these options, sub-GHz and ZigBee are the most commonly used protocols for home automation as they provide the energy efficiency, long battery life (typically 3-5 years) and extended range required to locate a sensor node anywhere in a house without the inconvenience of having to change batteries frequently. Bluetooth lacks adequate range for many wireless sensor node applications because it there is no provision for repeaters. The power requirements of Bluetooth are also significantly greater than ZigBee. Wi-Fi requires higher power consumption than ZigBee and sub-GHz and is thus not appropriate for battery-powered applications in which the battery cannot be easily recharged.

For sub-GHz star endpoints or flooding-capable RF stacks and space-constrained applications such as sensor nodes, a small footprint, ultra-low energy 8-bit MCU and RF transceiver, or SoC with integrated MCU and transceiver may offer the most cost-effective solution. For ZigBee mesh networking applications, an SoC with integrated MCU and RF subsystems might be the best option, particularly where PCB area is at a premium. Look for MCU and RF transceiver suppliers who offer low-energy 8-bit and 32-bit Cortex-M MCUs and wireless SoCs along with the development tools to simplify implementing the RF stack requirements.

The advanced IoT end node might be a smart thermostat, wireless camera or a white goods device such as a washing machine, as shown in Figure 4. The main system MCU is likely to be a 32-bit ARM Cortex-M or Cortex-A class device combined with one or more secondary 32-bit Cortex-M class or 8-bit MCUs used to offload the primary processor, provide features such as capacitive touch sensing, or optimize the energy efficiency of the system by consolidating sensor functions.

Key considerations for selecting the primary MCU include memory and processing requirements for the RF stacks, sensor and system management, and cost. Energy consumption will be of concern for battery-powered-solutions. Considerations for selecting the secondary MCU include integrated features and energy efficiency. Look for MCU suppliers that offer the most energy-friendly 8-bit and 32-bit MCUs. Considerations for selecting the optimal RF connectivity solution include bandwidth, energy consumption link budget and cost, with ZigBee, Bluetooth and Wi-Fi being the most common options. Wi-Fi is the most widely used protocol for bandwidth-intensive applications such as a wireless camera, while ZigBee is ideal for thermostat applications with multiple nodes and lower data rates. Wi-Fi or Bluetooth provide easy connectivity with smart phones and tablets, which end users typically use to control their connected home applications.

IoT developers must consider this question when optimizing their end node application's energy efficiency: "Which is more important for my low-energy application—suspend current or active current?" The answer depends on the active time duty cycle. Some energy-friendly ARM Cortex-M class MCUs can consume as little as 110 µA/MHz in active mode and 900 nA in deep sleep with brown-out detection active, which means suspend and active operation contribute equally at 0.1% duty cycle at 8 MHz operation. Navigating MCU vendor datasheets to compare performance for low-energy applications can be a challenge. Look for MCU suppliers that offer energy estimation and profiling tools and offer excellent suspend and active current performance.

# PIC12F157X 8-bit Microcontrollers

## Small Form Factor with High-Resolution 16-bit PWMs


**The PIC12F157X family of MCUs combine high-resolution 16-bit PWM drive, closed-loop control and communication capabilities into an 8-pin form factor, enabling increased precision for drive and control in cost-sensitive applications. With operating currents as low as 30 µA/MHz, these products are ideal for lower-power applications. In addition, on-board Intelligent Analog peripherals can be connected internally with the PWM modules to facilitate closed loop feedback without requiring pins or using PCB space, which simplifies your design process.**

### Microchip's 16-bit PWM Features

- Additional PWM modes
  - Center aligned mode to improve EMI
  - Set/toggle on register match to add flexibility
- Independent timers to drive separate power stages or motors and improve configurability
- Multiple internal compare modes

### PIC12F1572 RGB COLOR MIXING DEMONSTRATION

The 8-pin PIC12F1572-based color mixing RGB badge provides a detailed insight into color mixing theory and demonstrates how PIC® microntrollers can provide intelligent color mixing for LED lighting applications.

MICROCHIP

Microcontrollers • Digital Signal Controllers • Analog • Memory • Wireless

The Microchip name and logo, the Microchip logo and PIC are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries. All other trademarks are the property of their registered owners.
©2014 Microchip Technology Inc. All rights reserved. 03/14

Another frequently asked question concerns the choice of MCU bit size for IoT applications: "When should I consider using an 8-bit MCU instead of a 32-bit solution for my end node application? Why not migrate to a modern 32-bit MCU based on an ARM Cortex-M architecture that supports expanded memory requirements, native 32-bit math and advanced peripherals?"

For many performance-intensive IoT applications, the 32-bit choice is of course the right answer, particularly where portability and future platform reuse are key concerns. However, for end-node applications where the goal is to fit in the absolute smallest footprint, run a lightweight RF stack or offload computation tasks from the main MCU, a streamlined and highly optimized 8-bit solution is often the right answer. A common misconception of an 8-bit architecture is that it suffers from low code density. In reality, this is true only when attempting 16- or 32-bit math. Control applications such as those found in offloading the main processor do not suffer from low density, and in fact, because 8-bit MCUs have very little overhead code, overall code density for control-type functions is higher than equivalent functions implemented on 32-bit MCUs.

