



MICROCHIP

ECOM meeting 2012



MICROCHIP

Wireless Products



Focus Wireless Technologies



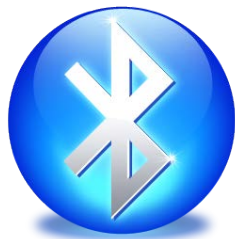
www.microchip.com/wifi



www.microchip.com/zigbee



www.microchip.com/miwi



www.microchip.com/bluetooth



www.microchip.com/wireless

Example Verticals

- **Many Wireless Verticals**

- Smoke and CO Sensors
- Metering
- Garage Door Openers (GDO)
- Home Improvement
- Smartphone, tablet accessories
- Hand held health monitoring
- Entertainment/Gaming

..... (plus many more!)

- **Many Wireless Technologies**

- Many solutions to a given problem
- Pro's and Con's in all implementations
 - We just need to think about the system requirement and architecture



Smoke and CO Sensors



Lifestyle Hubs

- Bi-directional
- Internet Connectivity
- Battery life (>1yrs)



High-end consumer

- Bi-directional
- Sensor arrays
- Long range
- Battery life (>5yrs)

Entry level: **Wi-Fi / BT**

Entry level: **SubGHz / 802.15.4**



**Smoke / Gas
Detectors**

Entry level: **SubGHz**



Low-end consumer

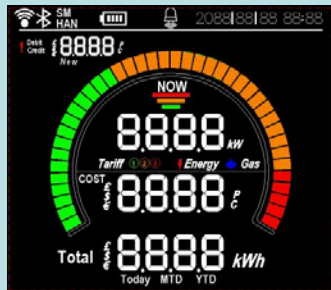
- Transmit Only
- Sensor arrays
- Battery life (>10yrs)

Metering



Battery Powered Meters

- Bi-directional comm(s)
- Hostile Environments
- Long Range
- Custom protocols / profiles
- Battery life (>10yrs)



In-Home Displays

- Bi-directional
- Consumer Protocols
- Long Range
- Battery life (1 yr)

Entry level: **SubGHz**



Entry level:
15.4 / Bluetooth / Wi-Fi

Entry level: **SubGHz / 15.4**



Utility Services

- Bi-directional
- Custom Protocols
- Long Range
- Battery life (>10 yr)

Garage Door Opener

Integrated Vehicle Control



- Bi-directional
- Data and Communications
- Battery life (medium)

Entry level: **BT**

Entry level: **Wi-Fi / BT**

Lifestyle Hubs



- Bi-directional
- Internet Connectivity
- Battery life (>1yrs)

How can we include a security light?



Entry level: **SubGHz**

'Clickers'

- One-Way
- Battery life (>5yrs)



Entertainment/Gaming

Mobile Type Gaming

- Point-to-point
- Other networks active
- PAN environments
- Use available radio technologies
- System size matters

Bluetooth is a good solution



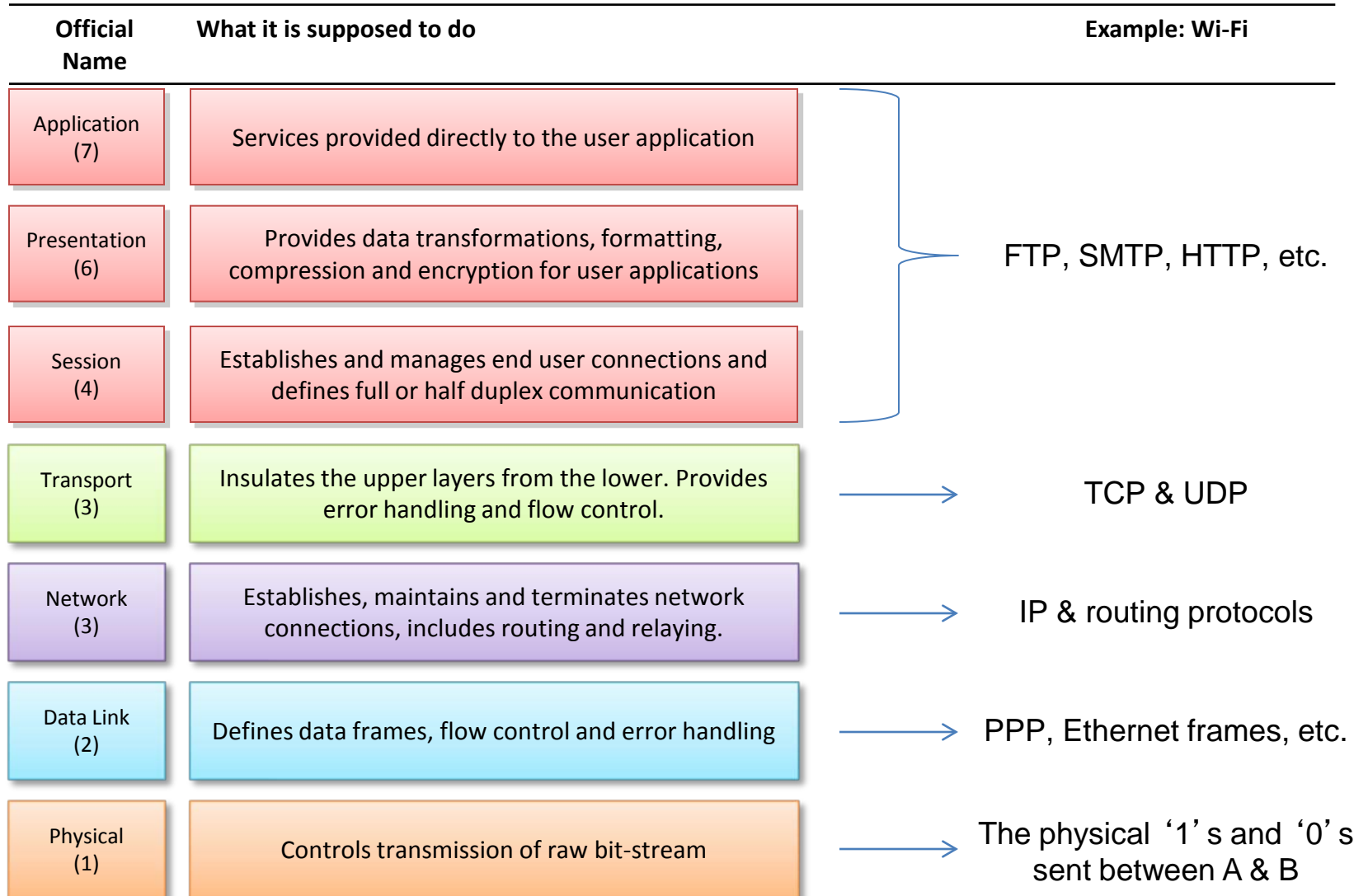
Next Generation Cloud Gaming

- Ethernet core
- Multiple players
- Broadcasts & point-to-point
- Audio / Data
- Higher bandwidth processing

Wi-Fi is a good solution



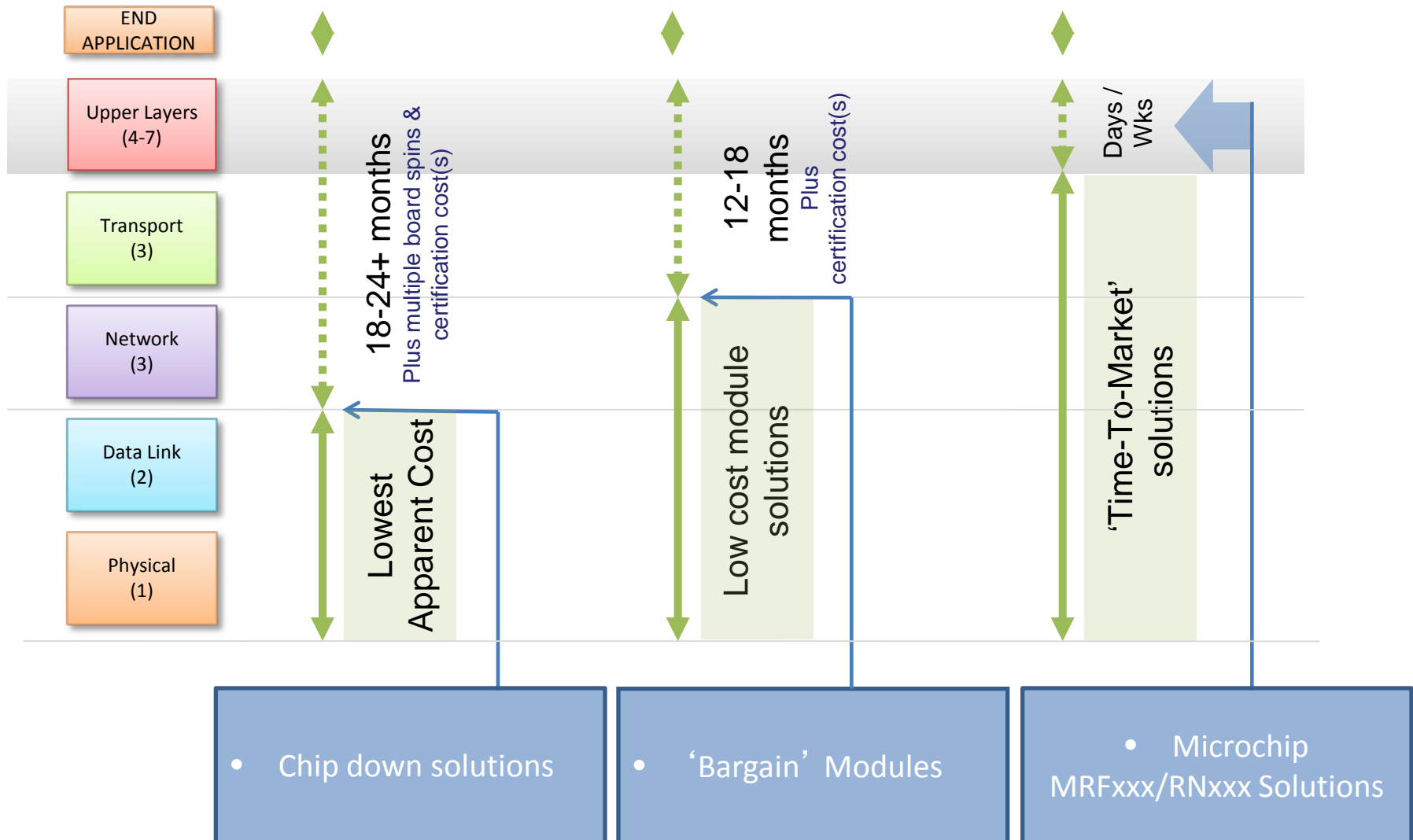
ISO communications model





Microchip's Solution

Balancing time and investment



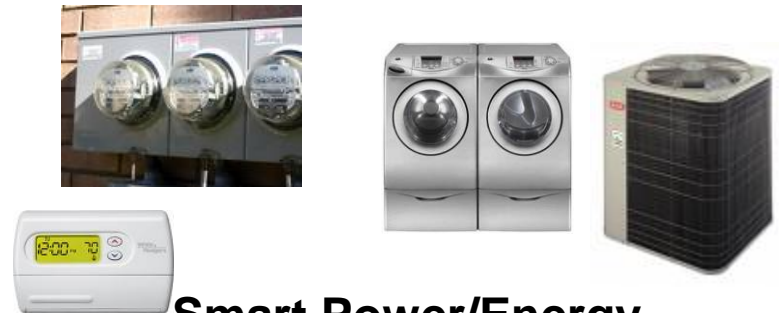


Supporting the Internet of Things With Embedded Wi-Fi

Microchip Focus: Wireless Connectivity of Things



Home health and Medical



Smart Power/Energy



Industrial Control and Monitoring



Home Control and Monitoring

- Embedded products: low power, low free resource host processors
- Get on the network, transfer data, and get off
- Communicate with other things or users via internet



Certifications

- **Wi-Fi**

- Wi-Fi certification ensures compatibility
 - does not extend to end products
 - Optional for final products



- **Regulatory**

- RoHS compliant
- USA/ Europe/Canada/Korea





Product Portfolio



MRF24WB0



MRF24WG0

**Microchip has multiple
Wi-Fi
products/solutions...**



RN171

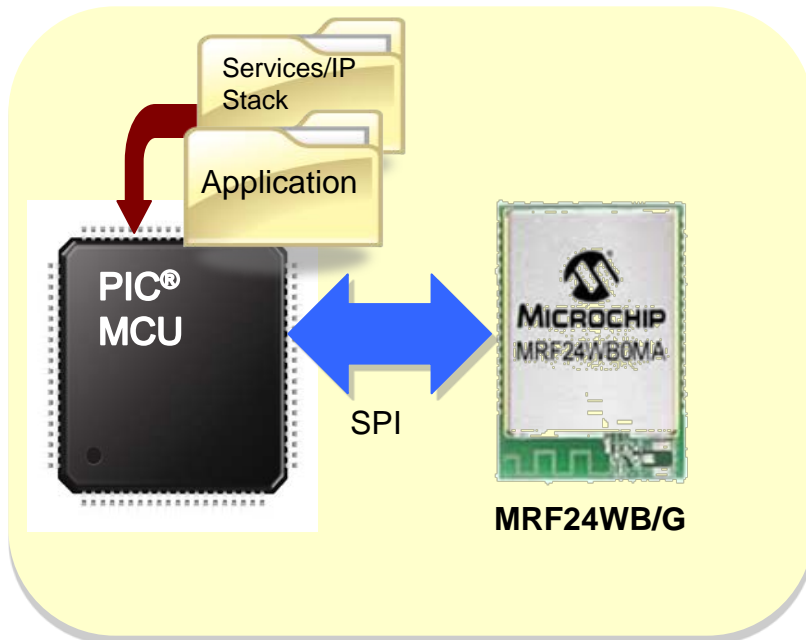


RN131

**But which is the right
one for the job?**

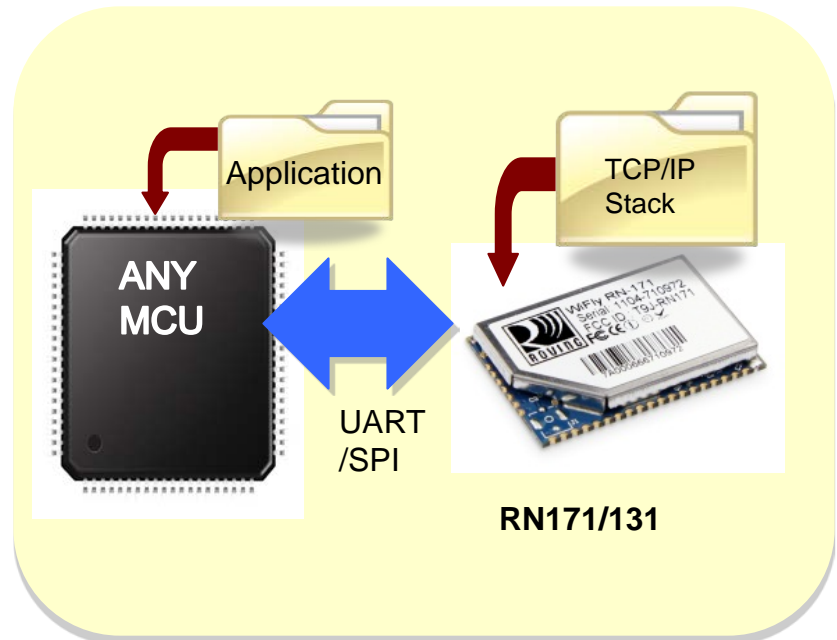
WPD Product Families

MRF Family



- Microchip TCP/IP stack
- 802.11 b & b/g
- Low Power, Higher bandwidth
- Microchip development environment
- Provides complex IP services

RN Family



- TCP/IP stack onboard module
- 802.11 b/g
- Low power, fast connect (<100ms)
- Works with any microcontroller
- Data to Wi-Fi services



Product Portfolio



MRF24WB0



MRF24WG0



RN171

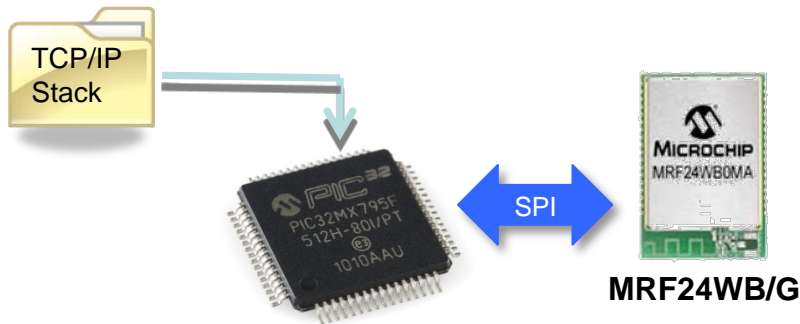


RN131

Depends on where you are starting from...

