Introducing the First 40 MHz PIC® Microcontrollers with 128 Kbytes of Self-Reprogrammable Flash Memory for High-End Designs

Microchip introduced four new high pin-count, high density members of the PIC18F family: the PIC18F6627, PIC18F6722, PIC18F8627 and the PIC18F8722. These microcontrollers offer: cost-effective 96 Kbytes or 128 Kbytes of self-reprogrammable, high-endurance Flash memory with up to 10 MIPS performance over a wide operating voltage range of 2.0V to 5.5V. These features, combined with nanoWatt Technology power management and a rich set of analog and digital peripherals, allow this microcontroller series to compete with 16-bit devices in high-end embedded applications, while retaining ease-of-use and helping designers to preserve their 8-bit development tool and software investments.

Engineers have a growing need for microcontrollers with increased computational power and larger program memory sizes, due to the transition of code development methodologies from assembly to C language, and they would rather not discard their 8-bit code and development tools. The PIC18F8722 8-bit microcontroller series addresses these performance and memory needs by providing linear access (no pages) to a memory space as large as 2 Mbytes, while offering complete code and tool compatibility with smaller Microchip microcontrollers. In addition, the new PIC18F microcontrollers include nanoWatt Technology for reduced energy budgets and prolonged battery life, along with two synchronous serial ports (capable of SPI™ or I²C™) and two asynchronous serial ports (LIN-capable USARTs) for expanded connectivity.

“Microchip’s commitment to offering the greatest breadth of Flash microcontrollers is exemplified by the PIC18F8722 series, providing the largest memory sizes and richest integrated features for embedded control applications,” said Ganesh Moorthy, Vice President of Microchip’s Advanced Microcontroller and Memory Division.

Applications that are ideal for the PIC18F8722 series’ huge linear-memory access space include the following:

- **Consumer** - wireless internet-enabled appliances, swing-gate controllers, hands-free cell phone adapters, coffee machines, two-way pagers
- **Automotive** - car alarms
- **Medical** - biological flow meters

**Additional Product Features**
- Two Enhanced Universal Synchronous/Asynchronous Receiver/Transmitters for RS232, RS485 and LIN serial interfaces
- Two Master Synchronous Serial Port modules, each supporting Master I²C or SPI interfaces
- 16-channel, 10-bit Analog-to-Digital Converter with auto-acquisition timing
- Two Analog Comparators
- Enhanced Capture/Compare/PWM modules with support for MOSFET (H-bridge) motor drives
- Extended Watchdog Timer with prescaler options
- Programmable Brown-out Reset and Low-voltage Detect circuits
- Software-selectable PLL options
- 8-bit/16-bit mode External Memory Access
- Enhanced Instruction Set for improved C Compiler efficiency

**Development Tools**
The PIC18F8722 microcontrollers are supported by Microchip's high-performance development tools, including:
- MPLAB® Integrated Development Environment (IDE)
- MPLAB C18 C Compiler
- MPLAB SIM 30 Software Simulator
- MPLAB ICD 2 In-Circuit Debugger
- MPLAB PM3 Universal Device Programmer

**Availability**
The PIC18F8722 series microcontrollers are available now in the following package options:

- PIC18F6627 - 64-pin TQFP
- PIC18F6722 - 64-pin TQFP
- PIC18F8627 - 80-pin TQFP
- PIC18F8722 - 80-pin TQFP

For more product information visit: www.microchip.com/PIC18FXXXX
The new PIC16F785 microcontroller provides a complete set of integrated peripherals for cost-effective digital control in power-conversion designs. This 8-bit Flash microcontroller has a large complement of on-board analog peripherals, including Analog-to-Digital Converters (ADCs), comparators, a voltage reference and two operational amplifiers (op amps), which appeal to a broad range of sensing and closed-loop control applications.

The PIC16F785 offers engineers the flexibility to cost effectively address a wide variety of power-conversion topologies and parameters in applications such as Switch Mode Power Supplies (SMPS) and battery chargers. Digital control in power-conversion applications is emerging as a viable means to manage the increasingly complex power requirements in today’s electronic systems. Today’s electronic systems require intelligent and deterministic control of multiple power rails, startup conditions, fault detection, exception handling, and complex battery-charging algorithms. The PIC16F785 makes it easier for power-supply designers to utilize the programmability of digital control in power-conversion applications by providing the familiar analog building blocks within a programmable microcontroller.

