

Introduction to the 16-bit PIC24F Microcontroller Family

© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 1

Welcome to PIC24 Family Introduction Webinar. My name is Don Schneider and I am a Product Marketing Manager on the PIC24F product line. I will be your guide on this tour of Microchip's 16-bit products. With another 20 minutes or so ahead of us I would like to take a moment to discuss who should be watching this Web Seminar and why.



Objectives

After viewing this webinar you will be able to...

- **Identify the basic differences between Microchip's four 16-bit families**
- **Understand the capabilities of the PIC24F**
- **Know what tools and software support is available for Microchip's 16-bit products**

© 2006 Microchip Technology Incorporated. All Rights Reserved.

PIC24F Family Introduction


Slide 2

Perhaps you are currently using 8-bit PIC[®] microcontrollers but need more performance for your next project. Or you may have heard about the PIC24F, PIC24H or the dsPIC[®] Digital Signal Controllers, but haven't had time to read the product briefs. Maybe you have been looking for a 16-bit, or possibly even considering a 32-bit product but aren't sure where to start. Today's Webinar should be beneficial to you in all of these cases.

So what can you expect to get out of this presentation? First you will learn enough about Microchip's 16-bit product families to determine which family best suits your application.

We will also take a closer look at the capabilities of PIC24F, Microchip's entry level 16-bit. Hopefully you will get enough detail to know which samples to request from microchip.com. (sample.microchip.com)

Finally, you should finish this webinar with a good idea of which demonstration boards to order and what software is available to shorten your development time when using any of the 16-bit families.



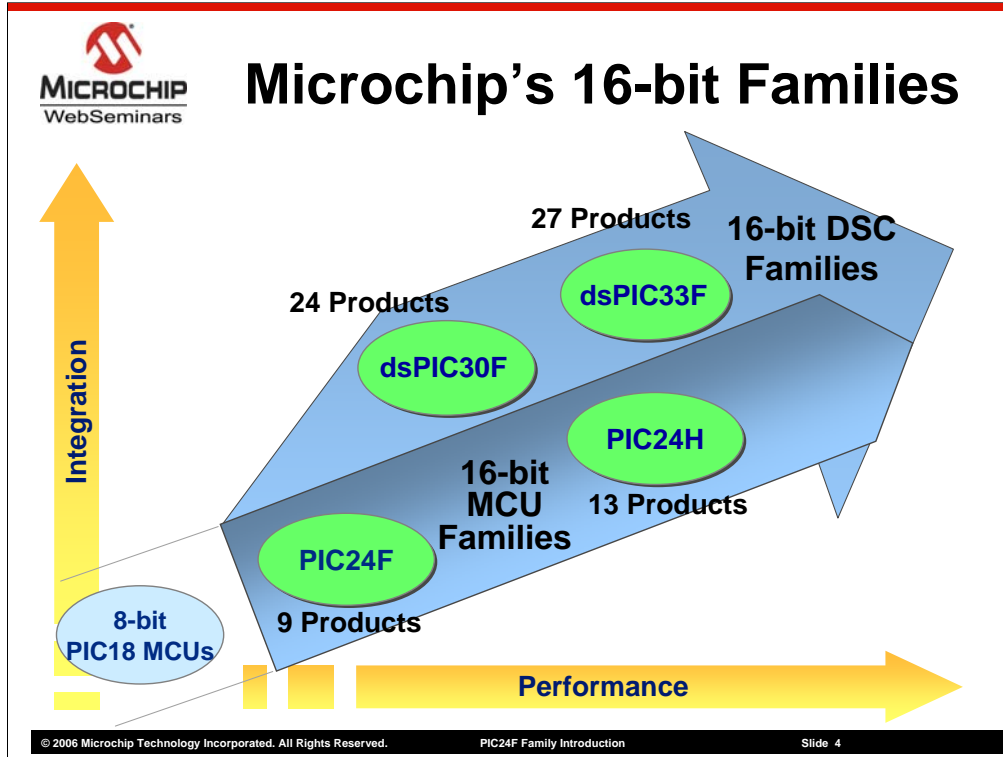
Agenda

- **Overview of Microchip's four 16-bit microcontroller (MCU) and Digital Signal Controller (DSC) families**
- **A closer look at the PIC24F Family**
- **Development Tool Support**
- **Software Library Support**
- **Additional Resources**

© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 3

So here is the agenda for today's Webinar. First we will start with a quick review of Microchip's 16-bit products, we will then take a closer look at the PIC24FJ128GA device and its associated family. From there I will move to the tools available and cover the software libraries to support the families.