1. Are you using a PIC® MCU?
2. Do you know Wi-Fi?
3. Do you know TCP/IP?
4. Do you have RF engineers on staff?
5. Do you want a custom solution?

MRF24Wxxx – Radio Module



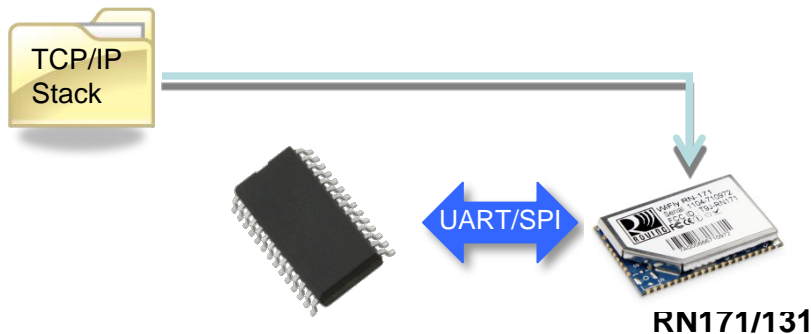
GREAT FIT FOR

- PIC® MCU Customers
- Rich/Custom Wi-Fi Services
- Experienced Customers
- MPLAB® IDE Savvy
- Low-power / higher bandwidth

When Do You Lead with the MRF24Wxxx Wi-Fi Solutions?

- Using a PIC 8,16,32 bit PIC MCU w/ the Microchip TCP/IP Stack
- Transitioning from MRF24WB modules to MRF24WG modules
- Wanting to support Ethernet and/or Wi-Fi
- Looking for higher data rate Wi-Fi
- Looking for a path to chip down for high volume applications
- Looking for more advanced or customized Wi-Fi services
 - **Wi-Fi Direct, WPS, SoftAP, HTTP Server, SSL, IPv6,**
 - Plus many other services and source code**

RNxxx – Co-Processor Module



GREAT FIT FOR

- Fast Time to Market
- Data transfer apps
- Canned Solutions
- 3rd Party MCUs
- Just add Wi-Fi

When Do You Lead with the RNxxx Wi-Fi Solutions?

- Need a quick prototype
- Don't know TCP/IP or Wi-Fi
- Using a PIC[®] MCU w/o the Microchip TCP/IP Stack
- Using a 3rd party MCU
- Want to “just add Wi-Fi”
- You can use the following Wi-Fi services:
 - **FTP client, TCP, UDP, WPS, SoftAP, DHCP, DNS Client, Telnet, HTTP Client**



Product Portfolio

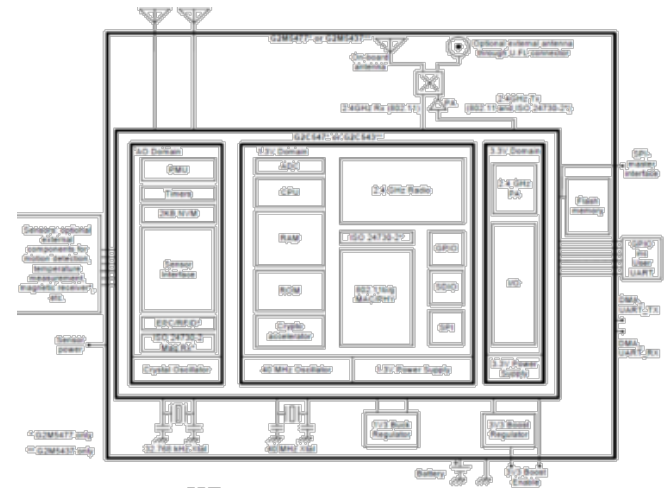
MODULES	MRF24W B0MB	MRF24W B0MA	RN171	RN131 C/G	MRF24W G0MB	MRF24W G0MA
802.11 Radio	b	b	b/g	b/g	b/g	b/g
Power	+10dBm	+10dBm	+12dBm	+18dBm	+18dBm	+18dBm
Antenna	uFL	PCB	PAD	Chip/uFL	uFL	PCB
Stack	PIC	PIC	Onboard	Onboard	PIC	PIC
Typ. Support MCU	8/16/32 bit	8/16/32 bit	8/16/32 bit	8/16/32 bit	8/16/32 bit	8/16/32 bit
Availability	NOW	NOW	NOW	NOW	NOW	NOW





RN171/131 Wi-Fi

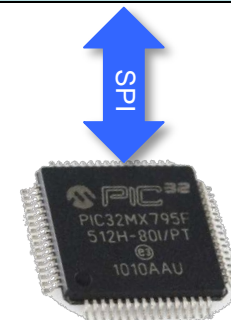
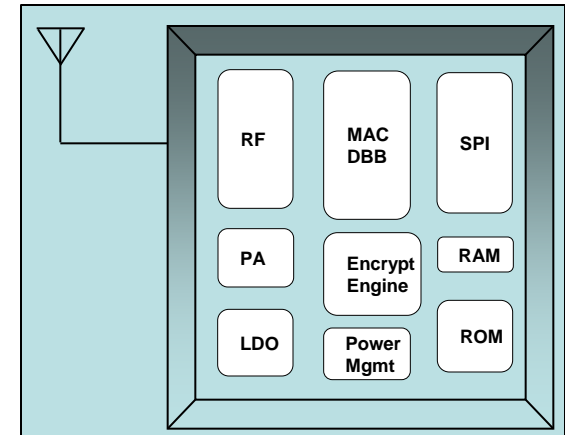
- **Wi-Fi market space**
 - Sensors, automation, RTLS, medical, automotive and others
 - End nodes
- **RNxxx unique silicon**
 - Single chip solution
 - Ultra low power
 - 4uA sleep
 - 30mA receive
 - Tx (variable based on PA configuration)
 - Fast wakeup
 - Sleep > Ready to transmit
11ms
 - Full Sleep to sleep TCP exchange
100ms
 - On-board stack
 - GPIO, 14 bit ADC, timers, etc.
 - Rich ASCII command line interface





MRF24WG0MA/MB (802.11 b/g)

- **Dual chip solution**
 - 802.11b/g MAC & baseband
 - RF & PA
- **Full b/g data rates**
 - Burst at 54Mbps
 - Sustained data rate 5Mbps
 - Programmable PA (0-18dBm)
- **Infrastructure, Adhoc, Wi-Fi Direct client**
- **Wi-Fi Services**
 - WEP, WPA2-PSK, WPA-EAP
 - Wi-Fi Protected Setup (WPS)
 - 802.11 PS
 - SoftAP
- **Agency Certified – FCC/ ETSI/ IC**



Getting Started

- Start with hardware platform of choice
- Download Microchip TCPIP Stack v5.42
- Comes with several demonstrations



- TCPIP Demo App
- EZConfig Demo App
- Console Demo App

- Provides out-of-box demos to start



Explorer 16
Development Board

DV240001



PICDEM.net™ 2 Development Board

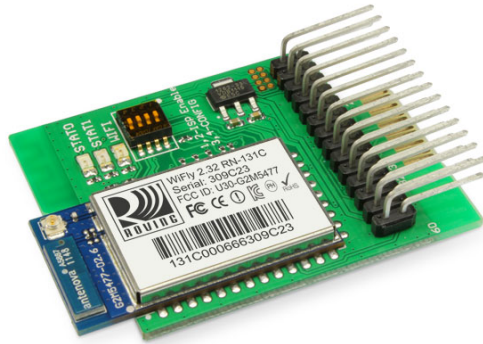
DM163024



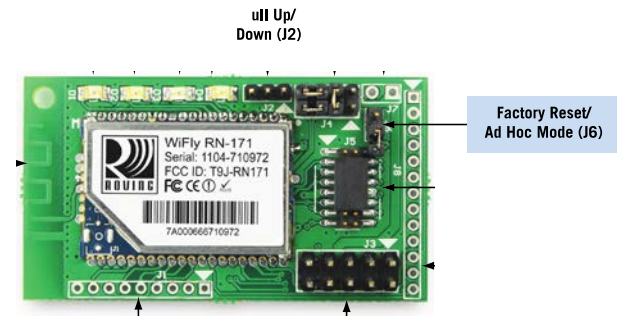
AC164136-4



Getting started with RN1xx Wi-Fi



RN-171-PICtail
RN-131-PICtail



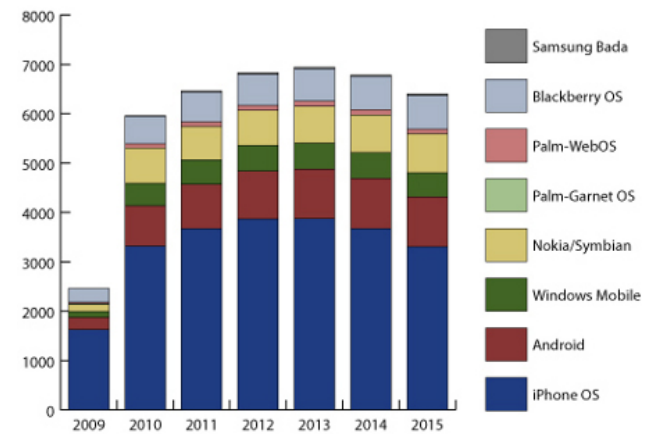
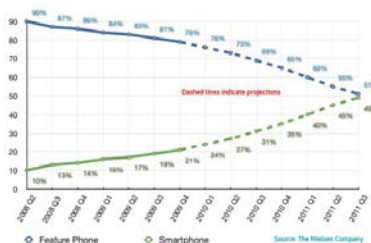
RN-171-EK
RN-131-EK



Technologies – Bluetooth (Customers/Markets)

● Key Markets

- Simple cable replacement
 - Its what BT was designed for!
 - Easily make legacy wired devices - wireless
- The Smartphone – a key driver
 - Apple is a catch-word; niche, high volume ‘cool’ products
 - Projections show it is replacing the standard feature phone
 - Lots of widgets use the smartphone as the interface
 - Becoming a lifestyle hub
 - Health/fitness
 - Automotive
 - Industrial control
 - Home entertainment
 - Home automation



Source: ABI Research

Technologies – Bluetooth (Customers/Markets)

• Example Applications



Health & Fitness



Consumer Gadgets



Engine Diagnostic



Toy



Access Control

Technologies – Bluetooth (Profiles)

- Roving focus' on key data profiles

- Our primary focus: DATA

- SPP: Serial Port Profile – [RN41-I/RM](#)
 - *RS232 replacement*
 - *Custom payloads*
- iAP: iPhone Accessory Profile – [RN41APL-I/RM](#)
 - *Proprietary version of SPP for iOS devices (APPLE)*
- HID: Human Interface Devices – [RN41HID-I/RM](#)
 - *Keyboards*
 - *Mice*
 - *Game controllers*
- HCI: Host Controller Interface – [RN41HCI-I/RM](#)
 - *Off module stacks*
 - *Enables other profile use on external processors*



http://en.wikipedia.org/wiki/Bluetooth_profile

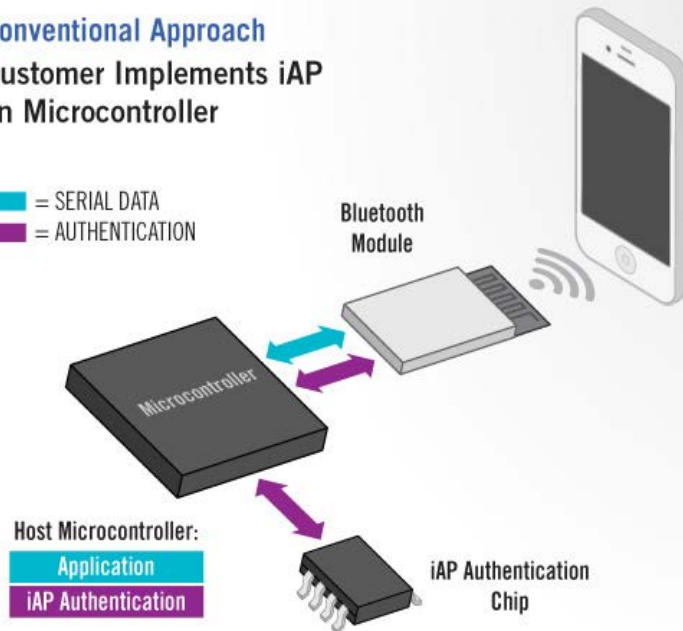
- Our secondary focus: Audio & BTLE

- A2DP: Advanced Audio Distribution Profile
 - *TBD – On road map*
 - *We have NOT released this module*
 - *We will talk to high volume teaching customers*

Profiles: iPod Acc. Profile (iAP)

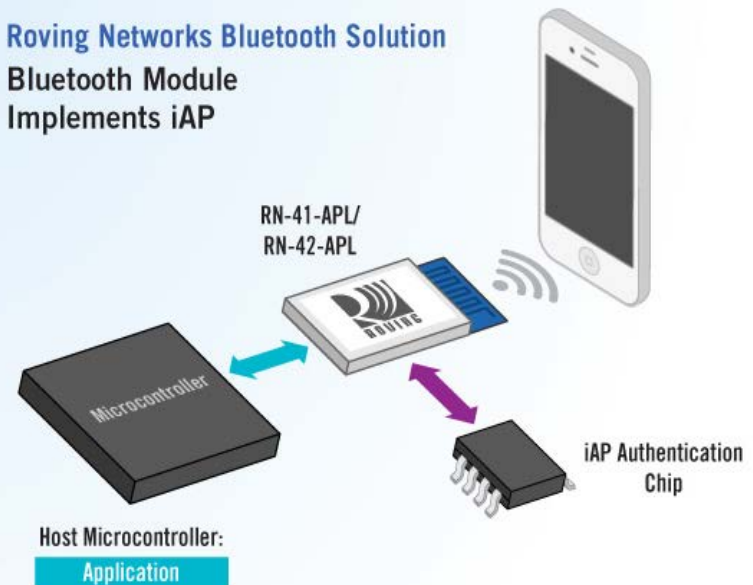
Conventional Approach Customer Implements iAP on Microcontroller

■ = SERIAL DATA
■ = AUTHENTICATION



- High-end host microcontroller
- Adds complexity to firmware and hardware design
- Longer development cycles and learning curves
- Increases power consumption
- Difficult to port code across microcontroller platforms

Roving Networks Bluetooth Solution Bluetooth Module Implements iAP

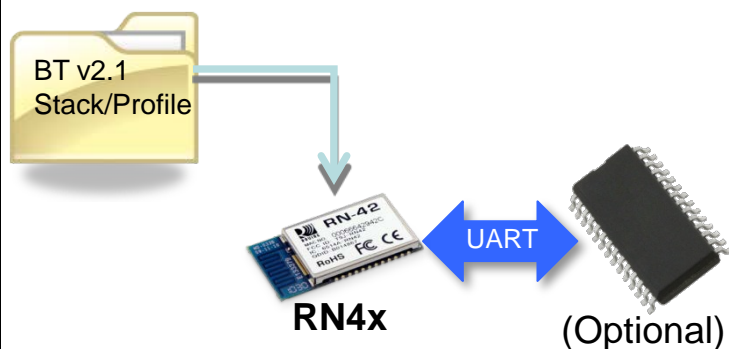


- Low-cost host microcontroller
- Simple host interface
- iAP transparent to user
- Developers focus on their design, not iAP protocols
- Same interface for other smart phones and computing platforms



Product Portfolio

RN4x – Co-Processor Module



KEY FEATURES

- BT v2.1 EDR stack on board
- SPP, HID, other profiles available
- Agency certified
- Class 1 (100M) and Class 2 (30M)
- Multiple antenna versions
- Apple authentication services available

Where do the RN4x Bluetooth Family of Products Fit?