“The PIC16F785 is an excellent fit for power-conversion applications, but our customer base is very creative and will find many applications in all the markets Microchip serves, including appliance, automotive, consumer and industrial,” said Steve Drehobl, Vice President of Microchip’s Security, Microcontroller and Technology Division.

By providing two general-purpose op amps with a 3 MHz Gain Bandwidth Product (GBWP) and 5 millivolt input offset voltage, the PIC16F785 allows designers the flexibility to implement filters, input gains stages and other functions. These two op amps, combined with an integrated 1.2V bandgap voltage-reference output and two high-speed (40 nanosecond) comparators, places the PIC16F785 in a class of its own when it comes to integrated analog peripherals for input sensing. In addition, the PIC16F785’s rich, standard features make it an excellent general-purpose microcontroller for closed-loop control applications.

Additional Product Features
- High-speed, two-phase PWM with asynchronous feedback
- 3584 bytes Flash program memory, 256 bytes EEPROM and 128 bytes RAM
- 8 MHz precision internal oscillator
- nanoWatt Technology power-management features
- 12 Channels of 10-bit A/D converter
- Standard Capture/Compare/PWM (CCP) module
- Software-controlled Brown-out Reset and an extended Watchdog Timer

Development Tools
The PIC16F785 is supported by Microchip’s high-performance development tools, including:
- PICkit™ 1 Flash Starter Kit
- MPLAB® Integrated Development Environment (IDE)
- MPLAB ICD 2 (In-Circuit Debugger)
- PRO MATE® II and MPLAB PM3 universal device programmers
- PICSTART® Plus cost-effective development system

Availability
The PIC16F785 is available in the following package options. General sampling is available now and volume production is expected in February.

PIC16F785 - 20-pin PDIP, SOIC, SSOP and 4x4 QFN

For more product information visit: www.microchip.com/PIC16F785
Microchip Delivers Two 16-bit dsPIC® Digital Signal Controllers with CAN for High-Performance Motor Control and Power Conversion Applications

Microchip's enhanced, Flash self-programming capability features a remote upgrade to the Flash program memory, allowing code revisions in end-users' applications. These features provide flexibility, reduced development time, increased manufacturing efficiency and faster time-to-market.

Additional Product Features

- 48 Kbytes of Flash Program Memory, which can withstand over 100,000 erase/write cycles and has 40-plus years of data retention over a wide operating voltage and temperature range
- 2 Kbytes of SRAM and 1 Kbyte of high-endurance EEPROM data memory
- Six Output Motor Control, Pulse Width Modulators (PWMs)
- 10-bit Analog-to-Digital Converter (ADC) with up to nine signal channels and 500k samples-per-second
- Five 16-bit Timers
- SPI™, I²C™ and up to two UARTs
- One CAN Interface
- Operates at 5 volts, which is valuable for noise immunity and minimizing voltage translation logic

Development Tools

All dsPIC30F DSCs are supported by Microchip’s high-performance development tools, including:

- MPLAB® Integrated Development Environment (IDE)
- MPLAB C30 C Compiler
- MPLAB SIM 30 Software Simulator
- MPLAB ICD 2 In-Circuit Debugger
- MPLAB ICE 4000 In-Circuit Emulator
- MPLAB Visual Device Initializer

Availability

The dsPIC30F4011 and dsPIC30F4012 are available today for general sampling and volume production in the following package options.

- dsPIC30F4011- 40-pin PDIP, 44-pin QFN or TQFP
- dsPIC30F4012- 28-pin SDIP or SOIC

For more product information visit: www.microchip.com/dsPIC30F40XX
Microchip Debuts Input/Output Expanders that Support 1.7 MHz \(\text{i}^2\text{C}\)\textsuperscript{TM} and 10 MHz \text{SPI}\textsuperscript{TM} Interfaces

Microchip has introduced two 8-bit input/output (I/O) expanders, the **MCP23008** and the **MCP23S08**.