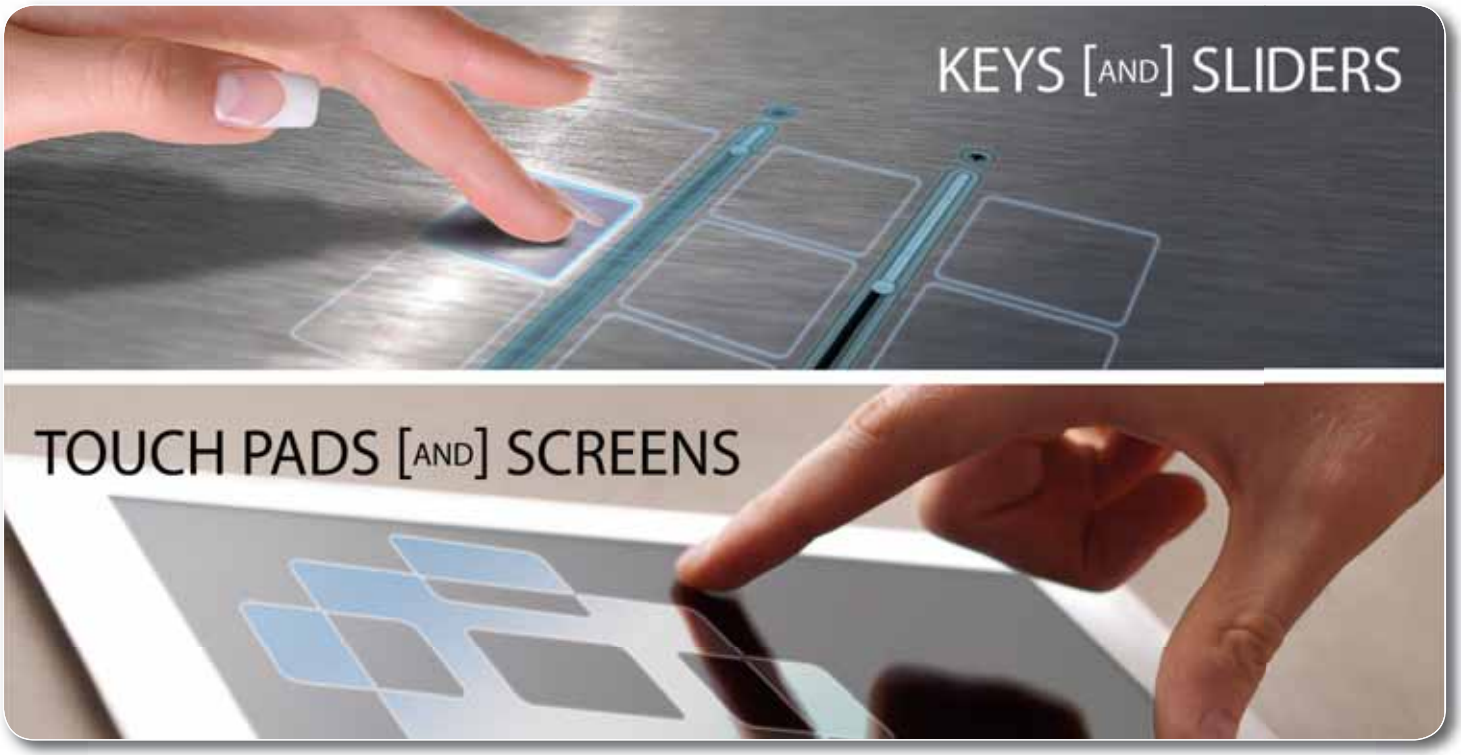
Another common misconception is that 32-bit MCU pricing is comparable to 8-bit options. Developers will hear this from MCU suppliers that are no longer investing in an 8-bit portfolio or competitive in the 8-bit market. The reality is that the 32-bit architecture and peripherals are significantly larger in gate count than 8-bit architectures and consume more silicon area when compared to 8-bit solutions in the same process geometry. Moving to a smaller process geometry shrinks the digital portion (which is about half of a typical MCU) and increases the system cost. When considering a comprehensive IoT solution provider, look for MCU vendors that are actively investing in both 8-bit and 32-bit MCU portfolios, and you will find the most flexible MCU options, the best technical solutions and the best pricing.

The IoT is the vision of a road to a hyper-connected world in which end users have dramatically expanded knowledge and control of their environments—at home, at work and on the road wherever they may be. Elegantly designed and innovative IoT connected devices, apps and cloud services will be most successful in driving the IoT revolution. IoT end nodes and gateways that offer the best combination of energy-efficiency, performance, cost effectiveness and appealing features—regardless of MCU bit size—will be in the driver's seat in the race to our IoT future. Are you ready?

*Greg Hodgson is director of marketing for Silicon Labs' microcontrollers group. He joined Silicon Labs in 2004 and has held senior roles in applications and systems engineering focusing on broadcast audio and in marketing focusing on 8-bit and 32-bit microcontroller products. Prior to joining Silicon Labs he was staff engineer at National Instruments focusing on design of audio analyzer equipment. Mr. Hodgson holds a BSECE from Ohio State University.*

# Integrate Touch Sensing Quickly and Easily

## With Microchip's Range of Low Power, Low Cost Solutions




**Microchip's mTouch™ Sensing Solutions offers a broad portfolio of low power, low cost & flexible solutions for keys/sliders, proximity and touch screen and touch pad controllers. Get to market faster using our easy GUI-based tools, free source code and low-cost development tools.**

### Capacitive Touch Keys, Sliders and Proximity

- Easy path to system integration
  - Turnkey products for fast time to market
  - Leverage Microchip's PIC® MCU portfolio
- High noise immunity and low emissions
- Extend battery life with eXtreme Low Power MCUs
  - Proximity sensing in less than 1 µA
- Proximity sensing up to 10 inches
- With **Metal Over Cap technology** you can:
  - Use polished or brushed metal surfaces including stainless steel and aluminum
  - Sense through gloves
  - Create waterproof designs
  - Deploy Braille-friendly interfaces

### Touch Screen and Touch Pad Controllers

- **Projected Capacitive technology**
  - Multi-touch enabling gestures
  - Low cost MCU implementation
  - Wide operating voltage: 1.8-5.5V
  - Low operating current 1.5 mA at 5V typical
  - Turnkey PCap Touch Controller MTCH6301 with multi-touch and gestures
- **Analog Resistive technology**
  - Lowest system cost, easy integration
  - Universal 4, 5 & 8-wire solution with on-chip calibration
  - Low power "touch to wake-up" feature

### GETTING STARTED IS EASY

Visit www.microchip.com/mtouch for source code, App notes, turnkey solutions and development tools

Enhanced mTouch Capacitive Evaluation Kit (DM183026-2) (For keys & sliders)

PIC32 GUI Development Board with Projected Capacitive Touch (DM320015)

Analog Resistive Touch Screen Development Kit (DV102011)

Analog Resistive with USB AR1100 Development Kit (DV102012)