- Customer looking for simple cable replacement
- Customer with data transfer options
- Customer who want to “just add “Bluetooth”
- Customer looking for SPP, HID or HCI services
- Customer looking for Apple iAP services

Bluetooth Products

Parameter	Roving RN42	Roving RN41
Stack	Onboard v2.1 with EDR support	Onboard v2.1 with EDR support
Max active links	7	7
Size	13.4 x 25.8 x 2 mm	13.4 x 25.8 x 2 mm
Class radio	2 (max. 30 meters)	1 (max. 100 meters)
Certifications	YES	YES
Protocols	SDP, RFCOMM, L2CAP	SDP, RFCOMM, L2CAP
Profiles	GAP, DUN, SPP, HID, HCI, IAP	GAP, DUN, SPP, HID, HCI, IAP
Interface	UART, SPI, PCM	UART, SPI, PCM
Data rates	2.4kbits to 3Mbits/s	2.4kbits to 3Mbits/s



Bluetooth™ Evaluation Kit Hardware

RN-4x-SM Evaluation Board

- Contains RN-4x module
- Serial Interface (RS-232 / TTL)
- Status LEDs
- Quick setting(s) jumpers
 - Auto-connect modes
 - Factory reset
 - Baud rate (9600 or 115,200)
- Voltage regulator

Mode	Green LED Status
Configuration Mode	Fast (10/sec)
Boot / Remote Config	Medium (2/sec)
Discoverable / Idle	Slow (1/sec)
Connected	ON (Solid)



RN-41-SM



RN-42-SM



MICROCHIP

Other Wireless



Focus Wireless Technologies



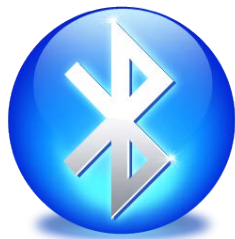
www.microchip.com/wifi



www.microchip.com/zigbee



www.microchip.com/miwi



www.microchip.com/bluetooth



www.microchip.com/wireless

Product Portfolio

IEEE 802.15.4



MRF24XA
Low power

MRF24J40

MRF24J40MA
+0dBm

MRF24J40MB
+20dBm, PCB Ant

MRF24J40MC
+20dBm, Ext Ant

Sub-GHz



MRF49XA
433/868/915

MRF89XA
868/915/950

MRF89XAM8A
868 MHz (EU)

MRF89XAM9A
915 MHz (US,CA)

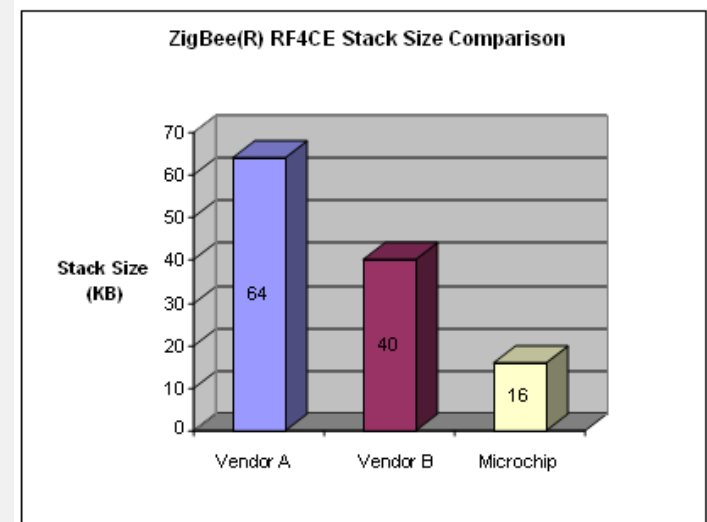
Smart Energy (SEP 1.1) Suite Includes:

- Certified ZigBee Pro Stack
- SE Profile Application
- ZigBee Cluster Library
- Security CBKE Library



ZigBee RF4CE

- Certified RF4CE Stack
- Controller & Target Profiles
- PIC18 and PIC24
- Smallest stack size @ 16KB

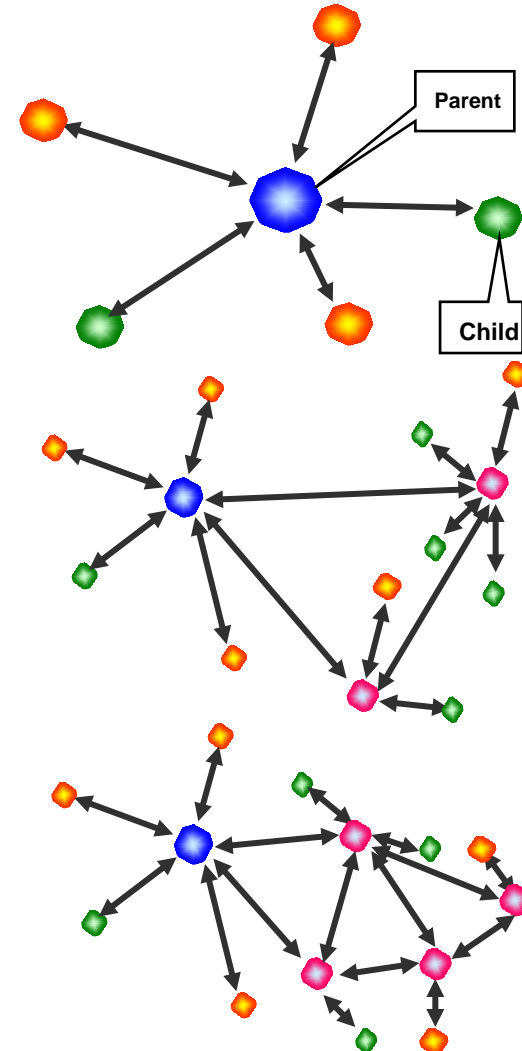


High Touch / Custom Designs



MiWi™ Protocol Stacks

- **MiWi™ P2P – Out of Box**
 - Simple Star Network
 - Size ~4KB
- **MiWi – Development**
 - Mesh Network – up to 4 hops
 - Size ~16KB
- **MiWi PRO – More Complex**
 - Mesh network
 - 64 hops of routing capability
 - Up to 8000 nodes
 - Network Freezer
 - Size ~25KB
- **Download today via MLA**





8-bit Wireless Development Kit

- eXtreme Low Power (XLP) PIC® Microcontroller
- Battery-friendly, portable
- Supports multiple radio

PICtail™ daughter boards

- 2.4 GHz
 - Sub-GHz
-
- Kit includes
 - 2 - Wireless PICtail™ daughter boards - 2.4GHz
 - 2 - PIC18 Wireless Development boards
 - 2 - LCD Serial Accessory boards
 - 2 - RS-232 Serial Accessory boards
-
- Available now





ZENA™ Wireless Adapters

- **ZENA™ Wireless Adapters**

- 2.4GHz – AC182051-1
- 868MHz – AC182051-2
- 915MHz – AC182051-3

- **Multi-function capability**

- MiWi™ Sniffer
- MiWi Node
- More to come!





Wireless Development Studio

- **Features**
 - MiWi™ Sniffer
 - MiWi Configurator
- **Cross Platform Support for**
 - Windows®
 - Mac OS®
 - Linux



- **Free download via Microchip's website:**
www.microchip.com/WDS



MICROCHIP



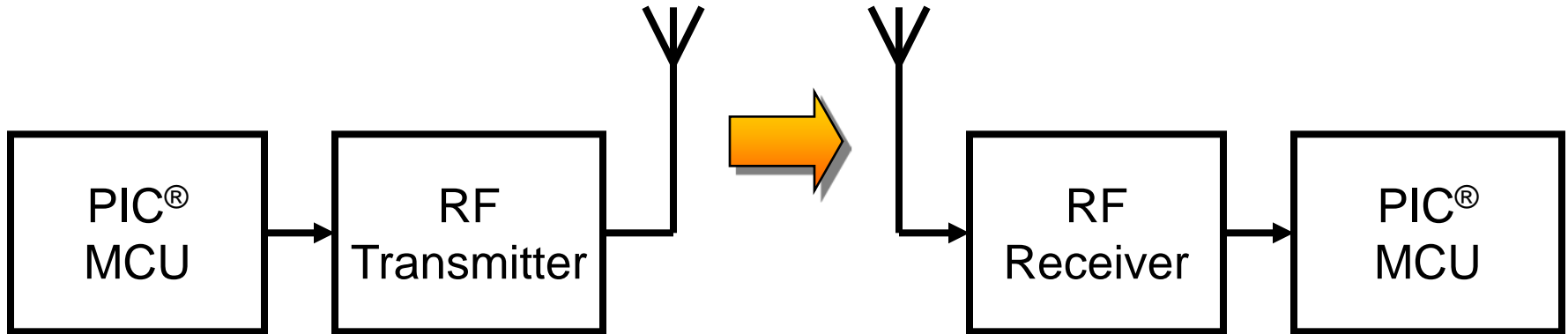
KeeLoq®

&

Remote Keyless Entry (RKE)

Sub GHz – (310-915 MHz)

RKE Wireless



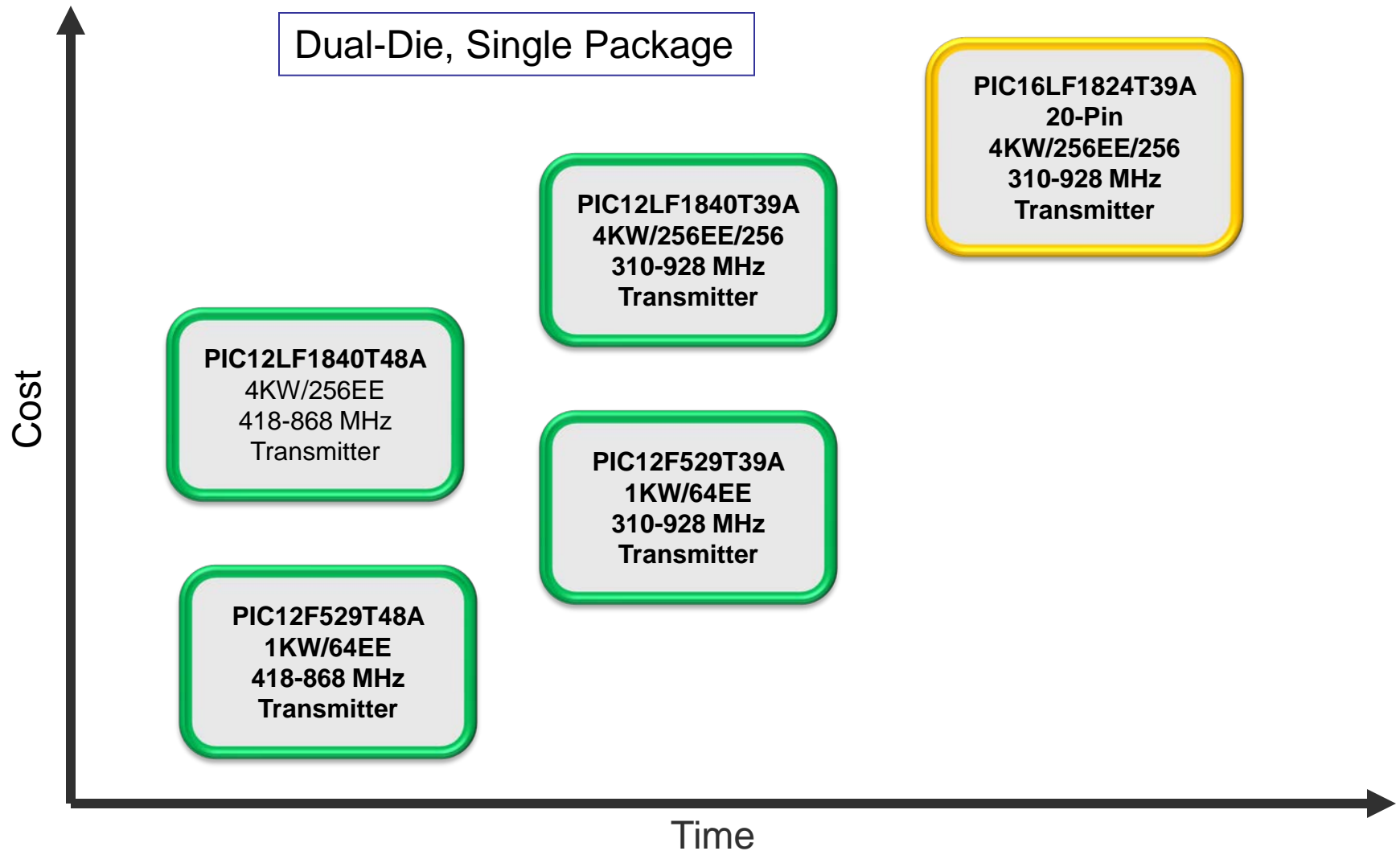
- Home Automation
- Wireless sensor nodes
- Security Systems
- Remote control
- Command and control

- Remote Keyless Entry (RKE)
- Garage Door Openers (GDO)
- Energy Displays
- Tire Pressure Monitoring





MCU+Tx Portfolio



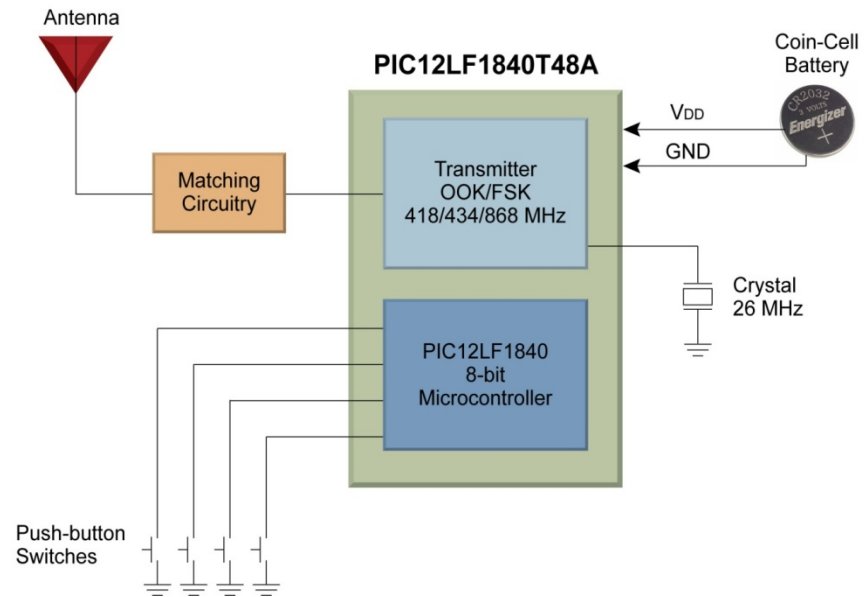


PIC12LF1840T48A

- **1.8V-3.6V Operation**
- **Standby Current:**
 - 170nA Sleep
- **Operating Current:**
 - 9.67 mA at +0 dBm,
 - 16 mA at +10 dBm
- **Transmit Radio:**
 - FSK Operation up to 100 kbps
 - OOK Operation up to 10 kbps
 - 418, 434 and 868 MHz



PIC12LF1840T48A Block Diagram





Next Steps with RKE

Wireless Security Remote Control Development Kit

- 433.92 MHz (DM182017-1)
- 868 MHz (DM182017-2)
- 915 MHz (DM182017-3)



Wireless Security Remote Control
Development Kit 433.92 MHz
(Part # DM182017-1)

- Download the demo firmware and user's guide from www.microchip.com/security



MICROCHIP

Wired Connectivity Featuring USB

**Enhance your products'
Connectivity to meet the demands
of a smarter world**



Agenda - USB as a total solution

- **What do you need?**
 - **Hardware**
 - Serial Interface Engine SIE
 - USB Transceiver - Physical Layer PHY
 - USB Analog – Comparators, Pullups, Regulators
 - **Firmware**
 - USB Software Stack (Low Level)
 - Drivers (Device Class Level)
 - Examples (Application Level)
 - **PC Software**
 - Drivers, Examples



USB Framework

- **Distribution package containing:**
 - PIC16, PIC18, PIC24F and PIC32 firmware projects
 - Class Drivers
 - Demo code for PIC micro
 - Demo code for PC application
 - Configuration tool
 - Schematics



Part of the Microchip Applications Library

www.microchip.com/mal



Free USB Software Stacks and Drivers

- **Stacks:**

- Device Stack
- Embedded Host Stack
- On-The-Go Stack

- **Class Drivers:**

- HID, MSD, CDC, Custom, Audio, Printer, PHDC
- Lib USB vendor class device
- WinUSB vendor class device

USB Host/Device Drivers:

- **Combination Support:**

- CDC host for ACM devices
- PCL 5 printer host support, Postscript, and some POS printers
- Composite driver
- DRD MSD host and HID device
- Composite MSD and CDC

*Use Microchip's
USB VID/PID*



Wide Range of USB Solutions



Adding Analog

A yellow starburst graphic with a black outline, containing the text 'Adding Analog'.