The last thing I will discuss is where you can go to get additional information.




This chart gives a quick, graphical view of Microchip's four 16-bit families. The lower band indicates a continuation from the 8-bit microcontroller line into the realm of 16-bit controllers.

At the beginning of the band, with 16 MIPS, is PIC24F, our entry level 16-bit product. The PIC24F provides a performance jump from the PIC18 microcontrollers with minimal cost impact. Next on the microcontroller band is the PIC24H -- our highest performance 16-bit microcontroller with about 40 MIPS of performance.

The upper band adds our Digital Signal Controller, or DSC product line with up to 40 MIPS performance and DSP instructions. While sharing the same architecture as the PIC24 MCUs, the added DSP instructions make these an ideal choice for applications requiring noise cancellation, voice recognition and motor control.



Unified Architecture



- Common **instruction set** PIC24F and PIC24H
- dsPIC30/33 add DSP instructions to PIC24 base instruction set
- Common low-cost **Tools Suite** covers ALL product families


© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 5

Microchip's 16-bit product line is designed to rival many 32-bit controllers in performance, with the ease of use typically associated with the 8-bit product lines.

The common architecture makes it easy to optimize a design for cost and to reduce risk by providing speed, memory and peripheral upgrade paths. This allows you to utilize a device with 64K of Flash and switch from a low-cost MCU to a high-performance DSC for specific applications requiring additional performance. Where possible, the devices in the four families share peripheral and pin-compatibility. Additionally, code libraries take advantage of the architecture to ease the transition between devices.


All devices in Microchip's 16-bit product line use the same MPLAB® Integrated Development Environment (IDE) and MPLAB ICD 2 development tool chain shared by Microchip's 8-bit products. Should a customer have to move from a 16 MIPS PIC24F MCU to a higher performance dsPIC33 DSC, the tool set would not change. In fact, many of the tools already purchased for our 8-bit products will also work for Microchip's 16-bit products.

Microchip's 16-bit families allow 8-bit ease-of-use, providing the only 16-bit architecture that bridges the MCU and DSC worlds.



Seamless Migration


	PIC24FJ	PIC24H	dsPIC30	dsPIC33
Performance	16 MIPS	40 MIPS	30 MIPS	40 MIPS
Voltage	3.3V	3.3V	5.0V	3.3V
Package	64–100 Pins	64–100 Pins	18–80 Pins	64–100 Pins
DSP	No	No	Yes	Yes
Operating Temp	-40 to 85°C 125°C Planned	-40 to 85°C 125°C Planned	-40 to 125°C	-40 to 85°C 125°C Planned
Flash	64K to 128K	64K to 256K	12K to 144K	64K to 256K
RAM	8K	8K to 16K	512 to 8K	8K to 16K
	Low Cost	High Performance	Low Pin Count 5 Volt Analog	High Performance



© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 6

I have mentioned migration between families several times and this slide highlights the difference between the families. While a number of differences can be seen here, several of them, Package, Flash and RAM sizes are rather fluid and you can expect the families to push beyond their current boundaries. The key differentiators, performance, DSP instructions and operating voltage will be the primary drivers for your family selection.

For an entry level 16-bit product on a budget, the PIC24F is an idea selection. If higher performance, greater than 16 MIPS, is required, the PIC24H would be an appropriate start. If your application can benefit from DSP instructions the dsPIC30 or dsPIC33 are your best choice. While motor control and voice applications tend to favor the dsPIC families it is helpful to remember that the DSP instruction can also be useful if your design contains any analog filtering. The dsPIC will often allow an analog low pass, high pass or band pass filter to be replaced by a software solution that eliminates external components, many of which are susceptible to age and temperature drift.