MICROCHIP

Microcontrollers • Digital Signal Controllers • Analog • Memory • Wireless

The Microchip name and logo, the Microchip logo, dsPIC, MPLAB and PIC are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries. All other trademarks are the property of their registered owners.
©2013 Microchip Technology Inc. All rights reserved. 04/13

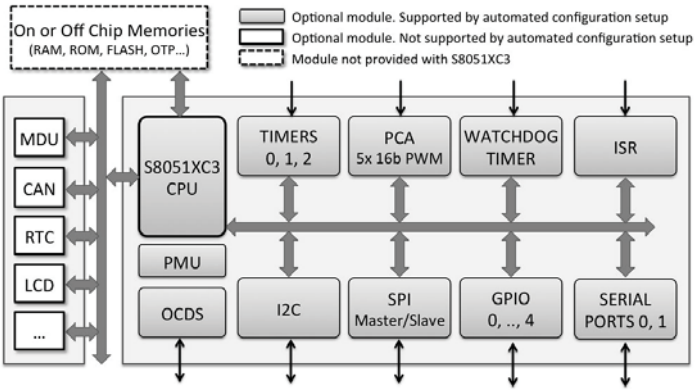
## S8051XC3 8-bit MCU IP Core

**Supported Architecture:** MCS-51

Implements a high-performance, low-energy, 8-bit microcontroller that executes the MCS®51 instruction set and includes a configurable range of features and integrated peripherals. The core's sophisticated architecture yields the fastest 8051-compatible 8-bit MCU available anywhere. It uses a single clock per machine cycle, and requires an average of 1.5 to 1.8 machine cycles per instruction. Dhrystone 2.1 tests show it runs from 9.41 to 26.85 times faster than the original 8051 at the same frequency, without requiring external arithmetic acceleration. ASIC results (65nm LP) have reached 500 MHz, for an effective speed-up of 1,000 times over 80C51 chips. Interrupt latency is a remarkably low two cycles. The core is one of the most energy efficient 8-bit processors available. Its small silicon footprint—CPU size can be under 6,500 gates—means very little power leakage. CPU dynamic power is as low as 2.3μW/MHz at 40nm, and its higher performance allows clocking at lower frequencies. Energy consumption can be adjusted to workload via dynamic frequency scaling and independent control of the CPU and peripherals clock. Available in RTL or FPGA netlists, the core's rich set of optional features and integrated peripherals allows designers to adjust performance and silicon requirements to best match an application's specific requirements. Development is facilitated by a single-wire or JTAG debugging interface, which operates seamlessly with popular IDEs.

### SPECIAL FEATURES

- Superior Performance: fastest available at 28.85x original (Dhrystone 2.1). Max frequency of 500MHz (65nm LP) makes it 1,000 times faster than original chips.
- Energy Efficiency: Small footprint for reduced leakage power. Better DMIPs/MHz enables lower frequency. Ultra-low dynamic power (2.3μW/MHz in 40nm), power-saving techniques.
- Great Configurability: easy selection and auto instantiation of wide variety of common peripherals and functions.
- Easy Development: JTAG or single-wire on-chip debug interfaces with low-cost debug pods and integration with Keil µVision and other IDEs.
- Cost-effective and Reliable: Simple, royalty-free licensing, backed by the most experienced 8051 IP team in the industry.




### TECHNICAL SPECS

- Fully MCS®51 code-compatible, with seamless IDE integration, easy breakpoint and trace setting, and included cycle-accurate simulation model.
- Rich set of bundled or custom peripherals and options, including Timer/Counters, Interfaces (CAN FD, I2C, SPI, LIN, and LCD), VDMA, MDU, and PMU.
- Flexible Memory Architecture with 64KB or 8MB address space; 8, 16, or 32-bit memory interface; Independent XTEM bus; acknowledged transactions for slow devices; & optional 16-bit or 24-bit DPTR.
- Extremely efficient interrupts handling, with up to 23 interrupts at two or four priority levels, and a two-cycle interrupt latency that beats 32-bit RISC processors.
- Hardware reference design boards available for IP evaluation or rapid system development.

### APPLICATION AREAS

Offloading main processors in complex SoCs, running deeply embedded systems, or managing analog sensors and other peripherals in IP subsystems. Application areas include Internet of Things (IoT) and wearable electronic devices, industrial control systems, and more.

### AVAILABILITY

Now

**CONTACT INFORMATION**

CAST
IP Cores & Subsystems

CAST, Inc.
11 Stonewall Crt.
Woodcliff Lake, NJ
07677 USA
+1 201.391.8300
+1 201.391.8694
info@cast-inc.com
http://www.cast-inc.com

# CAST, Inc.

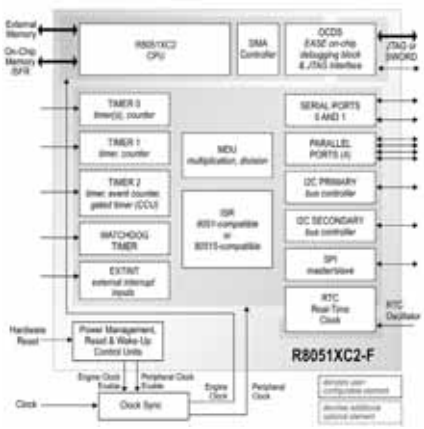
## 8051 MCU IP Core Family

**Supported Architecture:** MCS-51

CAST offers a comprehensive family of 8051 solutions ready for easy integration in new systems or to replace or upgrade discrete MCUs in existing systems. These combine the familiarity and reliability of the proven 8051 architecture with modern processor design techniques to provide fast, small, power-saving MCUs ideal for Internet of Things and other rapidly-growing applications. Working with 8051 development experts Silesia Devices and based on 16 years of satisfying 8051 customer requirements, CAST today provides its best 8051 product lineup ever. Available in RTL for ASICs or as FPGA netlists, the cores include the fastest 8051 in the industry, the most mature 8051 core available, and, coming soon, a version with configurable timing for exact replacement matching and an even faster 16-bit 80251 compatible. Full MCS®51 compatibility, JTAG or single-wire hardware debug interfaces, and the ability to use the Keil µVision or other poplar IDEs make system development quick and easy. The available Talos Series hardware reference design systems further simplifies IP evaluation or early system development with a complete, ready-to-run package. All of CAST's 8051 IP solutions are available without royalties and with simple, highly-competitive licensing, and are backed by what is probably the world's most experienced 8051 IP sales, support, and development teams.