MCP2200
MCP2210
USB to UART/SPI

An orange rounded rectangle with a blue border, containing the text 'MCP2200', 'MCP2210', and 'USB to UART/SPI' in white.



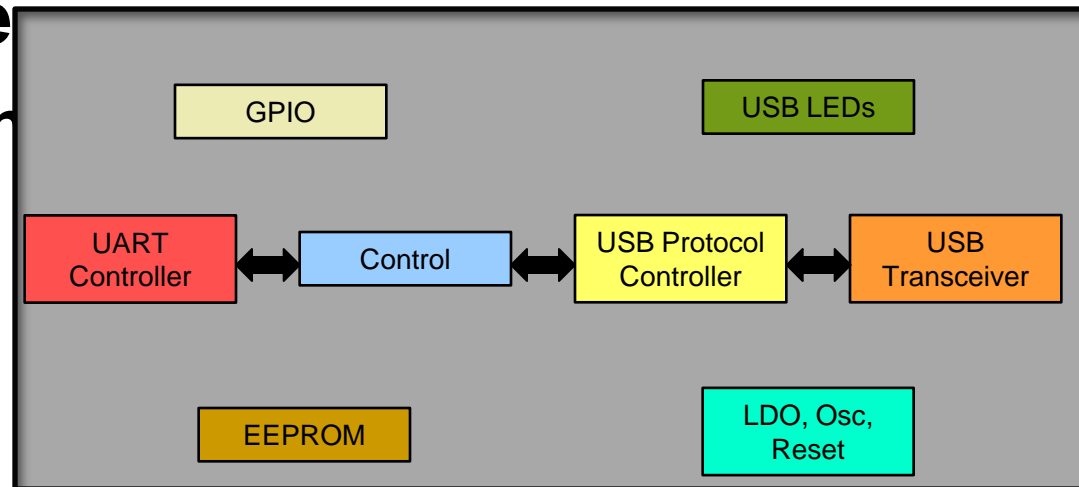
Let us introduce

MCP2200



MCP2200: USB to UART Serial Converter

- Enables USB connectivity in applications with UART
- Pre-programmed USB stack
- Easy to configure
- USB 2.0 Compliant
- Full-speed USB
- USB activity LED outputs
- Fully configurable VID and PID assignments

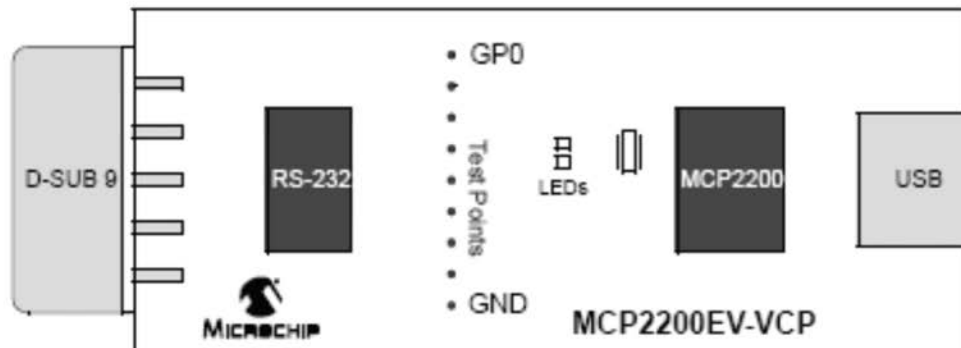


Easiest way to add USB to your design



MCP2200EV-VCP: USB TO RS-232 DEMO BOARD

- Demonstrates the MCP2200 in a Virtual Comm Port environment
- Provides method for I/O configuration development
- Configuration and Control S/W and DLL for custom S/W development at www.microchip.com/usb





Let us introduce

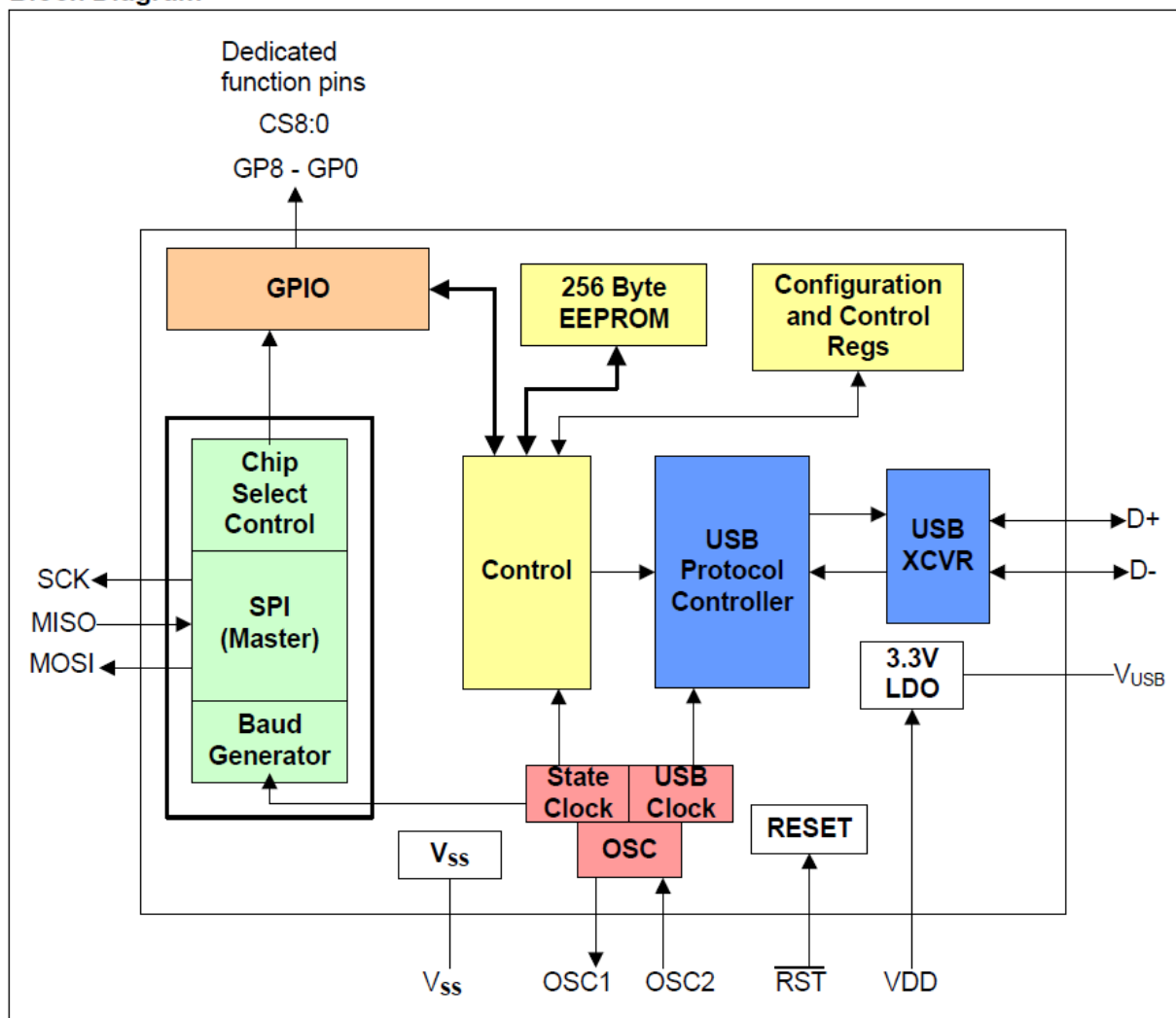
MCP2210



MCP2210 USB-to-SPI Serial Converter

**Add USB
connectivity in
applications
that have an
SPI interface**

Block Diagram

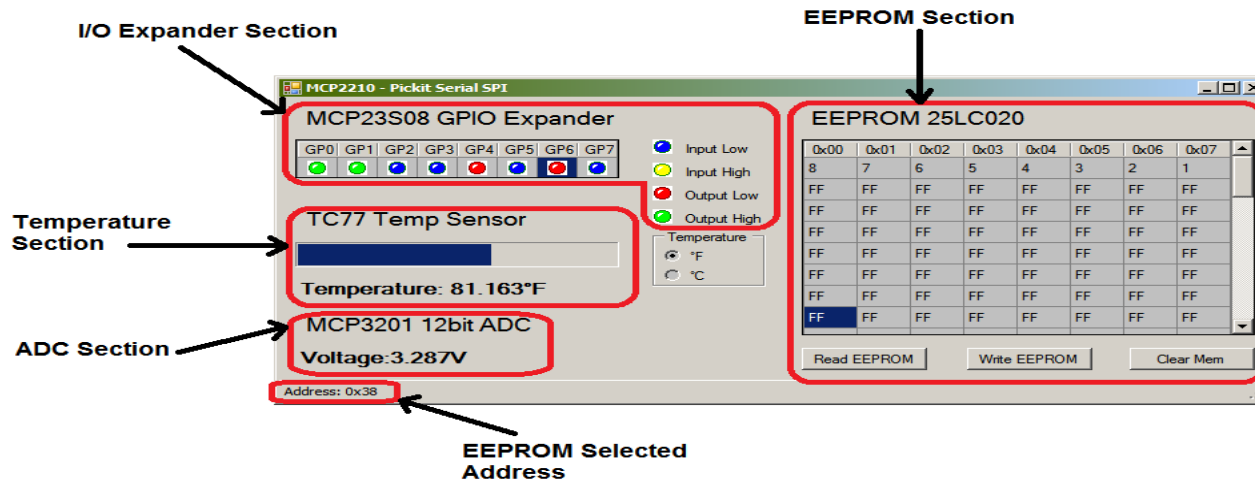




MCP2210 Evaluation Kit

- Motherboard includes 8-bit I/O expander, 12-bit ADC, 2kbit EEPROM and temperature sensor
- All communication through SPI

www.microchip.com/MCP2210EvaluationKit



MCP2210 Evaluation Kit

- **MCP2210 Breakout Board (ADM00419)**
- **MCP2210 SPI Slave Motherboard (ADM00420)**





Wide Range of USB Solutions

Adding 8Bit

MCP2200
MCP2210
USB to UART

PIC16F
USB
Device Support



Wide Range of USB Solutions

Adding 8Bit

PIC18F
USB
Device Support

PIC16F
USB
Device Support

MCP2200
MCP2210
USB to UART



Significance

- ✓ **First Microchip USB MCUs with Clock Recovery**
 - No External Crystal Required for USB communication
 - Saves **space**, saves **money**, and increases simplicity

- ✓ **Low Power performance for extended battery life**
 - Active current < 35uA/MHz
 - Sleep current < 20nA

- ✓ **Wide Range of feature set and core performance options**
 - PIC18 Core for performance, or PIC16 Core for cost savings
 - Up to 2KB of RAM Memory supports a range of USB classes
 - Peripherals to promote feature integration, resulting in BOM savings



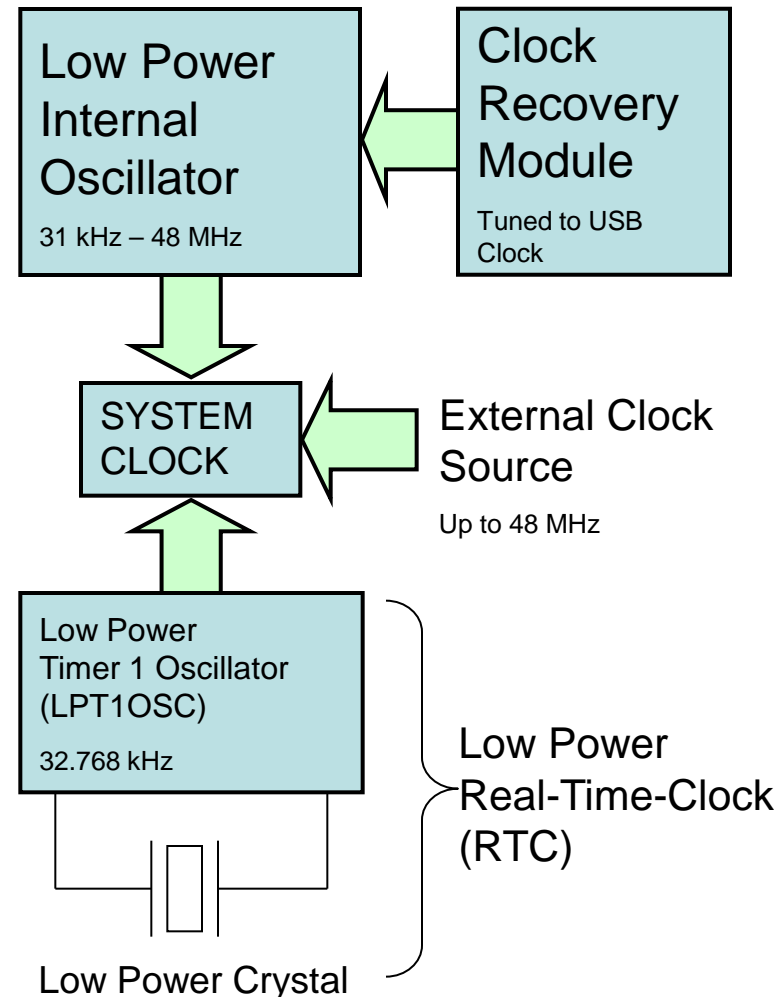
Clock Options

- **Internal Oscillator:**

- Software selectable frequency range
 - 31 kHz - 48 MHz
- Low current consumption
- Self-Tuning during USB operation

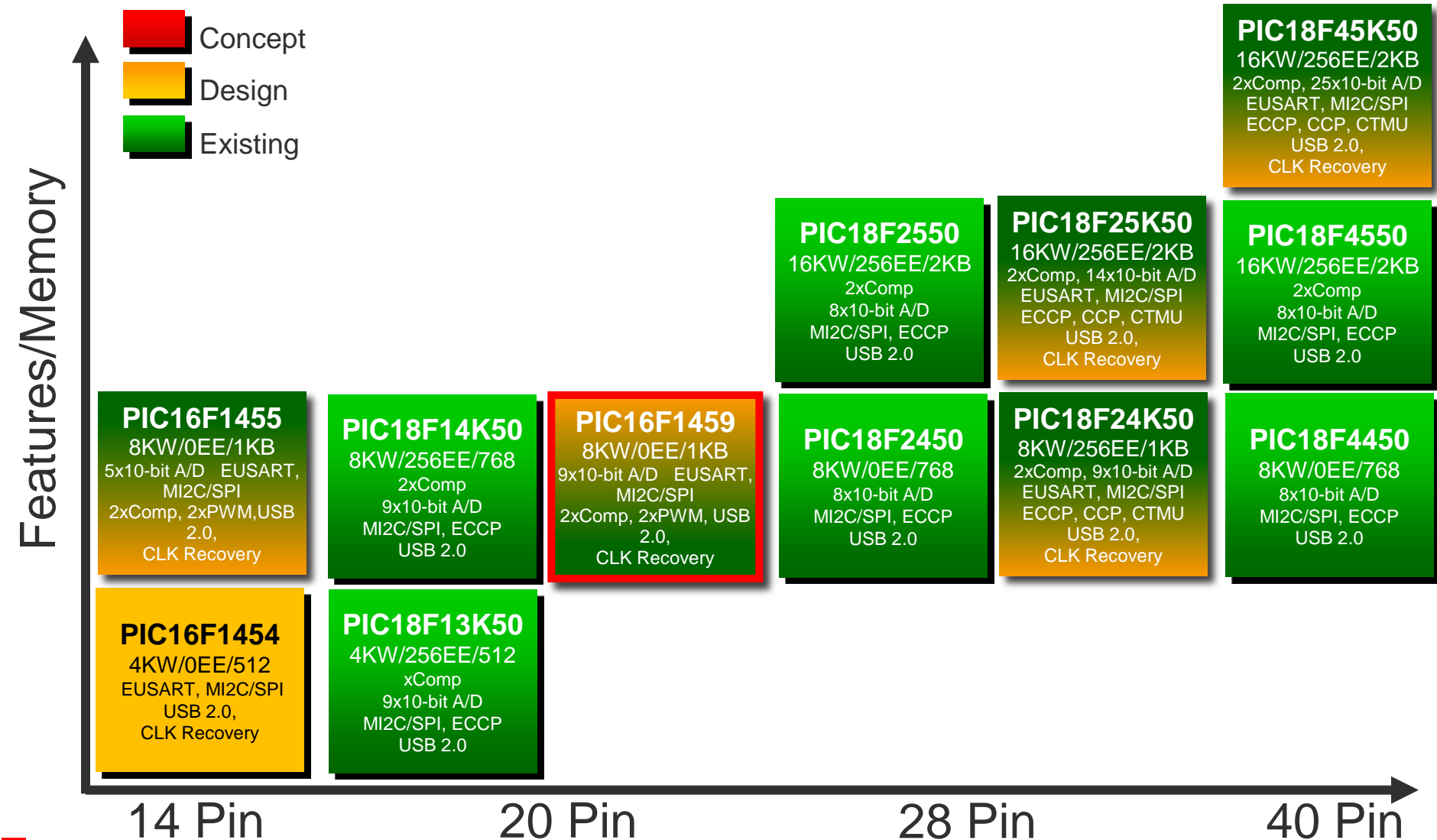
- **External Options**

- **EC - External Clock**
 - Up to 48MHz
- **LPT1OSC – Low Power Timer 1**
 - 32 kHz Low-Power Crystal Option
 - 500 nA current consumption
 - Real Time Clock implementation
 - Timing critical