The MCP23008 is the only I/O expander that supports standard (100 kHz), fast (400 kHz) and high-speed (up to 1.7 MHz) \(\text{i}^2\text{C}\)\textsuperscript{TM} communications. The MCP23S08 is the only I/O expander that features SPI\textsuperscript{TM} clock speeds of up to 10 MHz.

These unique product features make it easy and cost-effective for designers to upgrade or enhance their current microcontroller-based systems with additional I/O requirements. The MCP23008 and MCP23S08 provide system I/O expansion via existing microcontroller serial ports, saving development time and cost by eliminating the need to redesign the complete system with a higher I/O microcontroller.

**Additional Product Features**

- **8-Bit remote bidirectional I/O port:**
  - I/O pins default to input
- **Hardware address pins:**
  - Three for the MCP23008 to allow up to eight devices on the bus
  - Two for the MCP23S08 to allow up to four devices using the same chip select
- **Configurable interrupt output pin:**
  - Configurable as active-high, active-low or open-drain
- **Configurable interrupt source:**
  - Interrupt-on-change from configured defaults or pin change
- **Polarity inversion register to configure the polarity of the input port data**
- **External reset input**
- **Low standby current:** 1 μA (max.)
- **Operating voltage range:**
  - 1.8V to 5.5V @ -40°C to +85°C (I-Temp)
  - 2.7V to 5.5V @ -40°C to +85°C (I-Temp)
  - 4.5V to 5.5V @ -40°C to +125°C (E-Temp)

**Availability**

Samples and volume production are available in the following (Pb)-free packages.

**MCP23008** - 18-pin PDIP, 18-pin SOIC and 20-pin SSOP

**MCP23S08** - 18-pin PDIP, 18-pin SOIC and 20-pin SSOP

For more product information visit: [www.microchip.com/MCP23X08](http://www.microchip.com/MCP23X08)
Microchip Offers Acoustic Echo Cancellation and Noise Suppression Libraries for dsPIC® DSC-Based Speaker and Microphone Applications

Software Libraries Provide a Cost-Effective, Easy Way to Improve Sound Quality and Intelligibility

Microchip has introduced two new software libraries for its 16-bit dsPIC® Digital Signal Controllers (DSCs). The G.167-standard compliant dsPIC30F Acoustic Echo Cancellation Library offers improved performance for speaker and microphone-based products that either have no cancellation today, or can benefit from the reduced cost offered by Microchip’s unique licensing structure. The dsPIC30F Noise Suppression Library enables design engineers to gain a competitive edge for their microphone-based products with a methodology that goes well beyond standard filtering techniques for impressive intelligibility gains in environments subject to variable noise. These libraries can be used together to provide an ideal solution for applications with high levels of ambient noise and echo in compact environments.

The dsPIC30F’s DSP instructions are used extensively in both libraries. Yet, despite the complexity of these libraries, the user-interface is simple – just one library file and one header file.

Product Applications

Applications that can benefit from these advanced libraries include:

- Hands-free cell phone kits
- Speaker phones, intercoms
- Emergency vehicles
- Teleconferencing systems, headsets
- Front end of speech-recognition systems

“Most people use complex analog filters to achieve noise suppression. However, detecting and suppressing a wide range of rapidly-changing noise profiles requires something more,” said Sumit Mitra. “With an evaluation license fee of $5 USD, Microchip makes it easy for engineers to test-drive our Noise Suppression Library or Echo Cancellation Library to determine whether the dsPIC DSC is right for their design.”

With the dsPIC30F Acoustic Echo Cancellation Library, the received far-end speech samples are filtered using an adaptive Finite Impulse Response (FIR) filter. The coefficients of this filter are adapted using the Normalized Least Means Square (NLMS) algorithm, such that the filter closely models the acoustic path between the near-end speaker and the near-end microphone. A Non-Linear Processor (NLP) algorithm is used to eliminate residual echo. Voice activity detection and double-talk detection algorithms are used to avoid updating filter coefficients when there is no far-end speech and when there is simultaneous speech from both ends of the communication link (double-talk). This library is configurable for 16-, 32- or 64-millisecond maximum echo delays (echo tail-lengths). The library is also compliant with the G.167 standard and has been tested for compliance with G.167 specifications for in-car applications.