### SPECIAL FEATURES

- Super-Fast, Low-Power S8051XC3 MCU — Modern processor techniques make it the fastest available, at 28.85x original, with superior area and power usage and a wide set of peripherals and functions.
- High-Performance, Configurable, Mature R8051XC2 — Competitively fast and small, used in hundreds of successful products over many years and built on 4th generation IP code.
- Configurable Discrete Part Replacement L8051XC1 — Modern 8051 design with tunable architecture & peripherals to exactly match functional and timing characteristics of existing chips (coming 3Q14).
- 16-bit, Higher Speed and Capacity S80251XC3 — Wider bus and increased speed using a modernized 80251-compatible design (coming 2Q14).
- 8051 IP Subsystems — Pre-integrated or custom-developed platforms for sensor management, embedded industrial functions, network controllers, display interfaces, etc. (available throughout 2014).




### TECHNICAL SPECS

- Sixteen years providing 8051 IP; highly experienced sales, support, and development team with over 200 customers and hundreds of millions of shipping devices.
- Superior solutions including the fastest 8-bit 8051 available, ultra-low interrupt latency and jitter, and the most mature IP code base.
- Easy development and debugging via full MCS®51 code compatibility, JTAG or single-wire hardware debug, reference design boards, and integration with Keil and other IDEs.
- Large library of integrated peripherals (and custom development available) for perfectly matching new or existing system requirements.
- Royalty-free licensing and competitive pricing make 8051s a cost-effective solution for nearly any project budget.

### APPLICATION AREAS

Offloading main processors in complex SoCs, running deeply embedded systems, or managing analog sensors and other peripherals in IP subsystems. Application areas include Internet of Things (IoT) and wearable electronic devices, industrial control systems, and more.

### AVAILABILITY

Now

**CONTACT INFORMATION**

CAST
IP Cores & Subsystems

CAST, Inc.
11 Stonewall Crt.
Woodcliff Lake, NJ
07677 USA
+1 201.391.8300
+1 201.391.8694
info@cast-inc.com
http://www.cast-inc.com

# New 70 MIPS dsPIC33 EP Family: High Performance & Integrated Op Amps

Microchip's new 70 MIPS dsPIC33EP devices offer high performance, advanced peripherals, and integrated analog. The 70 MIPS dsPIC® Digital Signal Controller core includes DSP acceleration, enabling high speed control algorithm execution. Beyond performance, the dsPIC33EP features advanced peripherals, including motor control PWM modules, a charge time measurement unit (CTMU), and multiple communication interfaces, including CAN and LIN. Finally, the dsPIC33EP integrates a high speed 10/12-bit ADC and three high speed op amps onto the device, reducing the need for external components and lowering costs. These features make the dsPIC33EP an excellent device for many applications including pumps, fans, power tools, white goods, and advanced sensors.

## SPECIAL FEATURES

- 70 MIPS of performance with DSP acceleration for high speed control algorithm execution
- Intelligent peripherals and integrated analog:
  - Up to 6 advanced motor control PWM outputs
  - Integrated, high performance on chip op amps
  - Charge time measurement unit for temperature and touch sensing
- Improved motor energy efficiency and quiet operation
- Reduce system costs:
  - dsPIC DSC performance enables sensorless control
  - On-chip op amps reduce external components

## TECHNICAL SPECS

- Flexible PWM Peripherals:
  - Dead-time insertion
  - Complimentary waveforms
  - Fault detection modes
- Intelligent interrupts:
  - Multiple PWM ADC triggers
  - Autonomous ADC controller
- Analog comparators for fault detection
- On chip, high performance op amps:
  - Reduce external components
  - Lower system cost
- Multiple package options ranging from 28 to 64 pins including new 5 x 5mm VTLA package


## AVAILABILITY

All products and supporting tools are available now.

- dsPIC33 "EP" Family: dsPIC33EP256MC506 includes variants from 32–256 KB Flash and from 28 to 64 pins
- All devices are available in I temp. (-40 to 85°C), E temp. (-40 to 125°C, Q100 Grade 1 qualified), and H temp. (-40 to 150°C, Q100 Grade 0 qualified) options.
- Supporting Motor Control and General Purpose Development Tools:
  - MCLV-2 Board for Low Voltage Motor Control Development (DM330021-2)
  - MCHV-2 Board for High Voltage Motor Control Development (DM330021-2)
  - dsPIC33EP256GP506 General Purpose PIM for Explorer 16 (DM240001 and MA330030)

## APPLICATION AREAS

- Automotive fans
- Sewing machines
- Washing machines
- Residential air conditioners
- Power tools
- Advanced sensors
- Pumps

**CONTACT INFORMATION**

MICROCHIP

Microchip Technology Inc.
2355 W. Chandler Blvd.
Chandler, AZ 85224
USA
888-MCU-MCHP Toll Free
480-792-7200 Telephone
480-792-7277 Fax
here2help@microchip.com
www.microchip.com

# Microchip Technology Inc.

## PIC24F "GA3" Family

The PIC24F "GA3" family features the industry's lowest active current for 16-bit Flash MCUs along with flexible new low-power sleep modes. The PIC24F GA3 devices feature 150 µA/MHz active current, a new low-power sleep mode with RAM retention down to 330 nA and a dedicated Vbat pin to back up the RTCC function to minimize the power consumed and maximize battery life. As an eXtreme Low Power Microcontroller the GA3 family has typical Deep Sleep currents of 10 nA and can maintain the RTCC with only 400 nA. The PIC24F 'GA3' family is also the first PIC24F to include segment LCD driver providing an expansion path for 8-bit designs requiring additional performance, Flash, RAM, or pins. Six channels of general purpose DMA increase the throughput of the family by offloading much of the data transfer associated with high bandwidth peripherals. Multiple serial channels and timers round out the feature set creating a versatile low power CMU family.