MICROCHIP
WebSeminars

16-bit Performance

PIC24H offers best in class performance among 16-bit processors:

- Approximately 40 MIPS performance

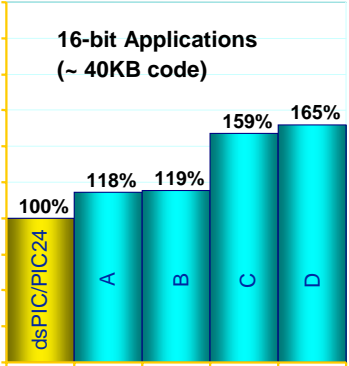
PIC24F provides high performance at competitive prices:

- Approximately 16 MIPS performance

Both devices take advantage of:

- Single Cycle Instruction Execution
- Deterministic 5 Cycle Interrupt Response

PIC24 and dsPIC® Architecture, when combined with Microchip's MPLAB® C30 Compiler provide best in class code size.



Device	Code Size (%)
dsPIC/PIC24	100%
A	118%
B	119%
C	159%
D	165%

© 2006 Microchip Technology Incorporated. All Rights Reserved.PIC24F Family IntroductionSlide 7


In the previous slide I mentioned that performance was a differentiator wanted to take a moment here to discuss performance in general. Using internal benchmarks based on industry standards and internal application code Microchip's entry level PIC24F family executes at 16 MHz with about 14 MIPS throughput showing the advantage of the RISC architecture's single cycle instruction execution. The PIC24F benchmarks beat all but one of our competitors. When the PIC24H and dsPIC® DSC were benchmarked they beat all 16-bit competitors benchmarked with approximately 37 MIPS performance. The PIC24H and dsPIC DSC had the same benchmark result because the applications code did not take advantage of DSP instructions.

The graph shows the results of compiling C code with various C Compilers for a number of processors. The code compiled was a combination of approximately 40K of application code used in various application notes. The higher the number the larger the resulting program memory. A smaller number indicates better c code efficiency. The combination of core and C Compiler allow Microchips 16-bit controllers to fit more C-code into a given memory space. This either allows you to do more with a given memory size or potentially migrate to a smaller device.



Agenda

- Overview of Microchip's four 16-bit microcontroller (MCU) and Digital Signal Controller (DSC) families
- **A closer look at the PIC24F Family**
- Development Tool Support
- Software Library Support
- Additional Resources



A Closer Look at PIC24F

- **Microchip's Entry Level 16-bit MCU**
 - **High Performance 16 MIPS Core**
 - **Independent Interrupt Vector with 16 Priority Levels**
 - **16 Working Registers**
 - **16-bit Math**
 - **17 x 17 Single Cycle Multiply**
 - **Single Cycle Hardware Multiple Bit Shifter**
 - **Improved C Efficiency**
 - **Repeat Instruction**

© 2006 Microchip Technology Incorporated. All Rights Reserved.


PIC24F Family Introduction

Slide 9

At Microchip we are very proud of the performance of our entry level PIC24F core. As you have heard earlier, performance wise it beats most of our 16-bit competitors and provides a real migration path for our 8-bit PIC18 Families.

First of all, when operating off a 32 MHz clock you can expect the performance to be roughly $\frac{1}{2}$ of the clock rate, or equivalent to instruction execution time. In addition to faster execution time and a 16-bit data bus there are several other additions to the core.

- First, the interrupt structure of the PIC24F family is significantly upgraded. The PIC24F provides an independent interrupt vector for each interrupt source. Interrupt priorities can be set at any of 16 levels.
- The PIC24F family provides 16 working register.
- The PIC24F implements 16-bit math, including a 17 X 17 single cycle multiply.
- The architecture also implements a single cycle multiple bit shifter, or barrel shifter.
- The instruction set and addressing modes work to improve the PIC24F C code efficiency.
- Finally, the PIC24F core incorporates a “repeat” instruction. This instruction allows a math instruction, or a memory transfer instruction to be repeated a specified number of times. For example, the repeat can be used to transfer a block of data with one word being transferred per instruction cycle.