Low Pin Count 8-bit PIC USB Family





Let us introduce

PIC16F1459

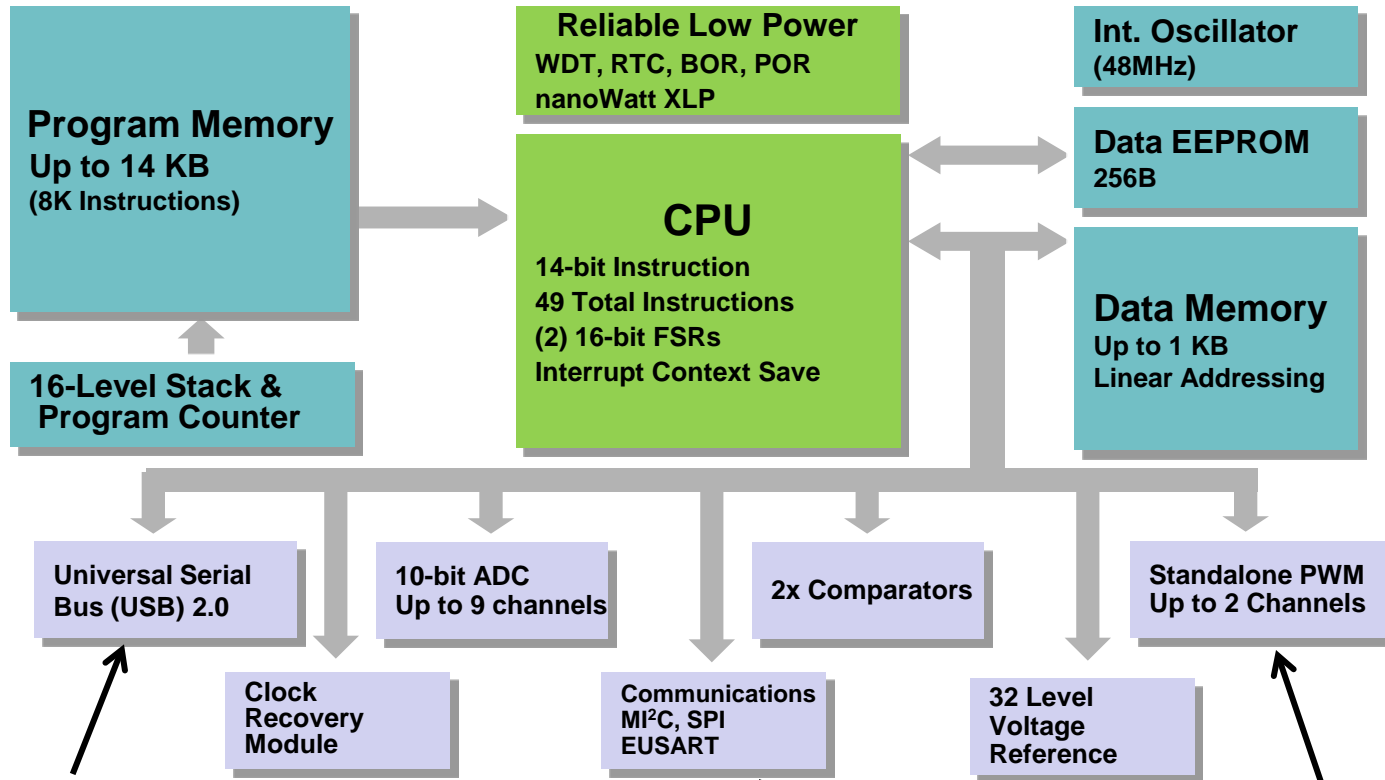


PIC16F145x Family

Our Lowest Cost USB MCUs to Date



PIC16F145X Block Diagram



Supports Full Speed
USB Communication

No External Crystal
Required!

Enhanced Communications

Available in 14- & 20-pin Packages

Low-Cost Integrated PWMs



Key Peripherals

PIC16F145x Family

Peripheral	Benefit / Result
48MHz Internal Clock w/ Recovery	<ul style="list-style-type: none">○ No external Crystal required for USB operation○ Integrates clocking control & saves board area
On-board Analog – 10-bit ADC, Comparators, Fixed Voltage Reference	<ul style="list-style-type: none">○ Wide range of sensing applications possible○ Built-in battery monitor capability○ Integrated control of simple SMPS circuits
Integrated I ² C/SPI and USART interfaces	<ul style="list-style-type: none">○ USB to UART or I²C Bridge capabilities
Integrated Temperature Indicator	<ul style="list-style-type: none">○ TEMP measurements at ZERO additional cost○ No need for external hardware
Pulse Width Control Modules	<ul style="list-style-type: none">○ Multiple PWMs for external output control○ Independently controlled duty cycle



Low Power Operation

PIC16F145x

Industry Leading Low Power Performance

- Sleep Current → 20nA*
 - WDT Current → 300nA*
 - Timer1 Current → 600nA*
- Low Active Current** → <35uA/MHz*
with Low Power BOR → 200nA*



Great for battery powered applications !!!



* Typ specs @ 1.8V for LF options



Let us introduce

PIC18F2x/4xK50

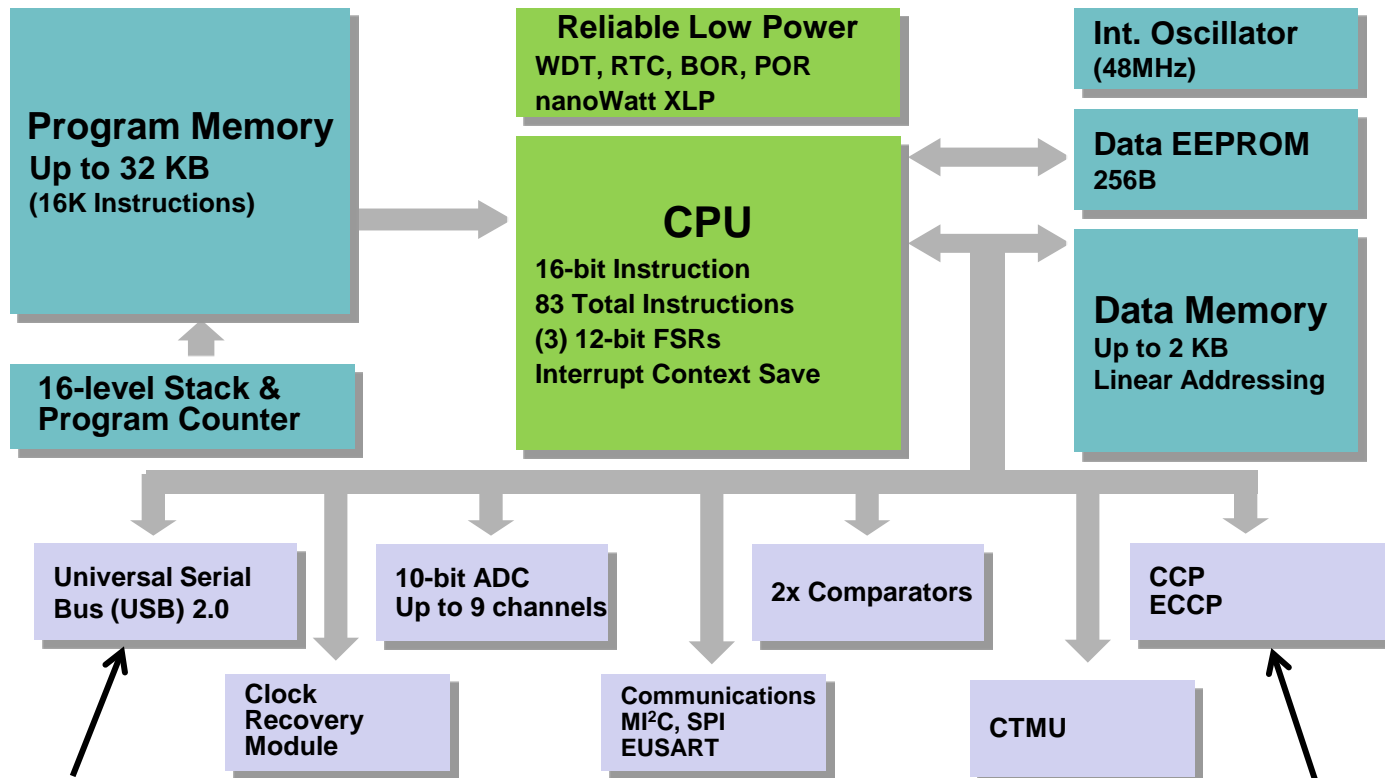


PIC18F2x/4xK50 Family

High Performance with Clock Recovery



Block Diagram



Supports Full Speed
USB Communication

No External Crystal
Required!

Touch, Temperature, Humidity
Sensing and More!
Available in 28- & 40-pin Packages

PWM with Complement
Generation



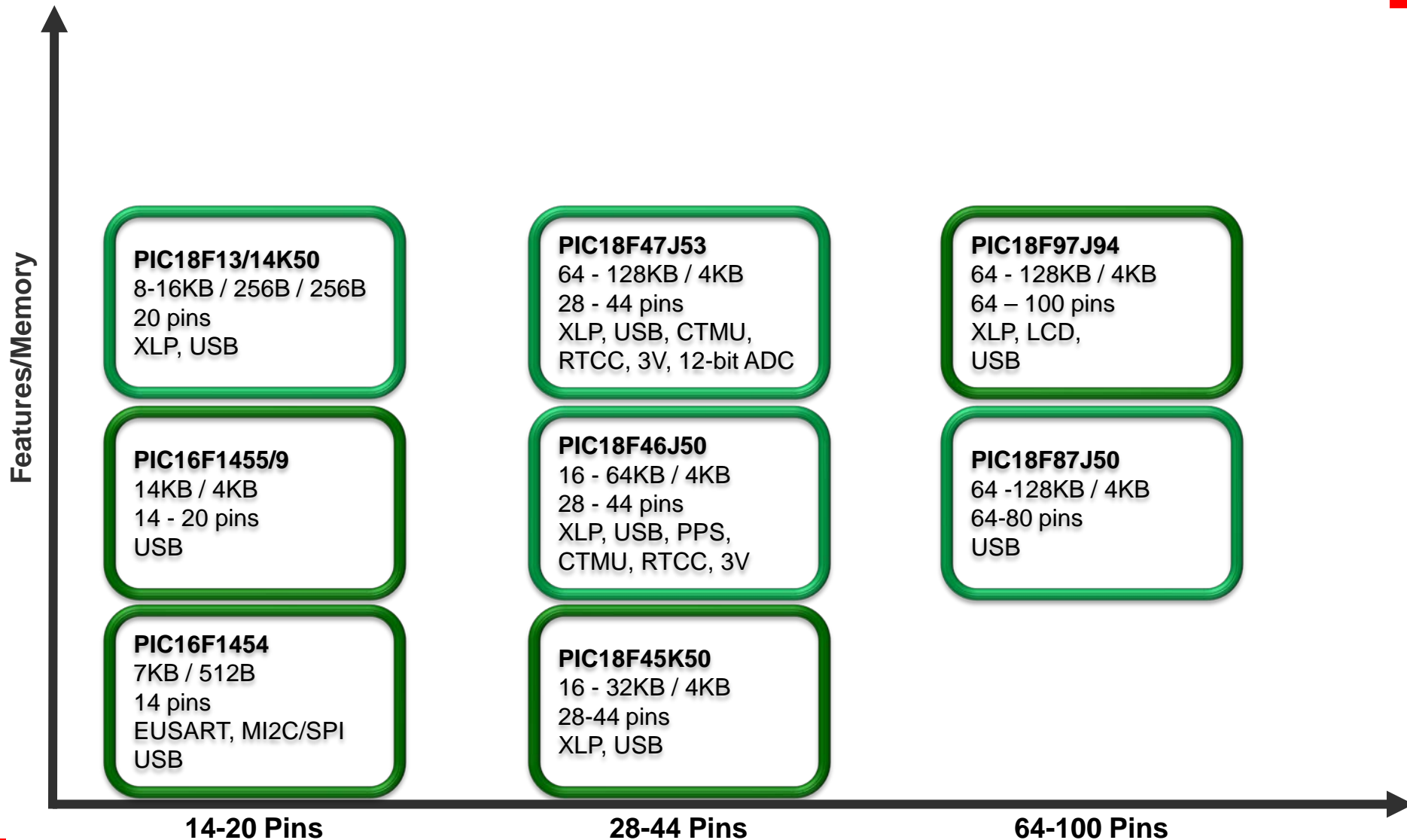
Key Peripherals

PIC18F2x/4xK50 Family

Peripheral	Benefit / Result
48MHz Internal Clock w/ Recovery	<ul style="list-style-type: none">○ No external Crystal required for USB operation○ Integrates clocking control & saves board area
On-board Analog – 10-bit ADC, Comparators, Fixed Voltage Reference	<ul style="list-style-type: none">○ Wide range of sensing applications possible○ Built-in battery monitor capability○ Integrated control of simple SMPS circuits
Integrated I ² C/SPI and USART interfaces	<ul style="list-style-type: none">○ USB to UART or I²C Bridge capabilities
Integrated Temperature Indicator	<ul style="list-style-type: none">○ TEMP measurements at ZERO additional cost○ No need for external hardware
Pulse Width Control Modules (ECCP and CCP)	<ul style="list-style-type: none">○ Multiple PWMs for external output control○ Automatic Complementary Waveform Generation○ Automatic Dead Time Insertion
Charge Time Measurement Unit	<ul style="list-style-type: none">○ Integrated On-chip Constant Current Source○ Used to perform various types of measurement