### SPECIAL FEATURES

- Integrated LCD display driver provides the ability to directly drive up to 480 segments, with an eight common-drive capability, enabling more informative and flexible displays that include descriptive icons and scrolling
- Dedicated Vbat pin for battery backup of the on-chip Real-Time Clock Calendar
- 6 DMA channels increase throughput by reducing CPU intervention required for high bandwidth peripherals
- Includes 24 channels of 12-bit 200 Ksps ADC with threshold detect. Threshold detect will allow the MCU to wake from sleep when the ADC meets a specified threshold.

### TECHNICAL SPECS

- **Advanced Low Power Features:**
  - Reduced Active Current - 150 µA/MHz
  - Deep Sleep Currents down to 10 nA
  - Watchdog Timer down to 270 nA
  - Vbat Battery Backup and Real–Time Clock/Calendar down to 400 nA
  - Low-Power RAM Retention with 330 nA Current
- Up to 128 KB for Flash Program Memory and 8 KB of Data Memory
- 4 UART, 2 SPI and 2 I²C™ serial channels
- 5 16-bit Timers, 9 IC and 9 OC
- CTMU for mTouch™ Capacitive Touch sensing


### AVAILABILITY

All variants of the PIC24FJ128GA310 family are in production. A PIC24FJ128GA310 General Purpose PIM (MA240029) and the LCD Explorer Development Board (DM240314) are also available to support development with the GA3 family.

### APPLICATION AREAS

- Consumer
  - Thermostats
  - Door Locks Industrial
- Security
  - Wired & Wireless Sensors
- Medical
  - Blood Pressure Meter
  - Glucose Meter
- Metering
  - E-Meters
  - Gas/Water/Heat Meters
  - Automated Meter Reading

**CONTACT INFORMATION**

MICROCHIP

Microchip Technology Inc.
2355 W. Chandler Blvd.
Chandler, AZ 85224
USA
888-MCU-MCHP Toll Free
480-792-7200 Telephone
480-792-7277 Fax
here2help@microchip.com
www.microchip.com

## Core Independent Peripherals

Embedded systems are becoming increasingly complex. The drive to add Internet connectivity, advanced diagnostics, and additional functionality to traditional consumer and industrial equipment has placed increasing demands on the MCUs that control these systems. Traditionally, each additional function supported by an MCU requires an increasing amount of FLASH memory to store variables, more RAM to execute code, and higher processing speeds to ensure that system timing is within specification. Unfortunately, this method of function integration requires a larger, more power hungry and expensive microcontroller than many system budgets can sustain. New microcontroller designs must support an increase in functional integration, while at the same time reducing overall power consumption, cost, and physical footprint. Today's cost-sensitive embedded design environment requires a move away from the traditional "arms race" of MIPS, Bytes, and Megahertz, and a paradigm shift into the era of function enablement.

### BREAK FREE WITH CORE INDEPENDENT PERIPHERALS

Microchip is leading the charge with its 8-bit PIC(R) microcontroller lineup by incorporating on-chip peripherals that can operate without supervision from the CPU, and have the ability to communicate directly with other peripherals to create flexible feedback loops. These "core independent" blocks of function-specific hardware intelligence require little to no code, consume very little power, and are much smaller than the RAM and FLASH needed to implement a given function within the core processor. This leads to flexible, power-efficient MCU designs with the capability to perform the same tasks as a much larger and more expensive device without the added cost.

### FLEXIBLE FUNCTIONAL BUILDING BLOCKS

Now, many functional building blocks – including power conversion, motor drive, sensor interface, and signal generation – can be implemented using a combination of these hardware peripherals. Because the Core Independent Peripherals require very little memory and CPU overhead, many functions can be implemented onto a single PIC MCU without sacrificing system timing or increasing power consumption. The following are just a few of the functions that can be enabled in hardware with Core Independent Peripherals: Power Conversion – Easily create self-correcting closed-loop control systems for many power control topologies with on-board PWMs for pulse drive and several unique analog peripherals that enable automatic slope compensation and AC mains zero crossing detection


Motor Drive – Utilize advance pulsing capability from the PSMC or 16-bit PWM module in conjunction with integrated hardware failure detection (with the Hardware Event Timer) to control almost any motor type – from brushed and brushless DC to AC Induction motors Signal Generation – 8-bit PIC MCUs have the widest array of pulse generation capability available on any 8-bit microcontroller. From kilohertz to Megahertz with integrated complement generation and dead band control, Microchip has your needs covered. Sensor Interface – From capacitive touch sensing to traditional analog sensor interface, our on-chip Intelligent Analog and digital communications peripherals will support an easy connection to a wide variety of sensors.

### EASY TO GET STARTED

Microchip's Code Configurator tool makes it easy to implement custom functional building blocks with Core Independent Peripherals. Just select your desired function, and the Code Configurator will provide the code to set up the PIC MCU's external pins, as well as the internal peripheral interconnections. Designing an embedded system has never been easier! For more information on Microchip's Core Independent Peripherals and the Code Configurator tool, visit www.microchip.com/CIP today!

**CONTACT INFORMATION**

MICROCHIP

Microchip Technology Inc.
2355 W. Chandler Blvd.
Chandler, AZ 85224
USA
888-MCU-MCHP Toll Free
480-792-7200 Telephone
480-792-7277 Fax
here2help@microchip.com
www.microchip.com

MICROCHIP

# Partner Guide

The Board Room Inc.

ELECTRONIC DESIGN & ASSEMBLY www.circad.com

**What can The Board Room do for you?**

> Ultra Low Power Embedded Systems
> USB, I2C, SPI Communications Protocols
> Wireless and Analog Designs
> ARM Cortex M3, M0+ Designs
> C++, .NET programming

**We Provide:**

> T&M Project Development
> Reliable Fixed Bid Engineering Quotations
> Customers Retain 100% of IP, Firmware, and Hardware Ownership

**The Board Room, Inc. - www.circad.com - 630-378-3500**

The Board Room is an Authorized Microchip Design Partner.