A Closer Look at PIC24F

- **Natural Migration Path from PIC18**
 - **Increased Memory**
 - **Flash – 128K on Current Devices**
 - **RAM – 8K on Current Devices**
 - **Enhanced Peripherals**
 - **32-bit Timers**
 - **High Speed 10-bit A/D**
 - **JTAG Boundary Scan**
 - **Multiple Independent I²C™, UART and SPI**
 - FIFO buffers added to UART and SPI
 - IrDA® function on UART
 - **Parallel Master Port (PMP) for External Data Memory Access**

© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 10

As mentioned earlier, the PIC24F provides a natural migration path up from the PIC18. First, the PIC24F provides increased memory. On the first family we expand the RAM to 8 KB and the Flash to 128 KB. It would be a fair guess that the 128 KB Flash on the first family will not be the limit for too long. Along with the increased memory is of course increased performance, with a 16-bit MCU operating at 16 MIPS.

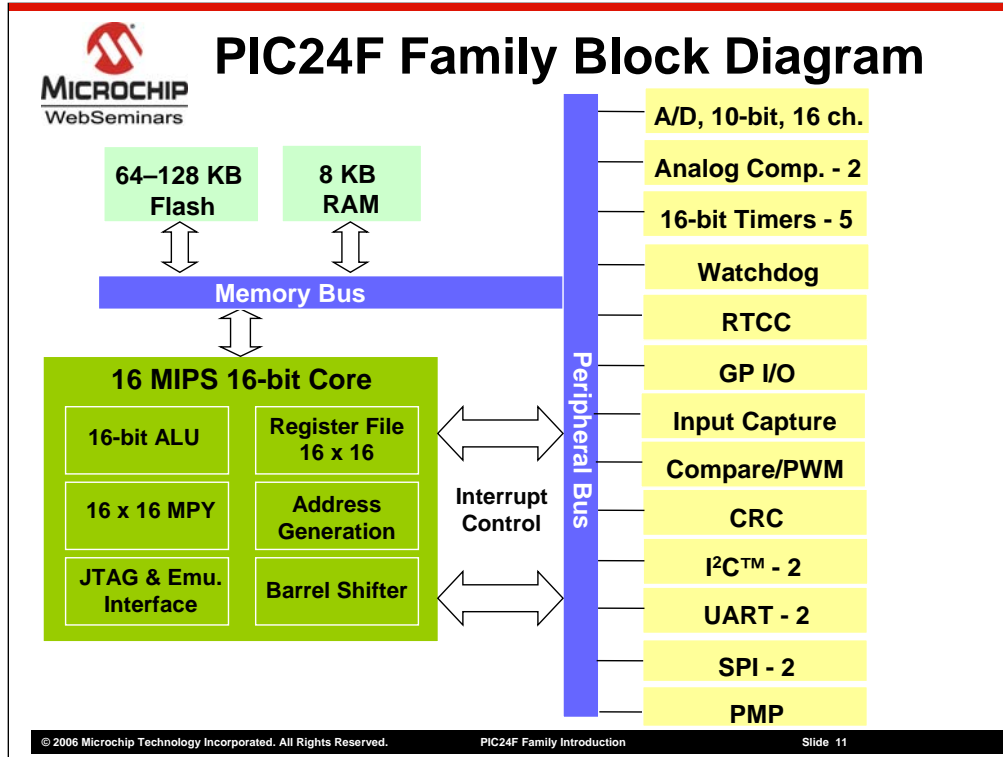
In addition to the natural core performance, there has been several improvements to the peripheral set. The device contains five 16-bit timers, four of which can be cascaded to form two 32-bit timers.

There is also a new high speed 10-bit ADC. The 10-bit ADC is capable of conversion rates of up to 500K samples per second.

JTAG Boundary Scan has been added to the PIC24F family to assist in board level testing and in system programming.