8-bit PIC MCU with USB Device





Let us introduce

PIC18F97J94

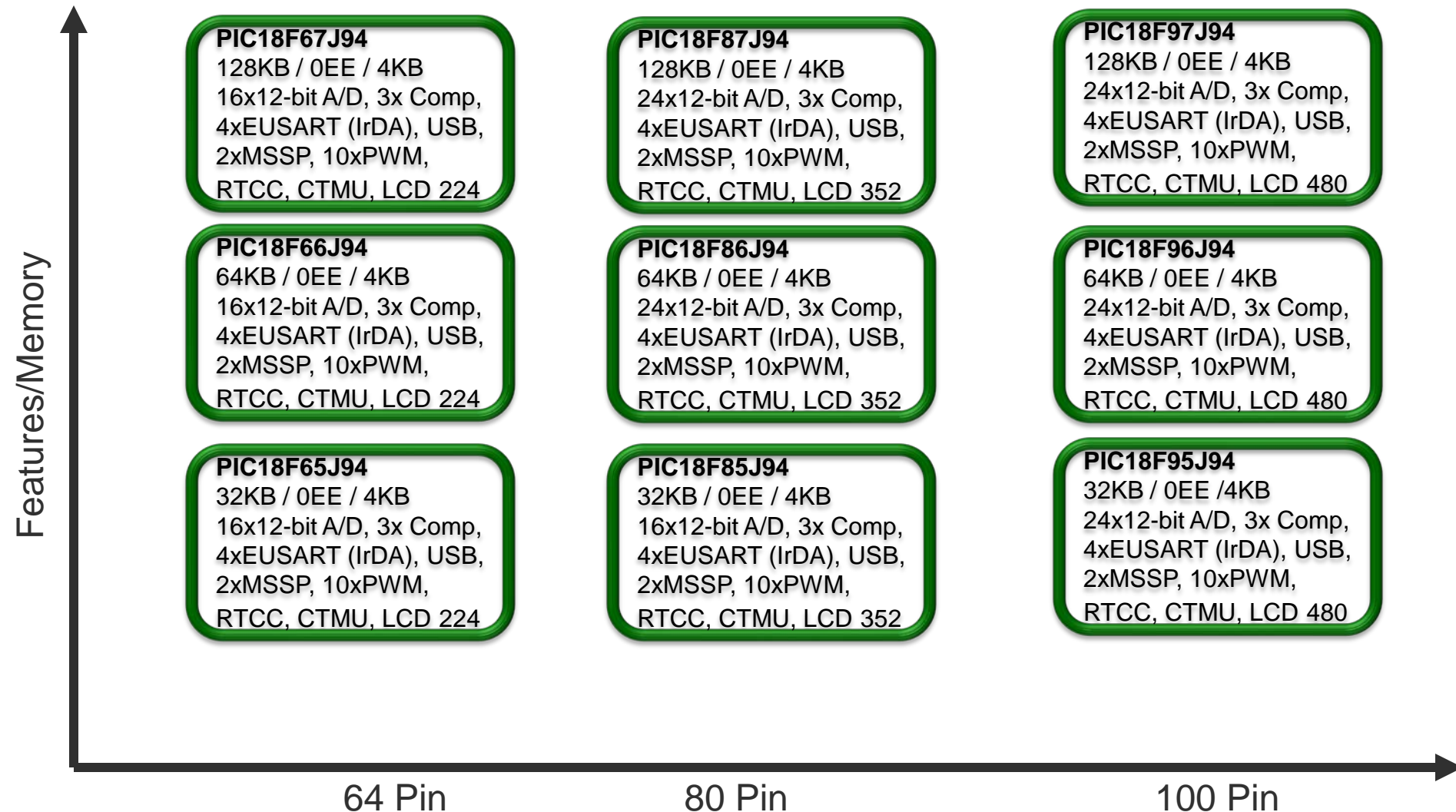


Significance

- ✓ **General Purpose 8-MCU with large Memory in 100/80/64 pins**
 - 128KB of Program Memory
 - 4KB of RAM

- ✓ **High End 8-bit MCU with Advance Peripheral**
 - LCD 480 segments with 8 commons
 - USB 2.0 Full Speed compatible
 - 4 EUSART with LIN and IrDA
 - RTCC with battery backup (Vbat)
 - CTMU and 24 channel 12-bit ADC

- ✓ **eXtreme Low Power**
 - Vbat allows lowest power consumption on backup battery for RTCC



Typical Applications

- Industrial
 - Security
 - Data loggers
 - Printers
- Consumer
 - Thermostats
 - Door Locks
 - Portable hand held devices
- Medical
 - Blood Pressure Meter
 - Glucose Meter
 - Pedometer
- Metering
 - Single phase energy meters

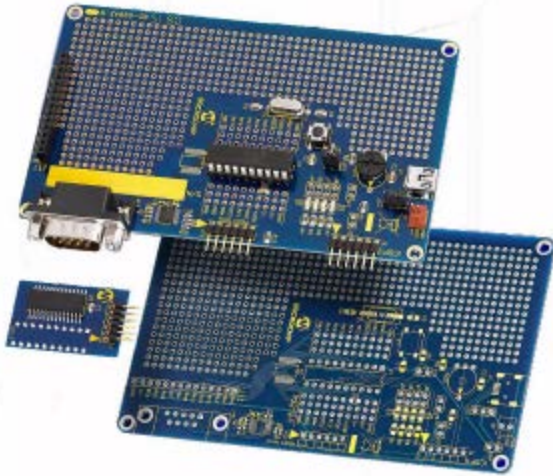




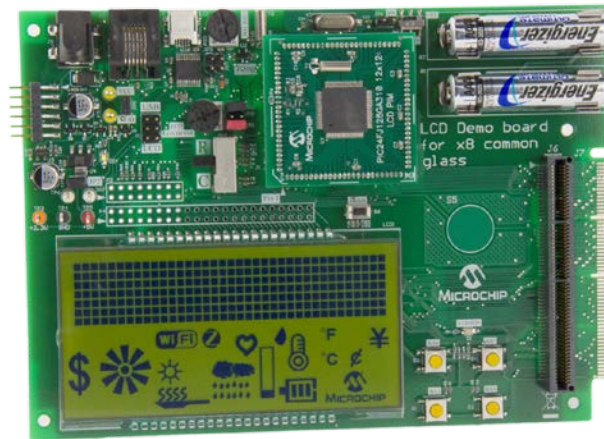
Development Tools

Low Pin Count Development Kit

Part Number: DM164127



LCD Explorer Dev. Board DM240314



PIC18 Starter Kit





Free USB Device Class Demonstration Code

Device Class Demo Code

- Bootloaders
- Audio – MIDI
- Composite
 - HID + MSD & MSD + CDC
- Mass Storage
 - Internal Flash
 - SD Card data logger & Reader
- HID
 - Custom Demos
 - Joystick, Keyboard, Mouse
 - Digitizers
 - Uninterruptable Power Supply HID
- **CCID, CDC, LibUSB, WinUSB, PHDC**





Wide Range of USB Solutions

Adding 16Bit

PIC24F
USB Device, Embedded
Host, OTG

PIC18F
USB
Device Support

PIC16F
USB
Device Support

MCP2200
MCP2210
USB to UART

USB On-The-Go (OTG)

- Allows item to operate as Host or Device
- PDA connected to PC will automatically be a Device
- PDA connected to Keyboard will automatically be a Host



PC Host

PDA OTG Device

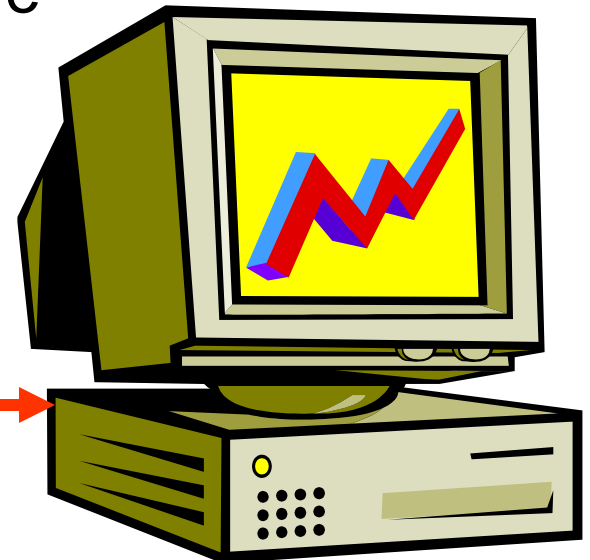


PDA OTG Host

Keyboard Device

USB Embedded Host Application

- **Embedded Application acting as a host**
 - No PC in system
 - Will not need to act as a Device
- **Advantage: Smaller, less complex firmware**
- **Example: Remote Temperature Data Logger**
 - Download data to a USB Flash Drive



Embedded Host Examples



POS Terminal



Video Game Console



Sprinkler Timers



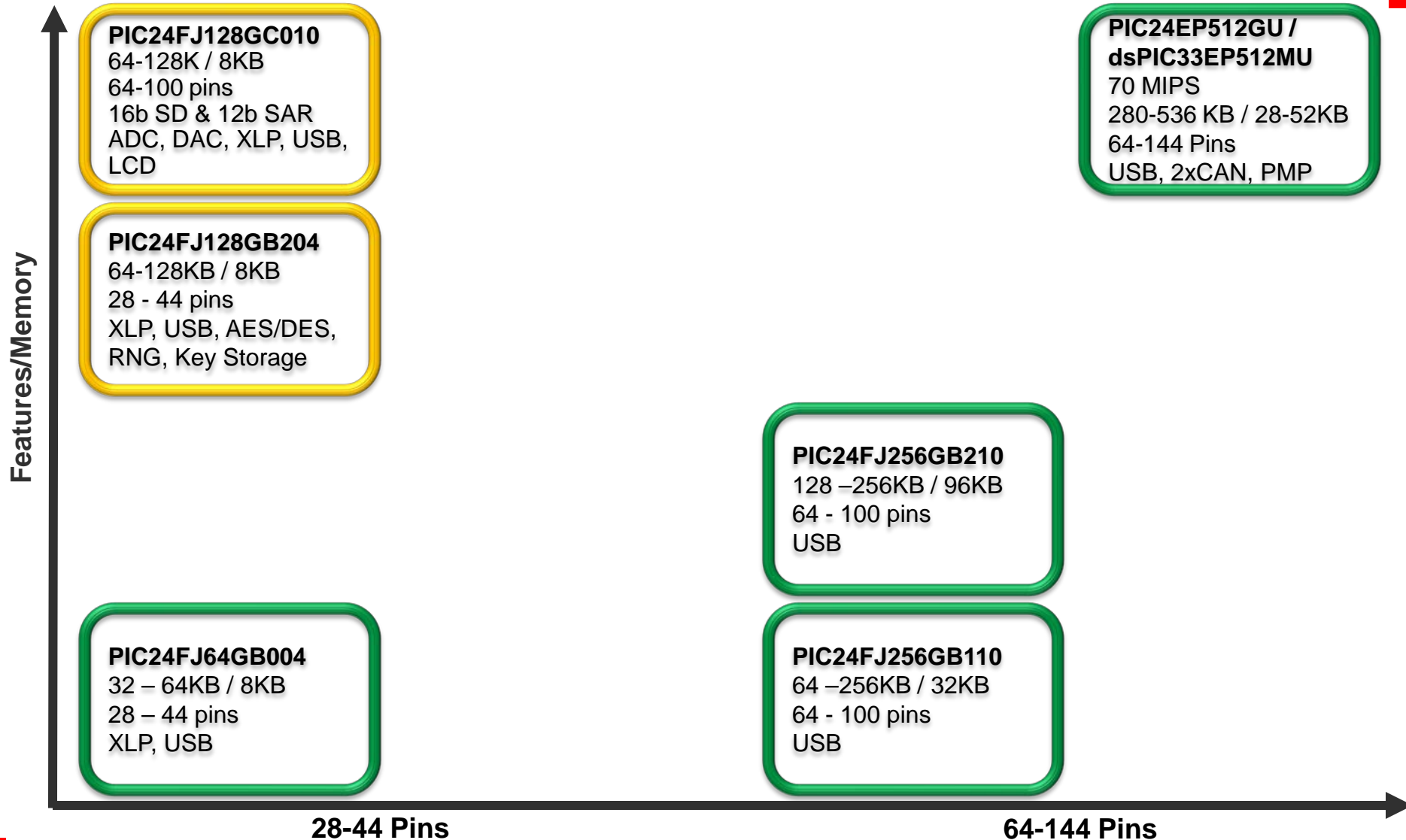
Exercise Equipment



Set-Top Box



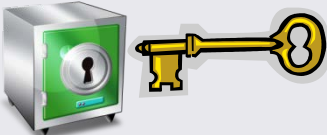

16-bit PIC MCU & DSC with USB Device, Host & OTG





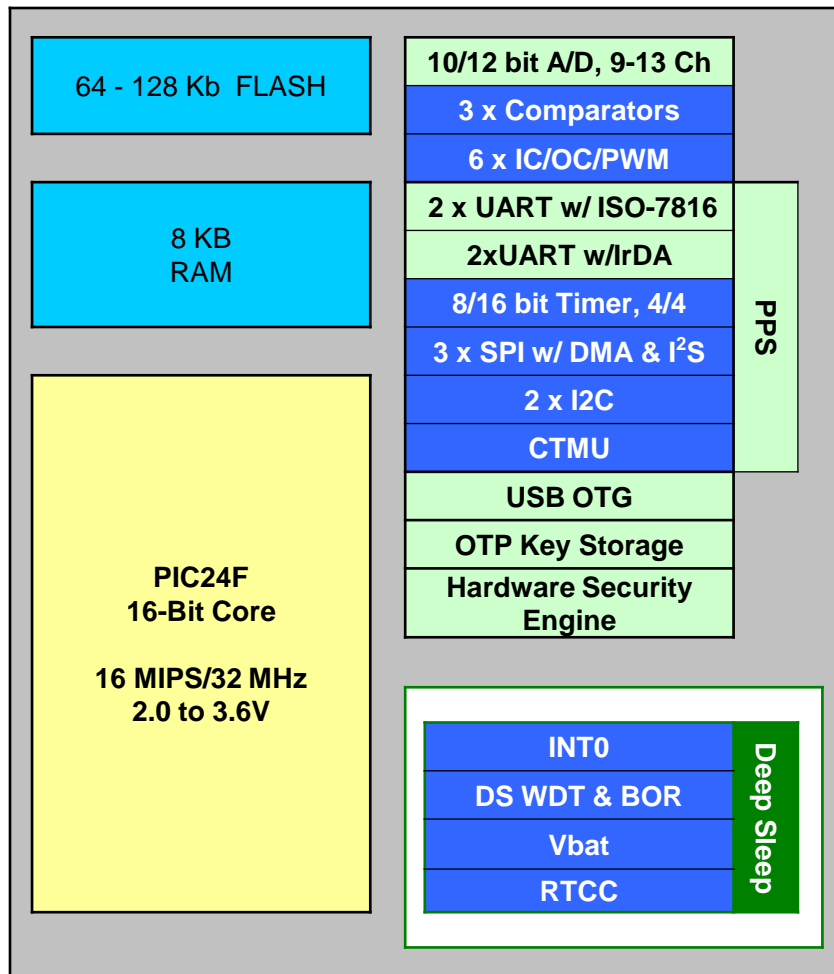
Let us introduce

PIC24FJ128GB204

Key Product Feature	Benefits
 Hardware encryption, Secure Key Storage, Pseudo Random Number Generation	<p>Reduces Software overhead, High speed, Security applications</p>
UART with ISO7816 support & USB	<p>Enables entry into smart card reader market Lowers BOM cost, Reduces software overhead, higher speed</p>
USB & mTouch™	<p>Easy connectivity, clean control</p>
 Technology with Vbat	<p>Battery back up for RTCC and Longer battery life</p>