## Cyclotronics


Cyclotronics wants to develop fast, efficient, and reliable 8 or 16 bit PIC or dsPIC firmware for your product. We implement Bluetooth, USB, motion control, touch screens, encryption, and complex algorithms to name a few highlights. We can also provide companion Windows or Smartphone programs and APIs. We're happy to consult on your electronic design to make sure the total solution optimizes hardware/firmware tradeoffs.

Having 35 years experience with microprocessors and 25 years specifically with Microchip PICs, Cyclotronics principal Mark Sullivan is one of the most experienced embedded systems engineers in the industry today.

We have completed hundreds of product designs for happy customers. Ask for references.

Please call or email today to discuss your project.

Cyclotronics
(713)823-9938
picguru@cyclotronics.com


## Dave Engineering


**World Class Engineering Innovation**

MICROCHIP AUTHORIZED DESIGN PARTNER

Engineering Consulting Services

- Firmware, Software
- Analog, Digital, Power, PCB Layout
- Prototypes & Pilot Builds
- Turnkey Product Design & System Designs
- IP Licensing & Customization Available

Technology

MODULO CONTROLS

- LCD Graphics Touch Screens
- Bluetooth, BLE
- WiFi, Ethernet
- MiWi, Zigbee
- Motor Control
- Power Supplies & Power Electronics
- Android/iOS Aps
- MIL Spec, Industrial, Commercial

Dave Engineering LLC
daveengineering.com

daveengineering.com
5988 Mid Rivers Mall Drive
St. Louis, Missouri * 63304
(636) 229-5291


## Ecco Biomedical


**Proof of Concept to Manufacturing**

**Product Lifecycle Services**

- Engineering
  - Electronic
  - Software
  - Mechanical
- Regulatory
  - 60601, FDA 510K,
  - Labeling, Packaging
- Quality
  - ISO13485, ISO9000, Quality System
  - Regulation 21 CFR Part 820
- Marketing
  - Artwork, Business and Financial Plans
- Manufacturing
  - IQ/PQ/OQ
  - Assembly Lines
  - Full Functionality Test Fixtures
- Intellectual Property
  - Patent Search, submission and valuation
- Corporate Law

More than 20 years in the industry.

Ecco Biomedical
Engineering Consulting

**Ecco Biomedical**
**3302 Azahar Pl**
**Carlsbad, CA 92009**
**Tel. 760.822.2758**
**info @eccobiomedical.com**
**www.eccobiomedical.com**

# Code Conquering C Compiler for Microchip PIC® MCUs

## C-Aware IDE Features:

- Pro-Level Optimization
- C Profiler Timing Tool
- Project Wizards: CAN, USB, TCP/IP
- Debugger Watch Items
- Data Streaming PIC →ICD→PC
- Code Metrics
- Native WIN32 Application

## Compiler Features:

- Easily migrate between all devices
- Minimize development time with: peripheral drivers and standard C constructs
- C++ style input/output streams
- Royalty free CCS libraries and object code
- Convenient functions like #bit and #byte allow C variables to be placed at absolute addresses
- The integral one-bit type (Short Int) permits the compiler to generate very efficient Bit-oriented code
- Easily define, set-up and manage interrupts

CCS Inc

**www.ccsinfo.com/picc**

sales@ccsinfo.com

ph: 262-522-6500 sales x35 support x32

## Accelerate Product Development

Cost-effective In-Circuit Serial Program & Debug


ZIF or ICSP


Hand-held Programmer No PC Req'd


8-port Production Programmer

ICSP Programmer/Debuggers designed for PIC MCUs. Reliable for prototyping, small production runs or updating products in the field. CCS offers a range of products designed to meet your needs and fit your budget.

### Engineering and Design Services

CCS has 20 years of experience in embedded software and hardware designs.

- Code review, conversions and bug investigations
- Custom design with CAD files and documentation
- Complete existing designs
- Rapid Prototyping
- Assembly and testing for production runs

**Request a free Fixed Price Quote**

PREMIER MICROCHIP THIRD-PARTY PARTNER

PIC® MCU and dsPIC® are registered trademarks of Microchip Technology Inc. in the U.S. and other countries. ICSP™ and In-Circuit Serial Programming™ are trademarks of Microchip Technology Inc. in the U.S. and other countries.

P. R. GLASSEL
AND ASSOCIATES, INC.
30255 Fir Trail - Stacy, MN 55079 651-408-9007 www.prga.com

# Engineering Solutions for Your Ideas

**PRGA is a Software and Hardware Engineering Firm**

Contract Engineering Resources

- Short & Long Term Staffing
- Complete Project Management

AUTHORIZED MICROCHIP PARTNER

- ◊ Embedded Systems
- ◊ Requirements Definition
- ◊ Application Design and Implementation
- ◊ Digital Design
- ◊ Internet Enabled Products
- ◊ FPGA design
- ◊ Concept Feasibility
- ◊ Object Oriented Programming
- ◊ Hardware and Software System Interfacing
- ◊ Controller Design
- ◊ Data Communications
- ◊ Prototype Development
- ◊ Instrumentation Design and Implementation
- ◊ FDA QSR Design Control
- ◊ Firmware Development
- ◊ Driver Development and Support
- ◊ Analog Signal
- ◊ Medical Device & Instrumentation Design
- ◊ Industrial Process Controls
- ◊ Interactive Displays
- ◊ Product Re-Engineering
- ◊ Microcode Design and Development
- ◊ Printed Circuit Board Design
- ◊ Real-time Software Design and Implementation
- ◊ Hazard Analysis Requirements
- ◊ Verification and Validation Testing
- ◊ Wireless Systems Development and Integration
- ◊ ZigBee Development