The PIC24F also includes multiple independent I²C™, UART and SPI ports. The UART functionality has been upgraded to include IrDA® functionality. Both the UART and SPI have been enhanced to include built in FIFO. The FIFO's are included in the serial port to reduce the number of times the processor must service the peripheral, reducing the overhead required to service the peripherals.


The Parallel Slave Port contained on the many PIC18 devices has been replaced by a Parallel Master Port. Similar to the PIC18, the PMP allows the PIC24F to address or be addressed as a parallel device, and perhaps more important, the PMP allows the PIC24F to use an external memory for data storage.



Sometimes a block diagram can replace a thousand words. All of the devices in the PIC24F family are built with the same base peripheral set. The primary difference being the Flash memory sizes, which include 64 KB, 96 KB and 128KB.

The devices start with the 16 MIPS PIC24F core. Around the core is a peripheral set that includes the 16 channels of 10-bit A/D converter and two analog comparators. The device includes a watchdog timer and five channels of 16-bit timers, four of which can be cascaded to form two 32-bit timers. The PIC24F family also includes a real time clock with calendar function that is often used for time stamping data logged information or communications data. The devices also include two I²C's, two UARTS and two SPI channels. To compliment the various serial channels there is also a Cyclic Redundancy Check peripheral that can be used to ensure data is or will be correctly communicated.

Rounding out the peripheral list is a Parallel Master Port (PMP) that can be used to communicate to parallel peripherals or potentially external data memory.



MICROCHIP
WebSeminars

PIC24F Family Look-up Table

Product	Pins	Flash (KB)	RAM (KB)	Timer	IC	O/P Comp. PWM	RTCC	A/D 10-bit 500 ksp/s	Compa-rators	U A R T	S P I	I 2 C™	P M P	JTAG
<i>PIC24FJ General Purpose</i>														
PIC24FJ64GA006	64	64	8	5	5	5	Y	16	2	2	2	2	Y	Y
PIC24FJ64GA008	80	64	8	5	5	5	Y	16	2	2	2	2	Y	Y
PIC24FJ64GA010	100	64	8	5	5	5	Y	16	2	2	2	2	Y	Y
PIC24FJ96GA006	64	96	8	5	5	5	Y	16	2	2	2	2	Y	Y
PIC24FJ96GA008	80	96	8	5	5	5	Y	16	2	2	2	2	Y	Y
PIC24FJ96GA010	100	96	8	5	5	5	Y	16	2	2	2	2	Y	Y
PIC24FJ128GA006	64	128	8	5	5	5	Y	16	2	2	2	2	Y	Y
PIC24FJ128GA008	80	128	8	5	5	5	Y	16	2	2	2	2	Y	Y
PIC24FJ128GA010	100	128	8	5	5	5	Y	16	2	2	2	2	Y	Y