In the dsPIC30F Noise Suppression Library, the noise suppression is primarily a frequency domain algorithm. The signal is sampled at 8 kHz and a Fast Fourier Transform (FFT) is performed on each 10-millisecond block of data to analyze the frequency components of the signal. Thereafter, a voice-activity-detection algorithm is used to determine whether the signal segment is speech or noise. The noise suppression algorithm maintains a profile, which is updated each time a noise-only block is detected. Every frequency band of the input signal is scaled down in proportion to the noise in that frequency band, thereby causing a significant degree of noise suppression in the resultant signal. The algorithm adapts to changes in the nature and level of noise and does not require a separate noise-reference input.

Availability and Pricing

All licensing options for both libraries are immediately available. Among these options is a one-year evaluation license, which is unaltered from the libraries that are used for production and can be purchased online at http://buy.microchip.com.

The dsPIC30F Noise Suppression Evaluation Library license (SW300040-EVAL) is $5 USD.

The dsPIC30F Acoustic Echo Cancellation Evaluation Library license (SW300060-EVAL) is $5 USD.

Industry-unique, one-time-fee licensing options are also available for production, which runs counter to the per-unit royalty business model that is common for this class of library. Starting at $2,500 USD for 5,000-unit products, the license fee that Microchip charges is attractive to many customers since it is a fraction of the cost they would incur developing it themselves.

For more product information visit: www.microchip.com
Microchip Technology Announces dsPIC30F Symmetric and Asymmetric Key Encryption Libraries for Secure Embedded Transaction Communications

Software Libraries Developed by NTRU Cryptosystems Cost-Effectively Reduces Risk of Unwanted Data Manipulation or Interpretation with Single dsPIC® Digital Signal Controller

Microchip has announced two encryption software libraries for its 16-bit dsPIC® Digital Signal Controllers (DSCs). The dsPIC30F Symmetric Key Encryption Library enables embedded designers to take advantage of the high data throughput intrinsic to the popular Advanced Encryption Standard (AES) and Triple Data Encryption Standard (DES) “Secret Key” algorithms.

The dsPIC30F Asymmetric Key Encryption Library supports the Digital Signature Algorithm (DSA) and Rivest-Shamir-Adelman (RSA) algorithms, which each utilize two separate keys to protect data – enabling design engineers to reduce code-breaking risks by sharing only one of the keys. Whether doing symmetric or asymmetric encryption separately or in tandem, the dsPIC DSC reduces customer costs and occupied board space by providing both, embedded control and secure data communication.

The two dsPIC30F Encryption Libraries, which were developed by NTRU Cryptosystems, Inc., of Burlington, MA, consist of C-callable functions. Both libraries are optimized for speed, code size and RAM usage. RAM usage with the Symmetric Library is below 60 bytes, and is below 100 bytes with the Asymmetric Library.

“Though communications have long been a part of embedded applications, encryption is a valuable addition for many,” said Sumit Mitra, Vice President of Microchip’s Digital Signal Controller division. “From an embedded processor viewpoint, encryption is the next stage of evolution after basic code protection. However, it takes a processor with the dsPIC DSC’s performance to handle the application alongside the demands of real-time secure communication.”

Any embedded application where data or code is uploaded or downloaded can benefit from these advanced encryption libraries. Applications that can benefit from these libraries include:

- Mobile and wireless devices (PDAs, smart-card terminals, secure banking and Internet applications)
- ZigBee™ protocol and other monitoring and control applications
- Secure devices and peripherals interoperating with personal computers running Trusted Computing Group (TCG) or Microsoft’s Next-Generation Secure Computing Base (NGSCB)
- Speaker phones, intercoms

The dsPIC30F Symmetric Key Encryption/Decryption Library functions support multiple modes of operation, including:

- Electronic Code Book (ECB) mode
- Cipher Block Chaining mode (CBC)
- CBC-based Message Authentication (CBC-MAC) mode
- Counter (CTR) mode and combined CBC-MAC and Counter Mode (CCM)

In addition to standard encryption, decryption and authentication functions, the dsPIC30F Asymmetric Key Encryption Library has several useful auxiliary functions. These auxiliary functions include:

- Modular Arithmetic functions
- Random Number Generator (RNG), SHA-1 Hash algorithm
- Message Digest algorithm MD5

“The dsPIC digital signal controller is well-suited for security applications and the porting effort was made extremely efficient by the architecture and tools provided by Microchip and the expertise of our engineers,” said Ed King, CEO of NTRU. “By providing these encryption libraries, we believe that Microchip has taken strong steps to address the emerging market for secure embedded communications.”