PIC24FJ128GB204 Family Overview

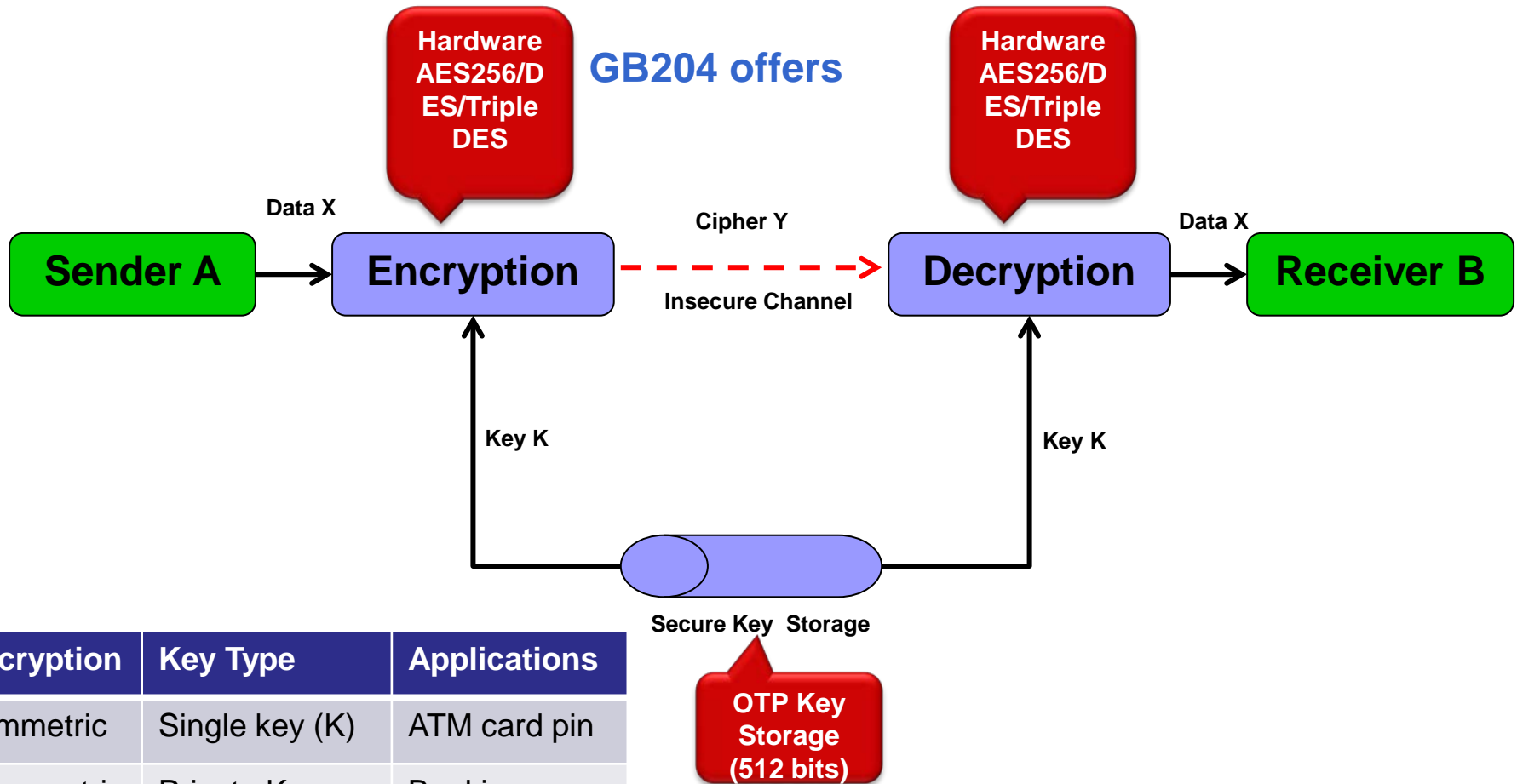


- **Package options**
 - 28-pin SOIC, SSOP, QFN
 - 44-pin TQFP, QFN

- **Hardware Security Features**
 - AES and DES/Triple DES
 - On-chip OTP Key Storage
 - Pseudo Random number generator
- **USB OTG**
- nanoWatt XLP Low Power Modes
 - Deep Sleep Mode
 - Vbat
- 9 – 13 ch. X 10/12-bit A/D (200/500 ksps)
- 4 x UART w/IrDA (UART 1&2 with ISO7816 compatibility)
- 2 x I2C
- 3 x SPI and I²S
- 6ch. DMA
- 3 x comparators
- CTMU
- Hardware RTCC
- Peripheral Pin Select



What is Security...





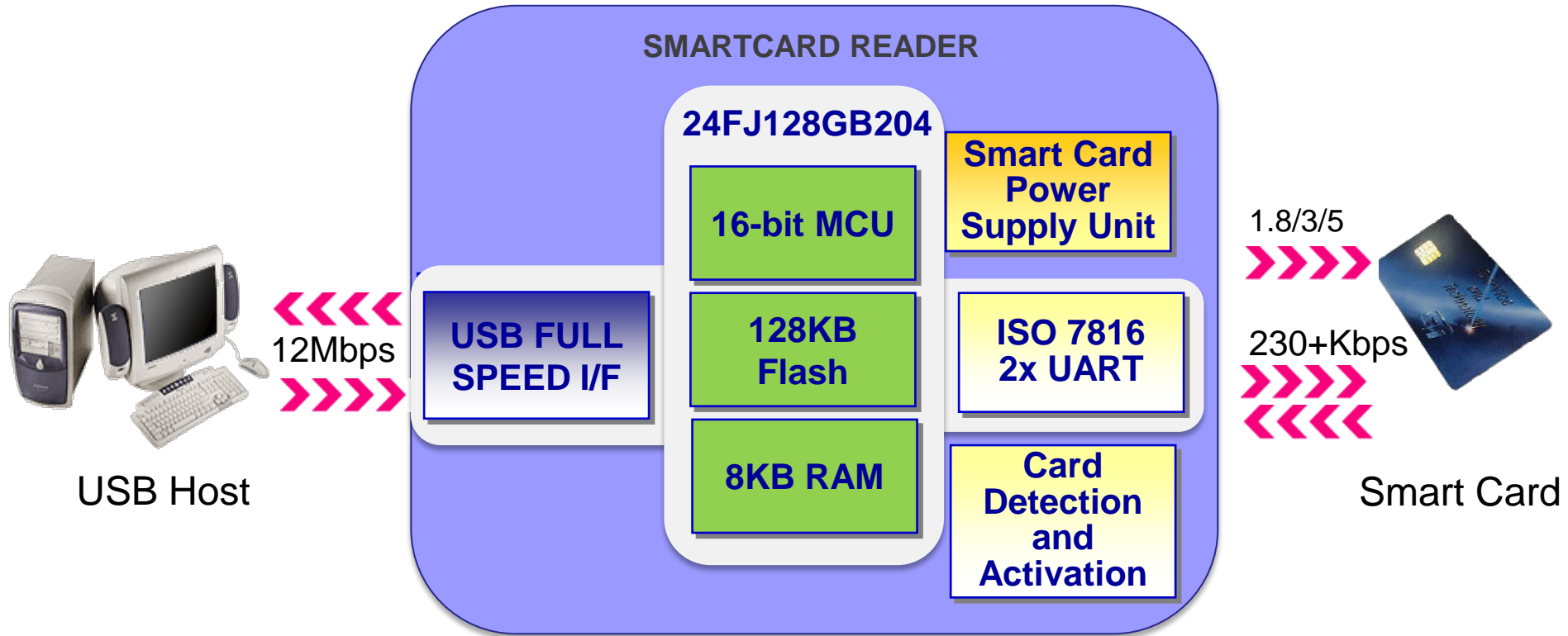
Application Example

Secure M2M Communication

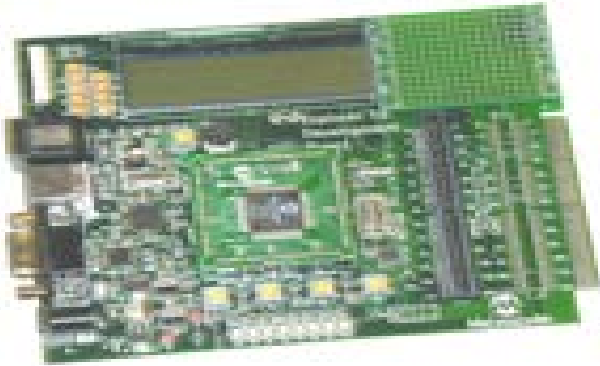


- **Encryption**
 - AES, DES, Triple DES for Higher speed and data authentication
 - Hardware AES is ~10 times faster than Software AES
 - Hardware DES is ~200 times faster than Software AES
- **OTP Key Storage**
 - 512 bits of on chip key storage
 - Prevents software tamper
- **PRNG**
 - Support for key generation
- **Use Cases**
 - Electronic Point of Sale
 - Prepayment

Smart Card Reader...



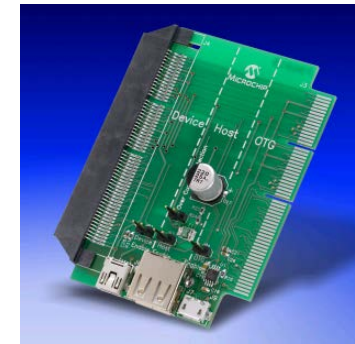
Development Board



- **Explorer 16 Board**
 - Can be used for General Purpose Applications

- **USB PICTail Daughter card**

- For USB Applications




- **Smart Card PICTail Daughter Board (AC164141)**
 - For smart card applications



Let us introduce

PIC24FJ128GC010

Key Product Feature	Benefits
Integrated Analog	Lower BOM, lower noise, higher speed
USB, LCD & mTouch™	Rich display, web connected, clean control
 Technology	Longer battery life

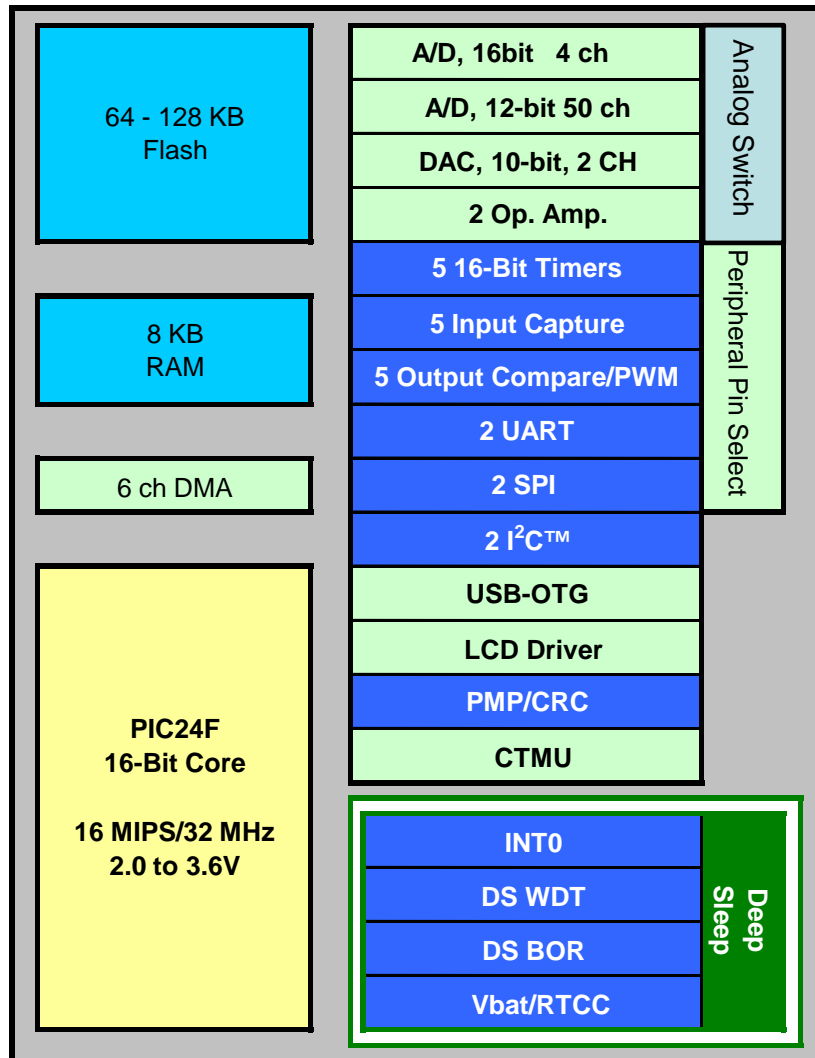


Analog So What...

- **Lower noise with higher throughput**
 - 16-bit ADC
 - More information (3 μ V) & eliminates amplifier
 - 12-bit ADC
 - Ultra-high speed data capture, 50 ch
 - 10-bit DACs
 - Analog control loops, stereo audio, stimulus
 - Operational Amplifier
 - Analog control loops, mic pre-amp



PIC24FJ128GC010 Family Overview



- **Precision Analog**
 - 4 ch x 16-bit Sigma Delta ADC
 - 50 ch x 12-bit SAR ADC
 - 2 ch x 10-bit DAC
 - 2 x Operational Amplifiers
 - Internal Connection Switch Matrix
- **Communications**
 - USB OTG
 - UART, SPI, I²CTM
- **LCD controller**
 - 472 Segment
 - Voltage Booster
- **128KB Flash, 8KB RAM**
 - DMA Controller
- **Package options**
 - 64-/80-/100-pin TQFP
 - 64-pin QFN, 121 BGA

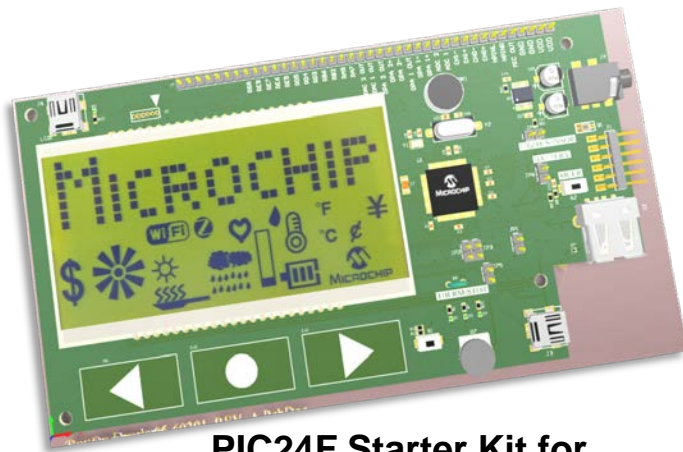
Application Example Glucose Meter



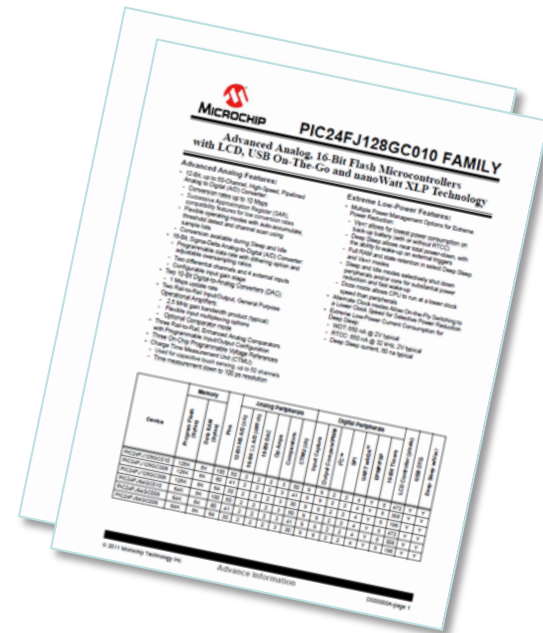
- **Integrated High Resolution Analog**
 - Reduces BOM, simplifies design
 - Fast 12-bit results & high resolution 16-bit
 - Operation Amplifier and 10-bit DAC for complete signal chain
- **Rich Information Display**
 - Can provide text guidance
 - Can show Asian characters
 - Adjustable text sizes for seniors
- **USB data upload**
 - Send data to physician or upload to web
- **XLP Low Power**
 - Runs longer on coin cell or round cell batteries
 - Low Run power and Vbat battery backup



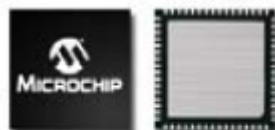
PIC24FJ128GC Beta Kit Contents



**PIC24F Starter Kit for
Simple.Portable.Analog**



**121-Ball BGA (BG)
10 x 10 x 1.1 mm**



**64-lead QFN (MR)
9 x 9 x 0.9 mm**



**64-lead TQFP (PT)
10 x 10 x 1 mm**



**80-lead TQFP (PT)
12 x 12 x 1 mm**



**100-lead TQFP (PT)
12 x 12 x 1 mm**

Development Tools for USB Host

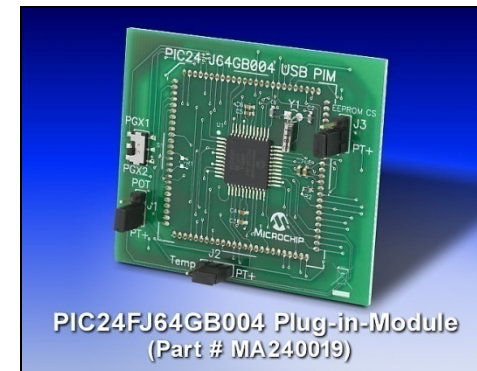
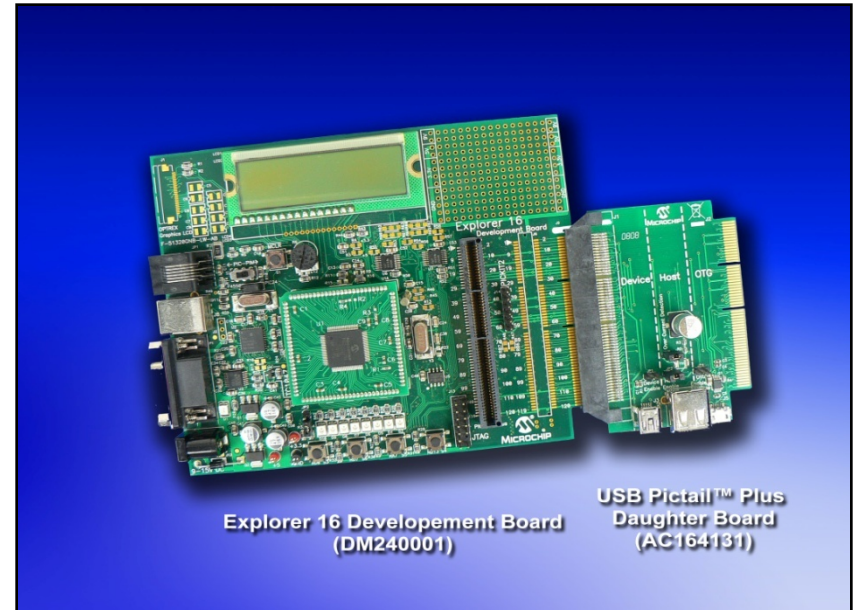
Explorer 16 Development Board