PIC24FJ128GA006

Package: 06 – 64 Pin, 08 – 80 Pin, 10 – 100 Pin

Product Identifier: G = General Purpose

Memory Size: 64K, 96K, 128K Flash

PIC24F Microchip's Entry Level 16-bit

© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 12

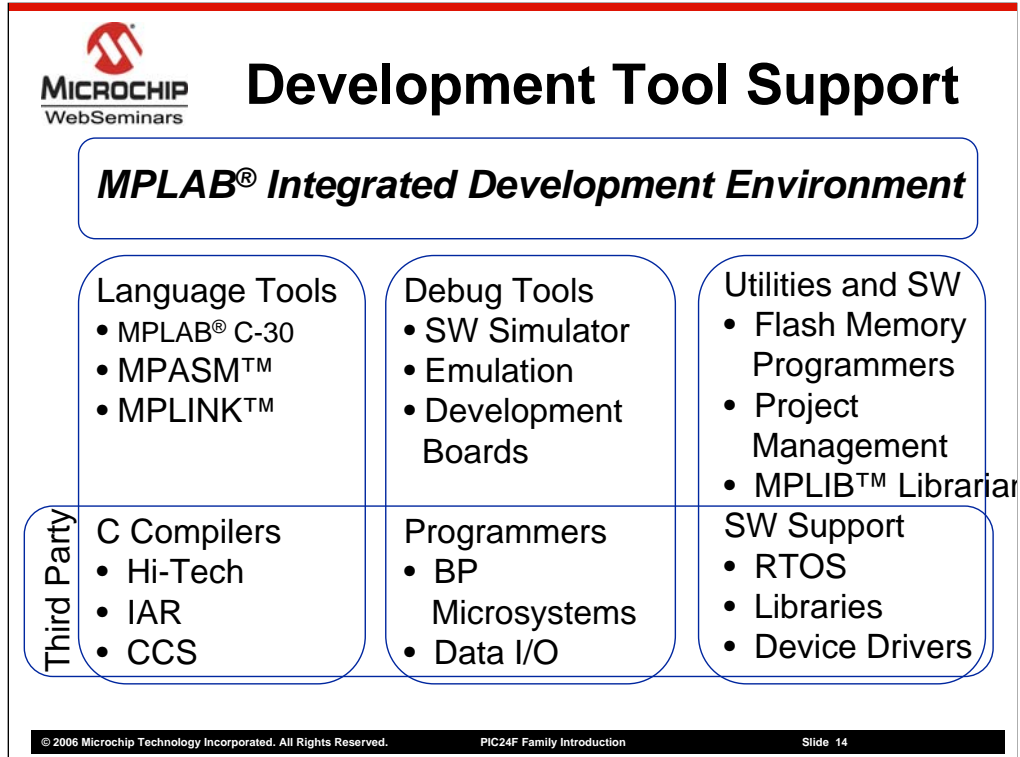
Well, there is always a table... the family look up table here will help confirm the specific device you are looking for, but it can be greatly simplified by remembering that the key differences between the devices are Flash and pin count. Both can be quickly deciphered from the Part number.

The part number begins with PIC24FJ which is a 16-bit entry level PIC Microcontroller. The Flash memory size immediately follows the FJ in the part number. The G indicates that the device is general purpose. In the future other designations will be added to match the feature set. The A0 are used to identify specific derivatives. The last two digits are a rough indication of the number of pins divided by 10. For example an 06 is 64-pins, 08 is 80-pins and 10 is 100-pins.



Agenda

- Overview of Microchip's four 16-bit microcontroller (MCU) and Digital Signal Controller (DSC) families
- A closer look at the PIC24F Family
- **Development Tool Support**
- Software Library Support
- Additional Resources




Microchip's PIC® microcontrollers are supported by the MPLAB® Integrated Development Environment (IDE), which is used to integrate the development, debug and software utilities available when developing code for a product. MPLAB® is the only platform you will need to develop for a Microchip microcontroller and can cover products from 6 pins to 100 pins and code space from 512 Bytes to 256 KB.


Language tools are available from Microchip in the form of an Assembler (MPASM™), a linker (MPLINK™) and a C Compiler (MPLAB C30). Development tool support also includes software simulators, emulators, development boards and programmers. Available utilities such as Flash programming, project management and MPLIB™ Librarian are also included in the MPLAB IDE.


MPLAB and most of our software development tools are available free from microchip.com. The MPLAB C30 is one notable exception, While the full version of the compiler itself isn't free there is a student copy available from Microchip. After the first 30 days the student version continues to run, but with reduced code optimization.


Beyond the Microchip tool-chain are a number of third party tool vendors that also provide valuable tool capabilities such as compilers, production programmers and software tools, including RTOS, libraries and device drivers.



Basic Hardware Tool Suite

- **MPLAB® ICD 2 In-Circuit Debugger/Programmer**


- **MPLAB® REAL ICE™ In-Circuit Emulation System**


- **MPLAB® PM3 Device Programmer**



© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 15

MPLAB® IDE is designed to work with all of Microchip's In Circuit Emulators and programmers. The Microchip 16-bit families are supported by the MPLAB ICD 2, MPLAB REAL ICE™, and the MPLAB PM3 programmer. All of the tools are designed to work with MPLAB.