sales@prga.com 651-408-9007 www.prga.com

# We are PIC® freaks. Just like you.


$249.00 $199.00 $199.00

**mikroC™**, **mikroBasic™** and **mikroPascal™** PRO for PIC® compilers

MIKROE-736 MIKROE-726 MIKROE-746

**Visual TFT™**
and **Visual GLCD™** software


$99.00 $99.00

MIKROE-790 MIKROE-1418

$99.00

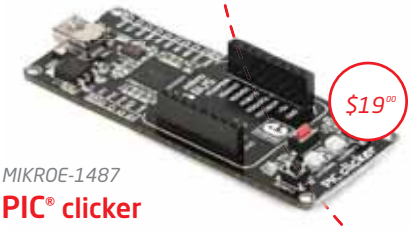
MIKROE-764

**mikroProg™** for PIC®, dsPIC® and PIC32® programmer & debugger

# PIC®

development solution

**Click™** boards



$19.00

MIKROE-1487

**PIC® clicker**

$99.00

MIKROE-607

**mikromedia™** for PIC18FJ®

$169.00

MIKROE-995

**EasyPIC PRO v7**

A full-featured development board for high pin-count 8-bit PIC® microntrollers

$149.00

MIKROE-798

**EasyPIC™ v7**

Top seller PIC® Development Board for 250 Microchip PIC® MCUs in DIP packaging

MikroElektronika
DEVELOPMENT TOOLS | COMPILERS | BOOKS

www.libstock.com

www.mikroe.com/pic/

## Ironwood Electronics

### Micro Giga-snaP™ BGA SMT Adapters

Micro Giga-snaP™ line of BGA adapters provide the most reliable interconnect to 0.5mm pitch BGA SMT pads. These patent pending adapters achieve 20 GHz bandwidth with 20mOhms contact resistance and 14g insertion force. The RoHS compliant BGA socket is soldered to a PCB using standard soldering methods without warping which results in reliable connection to PCB. Both BGA socket and adapter are constructed with high temperature polyimide material assuring match with target PCB's and preventing failures that occur due to CTE mismatch. BGA adapter, to which the user attaches a DUT, is plugged into the female BGA socket on the board, thereby chip is interconnected. The Giga-snaP™ BGA socket adapter line is available in many different pin counts/pitches and customs can be delivered in days.

Ironwood Electronics
1335 Eagandale Ct
Eagan, MN 55121
Tel: (800)404-0204
Fax: (952)229-8201
info@ironwoodelectronics.com
www.ironwoodelectronics.com

## Sign-up for the 8-bit & 16-bit Technologies E-Product Alert!


Subscribe at: *www.eecatalog.com*

## WE THINK INSIDE THE BOX

For 25 years, Silicon Engines has put microcontrollers into our customers' products — hundreds of thousands of PIC™ devices! When you need help getting intelligence into your box — contact Silicon Engines.

SILICON ENGINES
847-637-1180
sales@siliconengines.net
www.siliconengines.net

## Suntop Electronics Co.,Ltd

MICROCHIP AUTHORIZED DESIGN PARTNER

Suntop is specialized in the development &design of technology products, And technical services of related field. The promoted products and programs have made great achievements in various fields. In Suntop, there is a powerful R&D and service team of microcontroller software, hardware, including power and motor control and management etc. Our characteristic technical services including customized products, mass production test, standard certification and OEM electronic controller board.

- Support for MICROCHIP, SST, SMSC, Roving Networks full product family.
- MICROCHIP original development tools.
- Battery charge-management.
- Qi Compliant Wireless Power Transmitter Manager.
- Bluetooth & Wifi applications.
- BLDC Motor Control applications.
- PCBA OEM/ODM support.


Suntop 新拓电子
Knowhow For You

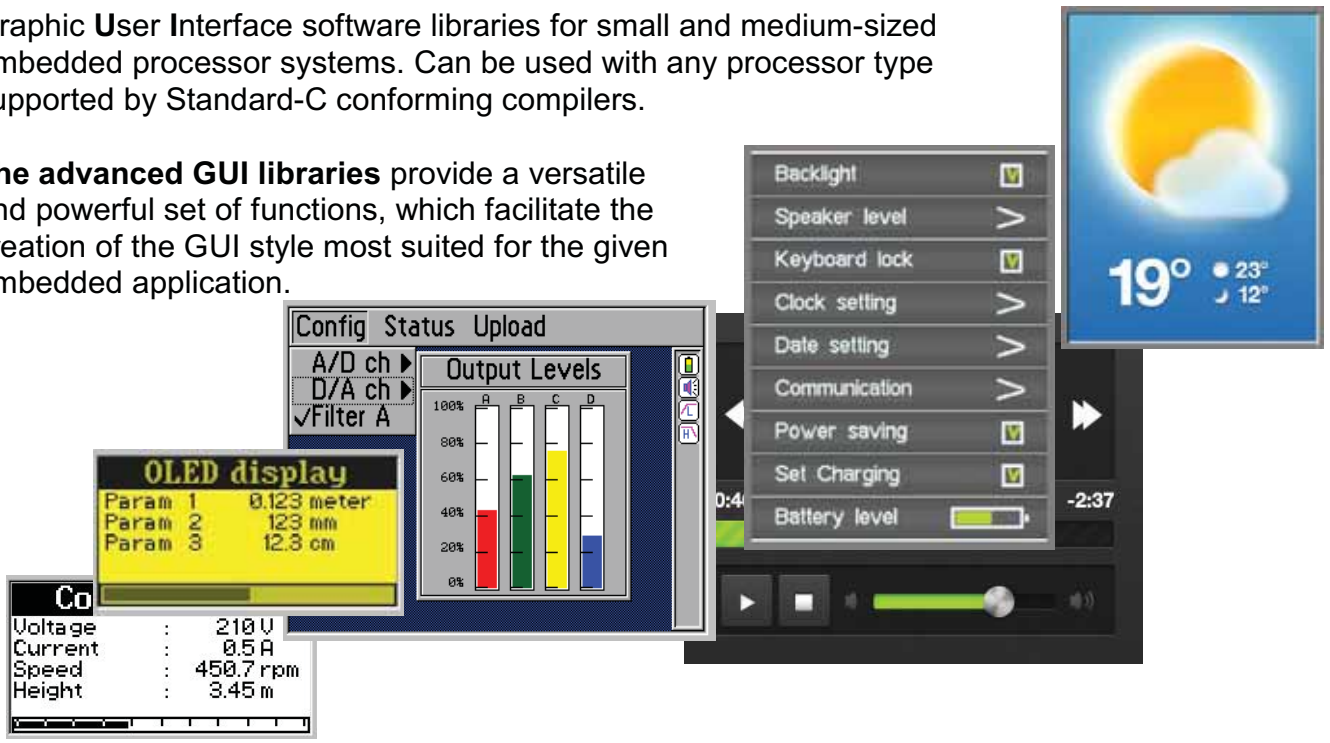
Suntop Electronics Ltd
Tel:+86 591 87767244
sales@1632bit.com
www.1632bit.com/en