Availability and Pricing

All licensing options for both libraries are immediately available. Among these options is a one-year evaluation license, which is unaltered from the libraries that are used for production and can be purchased online at http://buy.microchip.com.

The dsPIC30F Symmetric Key Encryption Evaluation Library license (SW300050-EVAL) is $5 USD.

The dsPIC30F Asymmetric Key Encryption Evaluation Library license (SW300055-EVAL) is $5 USD.

Industry-unique, one-time-fee licensing options are also available for production, which runs counter to the per-unit royalty business model that is common for this class of library. Starting at $2,500 USD for 5,000-unit products, the license fee that Microchip charges is attractive to many customers since it is a fraction of the cost they would incur developing it themselves.

For more product information visit: www.microchip.com
Thousands of engineers worldwide purchased Microchip’s power-packed dsPIC30F Design Contest Kit. Contestants created a product design, related block and flow diagrams, a schematic of the circuitry and project source code, all based on a dsPIC30F digital signal controller. Judging focused on innovation and the best use of on-board dsPIC30F features.

Microchip named Dave Wetzel of Roanoke, VA., the top prize winner of its dsPIC® Digital Signal Controller Design Contest.

The $15,000 USD first-place prize went to Wetzel’s “Stereo Audio System” entry. This top design is for an audio processing system, which takes advantage of the dsPIC30F’s buffered on-chip peripherals to minimize interrupt service time and maximize overall performance. As a result, Wetzel was able to include a dual 12-band graphic equalizer using independent IIR filters with performance left over for dual audio-amplitude compressors that are used to control dynamic volume range. His design also includes a real-time VU meter display using some of the dsPIC30F’s unique instructions to facilitate the fast calculation of decibels on the LCD display.

These features are particularly useful for environments where the range of audio volume should not vary to levels that are too quiet or too loud, such as an elevator.

The second-place prize of $7,500 USD was awarded to Alister Watt of Sunbury, Middlesex, UK, for his “Musical Instrument” design. Josef Stastny of Velke Mezinici, Czech Republic, earned the $3,000 USD third prize for his “Aircraft VOR Recorder” design.

“We were pleased to see so many high-quality entries and to receive so much positive feedback from contestants, who were impressed with the dsPIC digital signal controller’s capabilities, ease of programming, small learning curve and excellent tools. These features enabled entrants to create major designs in only a few months,” said Sumit Mitra vice president of Microchip’s Digital Signal Controller Division. “Microchip offers a unique digital signal controller that seamlessly integrates the control attributes of a 16-bit microcontroller with the computation and throughput capabilities of a digital signal processor. This contest offered participants an exciting way to experience the best of both worlds.”

The remaining prizes consisted of Microchip support hardware and software, including: MPLAB® ICE 4000 In-Circuit Emulators, MPLAB C30 C Compilers, MPLAB ICD 2 In-Circuit Debuggers and Digital Filter Design Software.

Below is a complete list of winning entries:

Dave Wetzel, Virginia: Top prize winner ($15,000 USD)
Alister Watt, UK: Second-place prize ($7,500 USD)
Josef Stastny, Czech Republic: Third-place prize ($3,000 USD)
Paco Tortosa, Spain: Easy Robot (GUI)
Scott Bishop, Virginia: Auto Transmission Controller
Dennis Newell, California: Sleep Monitor
Dale Shpak, Canada: Audio Lighting
Moe Wheatley, Georgia: Entry 1, Cuckoo Clock
Gerard Samblancat, France: MP3 Player
Tim Bagwell, California: Communication Analyzer “Eye”
Mikulas Kiss, Slovakia: GSM Recorder
Jason Clemens, Minnesota: Martial Arts Trainer
Moe Wheatley, Georgia: Entry 2, dsPIC Digital Signal Controller Performance Evaluation
David L. Roberson, Virginia: SSB Generator
Jason Young, Ohio: General-Purpose Communications Board
Arpana B. Jinaga, India: Communications Jammer
Ing. Raffaele Colella, Italy: I & Q Path Analyzer
Xavier Montagne, France: RTOS for dsPIC Digital Signal Controller
Henry Pfister, Florida: Acoustic “Eye”
Robert Lacoste, France: Contest Director’s Award; Digital Radio
Paul Bjork, Minnesota: Honorable Mention; Four Motor Controllers