MPLAB ICD 2 is a Flash upgradeable in-circuit debugger designed to operate with any PIC® microcontroller. The MPLAB ICD 2 can be connected to and powered by the USB connection on the host PC. It can also connect through a RS-232 port. As an in circuit debugger it will enable a device to single step, or set up to 3 break points and then upload relevant data to the host PC. At \$159.99 the MPLAB IDC 2 can be combined with MPLAB to create a cost effective tools platform.

While the MPLAB ICD 2 can program a device we also support the MPLAB PM3 for lab or low volume production programming.

So we have a free IDE and a cost effective In-Circuit Debugger. What can we connect it all to?



Explorer 16 Development Board



- Supports both PIC24 and the dsPIC® Digital Signal Controller (DSC) Families
- MPLAB® ICD 2, USB, RS-232, JTAG Interfaces
- PICtail™ Plus Connector*
 - SD/MMC PICtail Plus
 - Ethernet PICtail Plus board
 - PICtail Plus support planned for Compact Flash (CF), IrDA®, Wireless (ZigBee™), and Speech
- Available at \$129.99

© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 36

The Explorer 16 Development Board.


The Explorer 16 board is designed to interface with the MPLAB ICD 2 to provide a complete development platform. The board includes a PIC24FJ128GA010 and a dsPIC33 DSC. The processors can be changed by changing the Processor Interconnect Module, or PIM. The board includes the power supplies, buttons, switches and displays that you would expect in a development board. It also includes a small prototyping area and socket connector for use with Microchip's PICtail™ Plus daughter boards. At this time two daughter cards are available to quickly enable the Explorer 16 board to connect with a SD/MMC card or to connect to Ethernet through a ENC28J60.

There are future plans for additional PICtail™ Plus boards to support Compact Flash (CF), IrDA®, wireless and speech applications. These boards can be used in conjunction with various software libraries to improve your design turn around time.



Agenda

- Overview of Microchip's four 16-bit microcontroller (MCU) and Digital Signal Controller (DSC) families
- A closer look at the PIC24F Family
- Development Tool Support
- **Software Library Support**
- Additional Resources



Software Library Support

Free Evaluation Downloads

	Library/Tool Name	dsPIC30F	dsPIC33F	PIC24H	PIC24F
Memory	FAT16 File System (AN1045)	Future	Future	Future	Future
	SD Card Interface	Future	Future	Future	Future
	Compact Flash Card Interface	Future	Future	Future	Future
Connect	TCP/IP (Microchip) (AN833)	✓	✓	✓	✓
	ZigBee™ Stack	Future	Future	Future	Future
	IrDA® Stack (Microchip)	Future	Future	Future	Future
	C-30Math Lib	✓	✓	✓	✓
	Peripherals	✓	✓	✓	✓
	Triple DES/AES (AN1044)	✓	✓	✓	✓

© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 18

So, what software is available to support Microchip's 16-bit products?

Software support exists today for a TCP/IP Stack, math libraries, peripheral libraries, and encryption libraries.


Soon to be available is an application note for a FAT16 File system and how to use it with a Secure Digital™ Card. A Compact Flash Interfaces will also available. These building blocks allow simple microcontrollers and digital signal controllers to save data to portable media, allowing easy transfer to a personal computer (PC).

The TCP/IP stack and additional software for a ZigBee™ stack and an IrDA™ stack will allow a microcontroller or digital signal controller to be connected into a larger system.

The math and peripheral libraries are available to minimize the effort required to use a device and reduce risk by supplying proven libraries.

Encryption libraries can be beneficial if a customer is dealing with financial transactions or saving confidential data.

All of these libraries are or will be available free to support the PIC24F products.



Additional dsPIC[®] Libraries

	Library/Tool Name	dsPIC30F	dsPIC33F
Audio	Noise Suppression	✓	✓
	Acoustic Echo Cancellation (AEC)	✓	✓
	Line Echo Cancellation (LEC)	✓	✓
Speech	Speech Recognition	✓	✓
	SPEEX Speech Coding/Decoding	✓	✓
	G.726 Speech Coding/Decoding	✓	✓
DSP	DSP	✓	✓
	dsPICworks™ tool	✓	✓
	Digital Filter Design Tool	✓	✓
	Digital Filter Design Lite	✓	✓
Serial	Soft Modem	✓	✓
	CANbedded (Vector-Informatik)	✓	✓
	OsCAN (Vector-Informatik)	✓	✓

If you need these, you need a dsPIC!


© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 19

The DSP functionality of the dsPIC[®] families add some interesting capabilities to a controller line and while the focus of this discussion is the PIC24F family, I think it is worth pointing out the capabilities that software and the dsPIC core can enable. When you consider the libraries shown here, remember. They run on a core that is an easy step up from the PIC24F. This can help your designs cover multiple platforms.

Some examples of significant DSP libraries are the noise suppression and echo cancellation routines that are available for the dsPIC[®] DSC families. Additional libraries cover speech recognition, SPEEX speech coding and decoding, as well as G.726A Codec.

In addition, standard DSP libraries and design tools that integrate Graphical User Interface (GUI) filter design into the MPLAB[®] IDE help designers to fully utilize the device's capabilities.

From a connectivity point of view, the DSP capabilities of the dsPIC DSC families also allow the implementation of a soft modem.



Agenda

- Overview of Microchip's four 16-bit microcontroller (MCU) and Digital Signal Controller (DSC) families
- Details of the PIC24F Family
- Development Tool Support
- Software Library Support
- **Additional Resources**

© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 20

Our tour of Microchip's PIC24F product and support is almost complete. The last topic I would like to cover is where support can be found for the 16-bit families.



Additional Resources

- www.microchip.com/16bit
 - Product Tree
 - Literature
 - Development Tools
 - Design Centers
- www.microchip.com
 - support.microchip.com
 - Online Discussion Groups
 - 24/7 Technical Support
 - sample.microchip.com
 - Buy > **microchipDIRECT**

© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 21

Where do I go for help? The most logical answer is your local FAE, but they don't work 24 hours a day, so the next logical step would be the web. Unfortunately the web seminar does not lend itself to a tour of the web, but I can give you some pointers.

First, you can start with the 16-bit intro page. This page was put together to help concentrate all of our 16-bit product information. The 16-bit intro page can be found by clicking the link in this presentation or by clicking on MCU & DSC Overview under the product section of the Microchip home page. You can then click on any of the PIC24 or dsPIC[®] bubbles.

On the 16-bit intro page you will find a variety of information including, the product tree, links for literature, links for development tools and links to our design centers. This page is the best starting point for your 16-bit design effort.

The Microchip home page can also be used to access the information above but in a more indirect manner. It does have a few valuable links you may want to use. Under the Support header is a link for online discussion groups. The online discussion groups are frequently visited by other Microchip users and can often provide the answers and insight you need.

Another useful link under support is the 24/7 Technical Support Link. At this link you will find both a knowledge base you can search and a WebTicket link. Web tickets are answered 24 hours a day in the order they are received but you will need to register. The web ticket request are often used to build the knowledge base so it might be best to search the database first.

One final link is the microchipDIRECT link under Buy. This link can be used to purchase any of the parts or tools available from Microchip. Remember that much of our software is free to download and may not be on microchipDIRECT.



Thank You

Note: The Microchip name and logo, dsPIC, MPLAB and PIC are registered trademarks of Microchip Technology Inc. in the U.S.A. and other countries. dsPICDEM, dsPICDEM.net, dsPICworks, MPASM, MPLIB, MPLINK and PICtail are trademarks of Microchip Technology Inc. in the U.S.A. and other countries. All other trademarks mentioned herein are property of their respective companies.

© 2006 Microchip Technology Incorporated. All Rights Reserved. PIC24F Family Introduction Slide 22

With that, we have completed our PIC24F introduction. I hope you have some idea which of our 16-bit families is best suited to your application. You also have some idea what software and resource are available to assist with your design. Please stay tuned for future webinars on the PIC24F.

Thank you for your time and I hope our 16-bit families can help with your next design.