# Display Controller GUI Libraries

## C source Libraries for Embedded Processor Applications

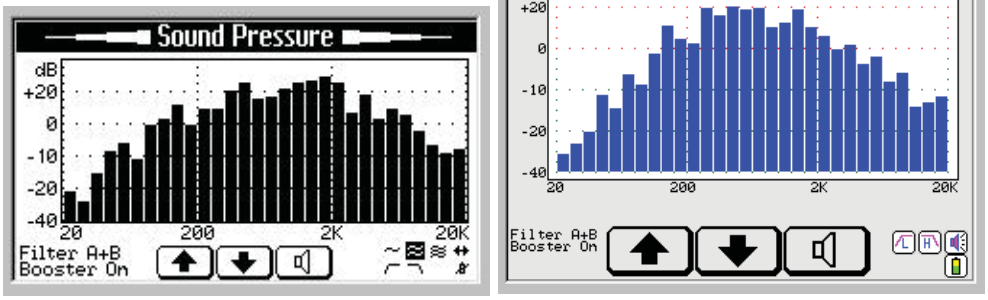
**G**raphic **U**ser **I**nterface software libraries for small and medium-sized embedded processor systems. Can be used with any processor type supported by Standard-C conforming compilers.

**The advanced GUI libraries** provide a versatile and powerful set of functions, which facilitate the creation of the GUI style most suited for the given embedded application.




**A uniform function interface** and use of adaptive design styles make it simple to reuse application C source code across different graphic controller types.

**Low-level driver code support** for more than 200 graphic display controller types. Support for b&w, grey-level, and color displays.




The libraries have been optimized for a small memory footprint. Support direct read-modify-write update of display controller memory. Can be used without video buffer in processor RAM.

**The tool chain supports** :

- Creation of graphic icons and multi-language fonts.
- Graphic image conversion for easy use with small embedded systems.
- Handling of large international fonts and text in external memory devices.
- Font optimization support for Asian languages.
- PC-simulation. Display controller simulation and fast prototyping using PC compilers.
- IOTester tool. Do GUI testing on the PC using real display module hardware for screen output.

More information at **www.ramtex.dk**

RAMTEX

RAMTEX International ApS
www.ramtex.dk
sales@ramtex.dk

Cooking up quality electrical, mechanical, software, and system engineering services

*Authorized Microchip design house*

technology kitchen™

***Providing innovative engineering solutions since 1998***

www.technologykitchen.com



XL Research Inc.

***Get Immediate Relief…***

What we specialize in:

- Real-Time Microcontroller Software (C and ASM)
- Single-Chip Microcontroller Hardware (PIC, dsPIC)
- Full Microchip™ Family Support (PIC10 thru PIC32)
- RS-485, USB, Ethernet and CAN-Bus Systems
- Wireless Data Transmission (RF, IR, Power-Line)
- Analog/Digital Circuit Design
- PCB Design (Altium Designer)

Why you'll like doing business with us:

- Microchip Design Partner since 1998
- Over 30 years of full-time consulting experience
- Honest, Personal and professional design approach
- Concept through first production prototype
- Extended network of highly qualified Design Associates

Call or email today to discuss your project needs.

XL Research Inc.

Jim Boyd
**XL Research Inc.**
P. O. Box 256 • Ironia, NJ 07845
Tel: (973) 584-0329
email: j.boyd@xlresearch.com



**8/16 bit-Technology** **ONLINE** **www.eecatalog.com/8bit**


**Explore...**

- ➔ Top Stories and News
- ➔ White Papers
- ➔ Expert Opinions (Blogs)
- ➔ Exclusive Videos
- ➔ Valuable Articles
- ➔ Directory of leading 8/16 bit-Technology Solutions

**Sign up for the EECatalog**
**8/16 bit-Technology Quarterly Report**
**Visit www.eecatalog.com/8bit**

# Flexible Cost-Effective BLDC Motor Control Solutions

## A New Generation of Digital Signal Controllers Enabling Simpler Designs


**Designers are being challenged to produce energy and environmental friendly solutions, which is driving the need for more advanced motor control. With the implementation of advanced, cost-effective motor control algorithms, the Digital Signal Controllers (DSCs) are poised to tackle the challenges facing the embedded control designer.**

dsPIC® DSCs contain innovative motor control PWM peripherals including complimentary waveforms and dedicated time-base. For applications that require variable speed with constant torque and field oriented control for greater efficiency, the high-performance dsPIC DSC core includes DSP instructions for more precise control. Advanced motor control algorithms are needed to produce quieter units that are more energy efficient. Field Oriented Control (FOC) has emerged as the leading method to achieve these environmental demands.

The single-chip motor control and motor drive solutions enable simpler designs and decrease board space. Advanced Motor Control often does not require a DSP, but benefits greatly from the DSP resources found on the dsPIC DSCs. For example, our sensorless field-oriented control algorithm makes use of the single cycle MAC with data saturation, zero overhead looping and barrel shifting to achieve stunning performance.

### GETTING STARTED IS EASY

Visit www.microchip.com/motor for more information.

Motor Control Started Kit with mTouch™ Sensing (DM330015)

dsPICDEM™ MCLV-2 Low Voltage Motor Control Development Board (DM330021-2)

MICROCHIP

Microcontrollers • Digital Signal Controllers • Analog • Memory • Wireless

The Microchip name and logo, the Microchip logo, and dsPIC are registered trademarks and mTouch and dsPICDEM are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries. All other trademarks are the property of their registered owners. ©2013 Microchip Technology Inc. All rights reserved. 08/13