For more product information visit: www.microchip.com/dsPIC30F
MCP62X5 Op Amp Family Receives analogZONE's “2004 Product of the Year Award”

Microchip’s MCP62X5 family of cascaded Operational Amplifiers (Op Amps) are the recipients of a “2004 Product of the Year Award” by analogZONE in its Best Signal Processing Architecture category. The winning products were selected by analogZONE editor-in-chief Paul McGoldrick and editor Lee Goldberg.

“As we have noted before, this is not a very democratic process,” commented Editor-in-Chief Paul McGoldrick. “We don’t ballot our readers; we don’t haggle with vendors, or - even as other publications do, heaven help us - ask the suppliers to submit essays for their reasons why they think they should win. As always at analogZONE, with every review we write, we put our money where our mouth is.” McGoldrick went on to say that he and editorial colleague Lee Goldberg believe the products selected “will make significant bottom line numbers for the companies involved” because of their strong technical merit, design innovation and marketability.

To view analogZone’s complete review visit: www.analogzone.com.

The innovative MCP6275/85/95 op amps enable a standard, two-stage amplifier signal chain to be implemented into an 8-pin package with a power-saving chip select. The internal connection of the two stages enables one op amp to feed into the other, making a more compact design. The devices are extended, industrial-temperature range (-40°C to 125°C), Rail-to-Rail input/output (I/O), single-ended op amps. Covering the 2 MHz, 5 MHz and 10 MHz Gain Bandwidth Product (GBWP), these devices allow for a current-flow efficient design by providing low supply-current requirements. With a migration path along the GBWP spectrum, designers can optimize the GBWP to be selected for the current flow, versus GBWP demand for the application.

Product Features

- **MCP6275** - 2 MHz gain bandwidth; operating voltage range of 2.0V to 5.5V; supply current of 165 microamps
- **MCP6285** - 5 MHz gain bandwidth; operating voltage range of 2.2V to 5.5V; supply current of 450 microamps
- **MCP6295** - 10 MHz gain bandwidth, operating voltage range of 2.4V to 5.5V; supply current of 1.0 milliamps

These devices are ideal for sensor, automotive, instrumentation, industrial and battery-operated applications.

For more product information visit: www.microchip.com/MCP6275  
www.microchip.com/MCP6285  
www.microchip.com/MCP6295

About analogZONE

analogZONE is the premier online source for electronics design engineers working in the fields of power management, audio/video, acquisition, connectivity, networking, wireless applications and green engineering. sub-ZONEs covering these specific areas enable the designer to focus directly on products of interest, with timely and insightful reviews. News headlines and a calendar of events keep readers current, knowledgeable and informed, while companion ZONEs, providing detailed technical notes and guest columns, offer a wealth of information in an independent arena, free from the limitations of print publication.

PIC10F20X Microcontrollers Win Electronic Products Magazine’s “29th Annual Product of the Year” Award

Revolutionary 6-pin PIC® Microcontrollers recognized for Innovation and Design Functionality have won prestigious awards from two leading design-engineering trade publications, Electronic Products magazine and ECN magazine.

PIC10F20X Microcontrollers Win Electronic Products Magazine’s “29th Annual Product of the Year” Award

From the thousands of products introduced in 2004, the editors of Electronic Products have chosen what they feel are among the most outstanding — based on significant advances in technology or its application, a decided innovation in design, or a substantial gain in price-performance.


For more product information visit: www.microchip.com/PIC10F20X

ECN Magazine Awards Microchip’s PIC10F20X Family with its 2004 “First Annual Product Technology” Award

Microchip’s PIC10F20X Microcontrollers won the Integrated Circuits category of ECN Magazine’s 2004 “First Annual Product Technology Awards”. The editors of the magazine nominated 10 products in each category, which were then voted on by their 126,000 readers.

To view ECN’s product description please visit: www.reed-electronics.com/ecnmag/article/CA487535

For more product information visit: www.microchip.com/PIC10F20X
**Tips ‘n Tricks - PICmicro® Microcontroller CCP and ECCP**

The Capture, Compare, and PWM (CCP) modules that are found on many of Microchip’s microcontrollers are used primarily for the measurement and control of time-based pulse signals. The Enhanced CCP (ECCP), available on some of Microchip's devices, differs from the regular CCP module in that it provides enhanced PWM functionality – namely, full-bridge and halfbridge support, programmable dead-band delay, and enhanced PWM auto-shutdown. The ECCP and CCP modules are capable of performing a wide variety of tasks. The tips below describe some of the basic guidelines to follow when using these modules, as well as give suggestions for practical applications. Additional tips and tricks can be found at: www.microchip.com.

**TIP 1. Measuring the Period of a Square Wave**

1. Configure control bits CCPxM3:CCPxM0 (CCPxCON<3:0>) to capture every rising edge of the waveform.
2. Configure the Timer1 prescaler so Timer1 will run TMAX(1) without overflowing.
3. Enable the CCP interrupt (CCPxIE bit).
4. When a CCP interrupt occurs:
   a) Subtract saved captured time (t1) from captured time (t2) and store (use Timer1 interrupt flag as overflow indicator).
   b) Save captured time (t2).
   c) Clear Timer1 flag if set.

The result obtained in 4.a is the period (T).

**Note:** TMAX is the maximum pulse period that will occur.

**TIP 2. Measuring the Period of a Square Wave with Averaging**

1. Configure control bits CCPxM3:CCPxM0 (CCPxCON<3:0>) to capture every 16th rising edge of the waveform.
2. Configure the Timer1 prescaler so Timer1 will run TMAX(1) without overflowing.
3. Enable the CCP interrupt (CCPxIE bit).
4. When a CCP interrupt occurs:
   a) Subtract saved captured time (t1) from captured time (t2) and store (use Timer1 interrupt flag as overflow indicator).
   b) Save captured time (t2).
   c) Clear Timer1 flag if set.
   d) Shift value obtained in Step 4.a right four times to divide by 16 – this result is the period (T).

**Note:** TMAX is the maximum pulse period that will occur.

**TIP 3. Measuring Pulse-Width**

1. Configure control bits CCPxM3:CCPxM0 (CCPxCON<3:0>) to capture every rising edge of the waveform.
2. Configure Timer1 prescaler so that Timer1 will run WMAX without overflowing.
3. Enable the CCP interrupt (CCPxIE bit).
4. When CCP interrupt occurs, save the captured timer value (t1) and reconfigure control bits to capture every falling edge.
5. When CCP interrupt occurs again, subtract saved value (t1) from current captured value (t2) – this result is the pulse-width (W).
6. Reconfigure control bits to capture the next rising edge and start the process all over again (repeat steps 3 through 6).

**TIP 4. Measuring Duty Cycle**

The duty cycle of a waveform is the ratio between the width of a pulse (W) and the period (T). Acceleration sensors, for example, vary the duty cycle of their outputs based on the acceleration acting on a system. The CCP module, configured in Capture mode, can be used to measure the duty cycle of these types of sensors.

1. Configure control bits CCPxM3:CCPxM0 (CCPxCON<3:0>) to capture every rising edge of the waveform.
2. Configure Timer1 prescaler so that Timer1 will run TMAX(1) without overflowing.
3. Enable the CCP interrupt (CCPxIE bit).
4. When CCP interrupt occurs, save the captured timer value (t1) and reconfigure control bits to capture every falling edge.
5. When the CCP interrupt occurs again, subtract saved value (t1) from current captured value (t2) – this result is the pulse width (W).
6. Reconfigure control bits to capture the next rising edge.
7. When the CCP interrupts occurs subtract saved value (t1) from the current captured value (t3) – this is the period (T) of the waveform.
8. Divide T by W – this result is the Duty Cycle.
9. Repeat steps 4 through 8.
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