- Alphanumeric 16 X 2 Display
- RS-232 Serial Port and Associated Hardware
- JTAG and Ethernet Connectors
- Push-button switches and LEDs
- ...and many more features

USB PICTail™ Plus Daughter Board

Plug-in Modules (PIMs)

- Many different PIC® MCUs with USB





Free USB Host Demonstration Code

Host Demo Code

- Bootloaders
- CDC: Serial Demo
- Charger: Simple Charger
- HID: Keyboard
- Printer
 - Print Screen
 - POS Demo
- Mass Storage
 - Thumb Drive Data Logger
 - Storage Demo
- USB OTG and DRD



www.microchip.com/usb



Wide Range of USB Solutions

Adding 32Bit

PIC32
USB Device, Embedded
Host, OTG

PIC24F
USB Device, Embedded
Host, OTG

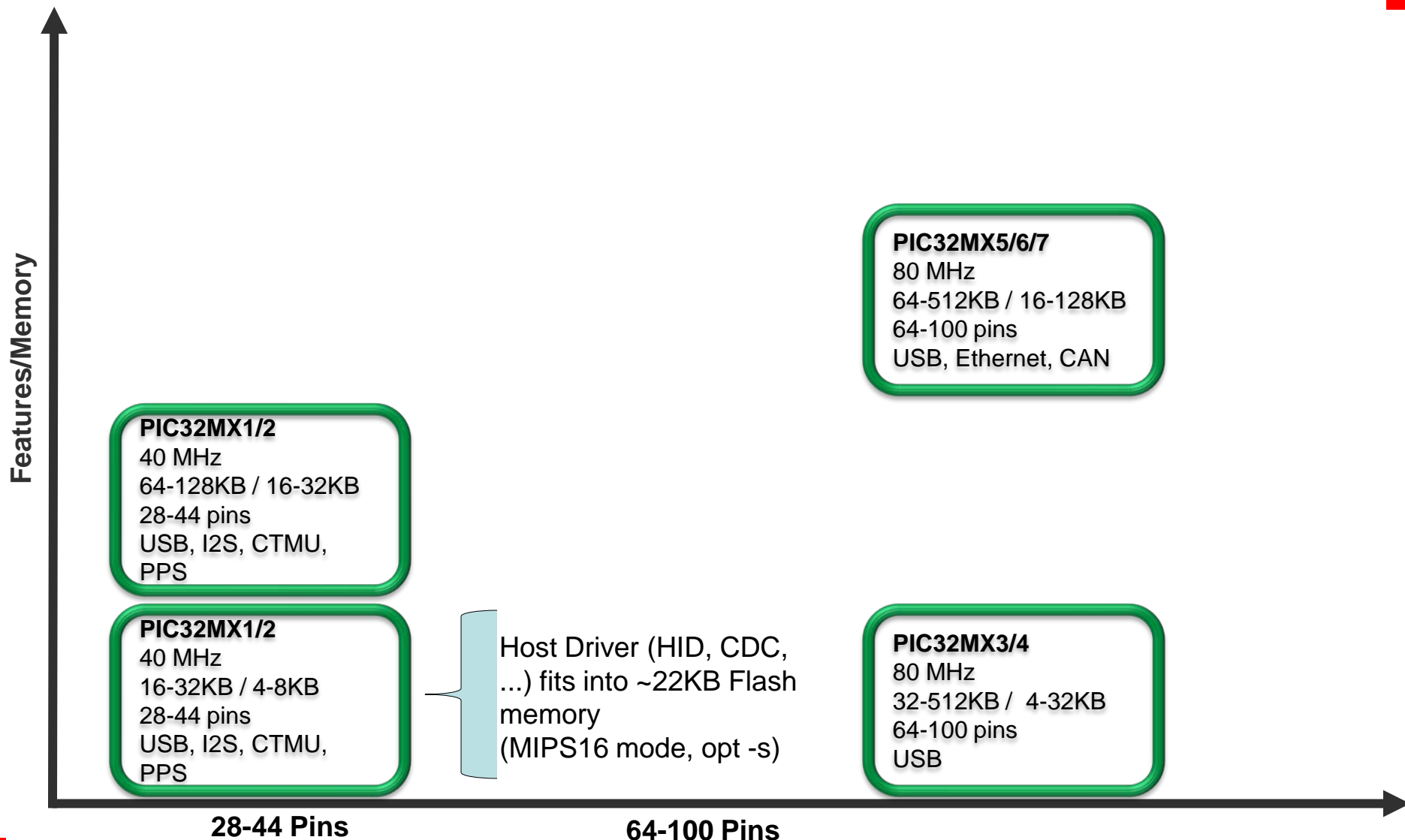
PIC18F
USB
Device Support

PIC16F
USB
Device Support

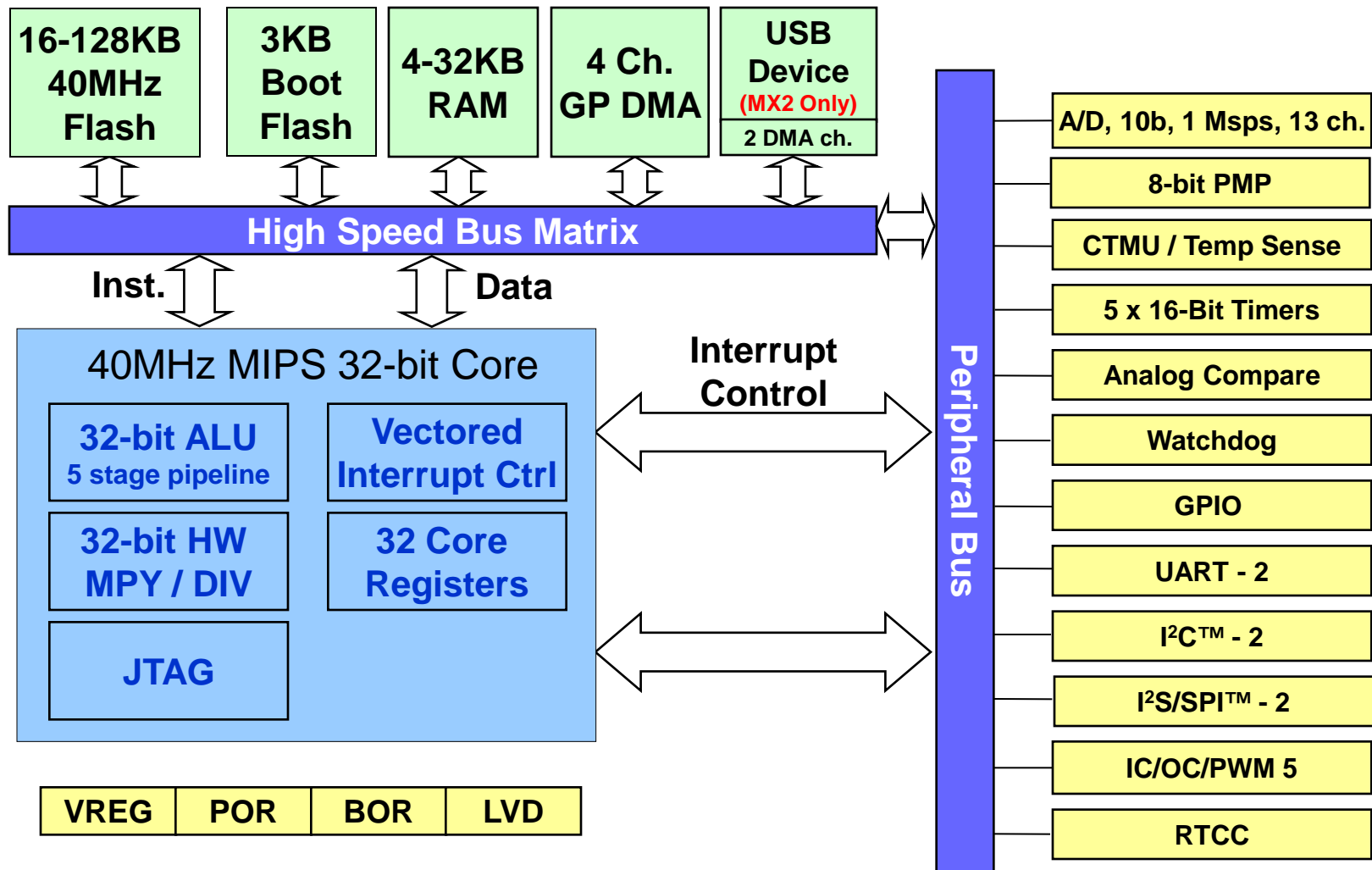
MCP2200
MCP2210
USB to UART



32-bit PIC MCU with USB Device, Host & OTG

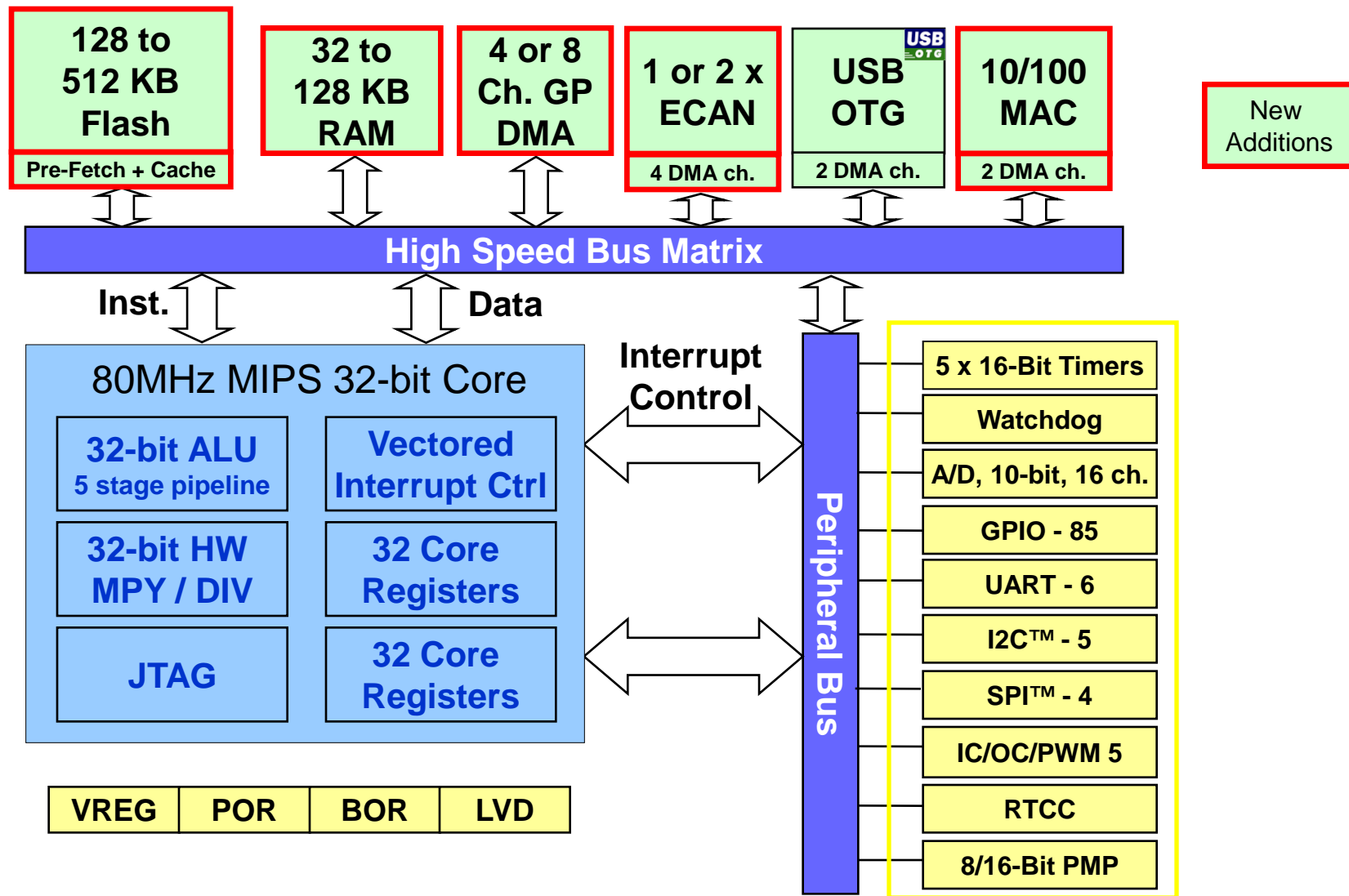


Starting with: PIC32MX1 & MX2 Block Diagram





Up to: PIC32MX7 USB OTG+ 2ECAN + E.net Family





Additional Resources

- **Online Design Centers:**

www.microchip.com/mal

www.microchip.com/usb



MICROCHIP

**ENC624J600 - 10/100 Base-TX
Stand Alone Ethernet
Controller**

Embedded Ethernet Solutions



www.microchip.com/ethernet
www.microchip.com/tcpip

Why Ethernet?

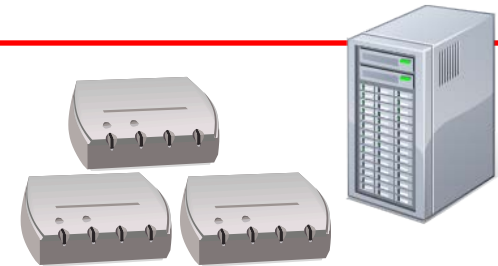
- **Most Widely Deployed Network**
 - Widely Understood
 - Offices, homes, industrial buildings
 - Huge existing infrastructure
- **Interoperable**
 - Open standards
 - Leverage existing protocols
 - Leverage existing software
 - Browsers, Email Clients, etc.
 - Large support community
- **Automated System Management**
 - Optional evolving protocols
- **Low Latency – “Real Time” Remote Delivery**



Why Ethernet?

- **Scalable Network**

- Inexpensive equipment
- Automatic configuration

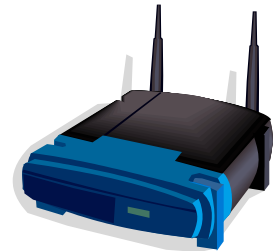


- **The Internet**

- Same standards, same protocols
- Standards are called Request for Comments (RFC)
- Cross-Platform – Windows®, Mac, Linux,...

- **Easy Migration to Wireless**

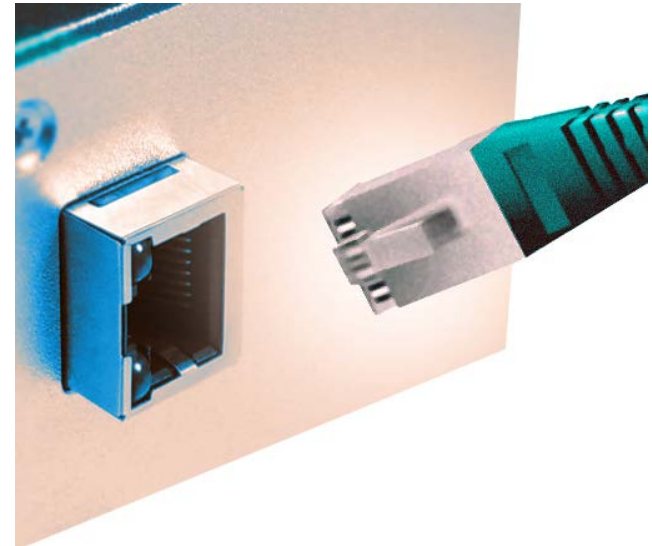
- WiFi 802.11 is interoperable with Ethernet
 - Same standards, same protocols
 - Just replace the MAC/PHY layers



- **Secure Sockets Layer (SSL) for Security**

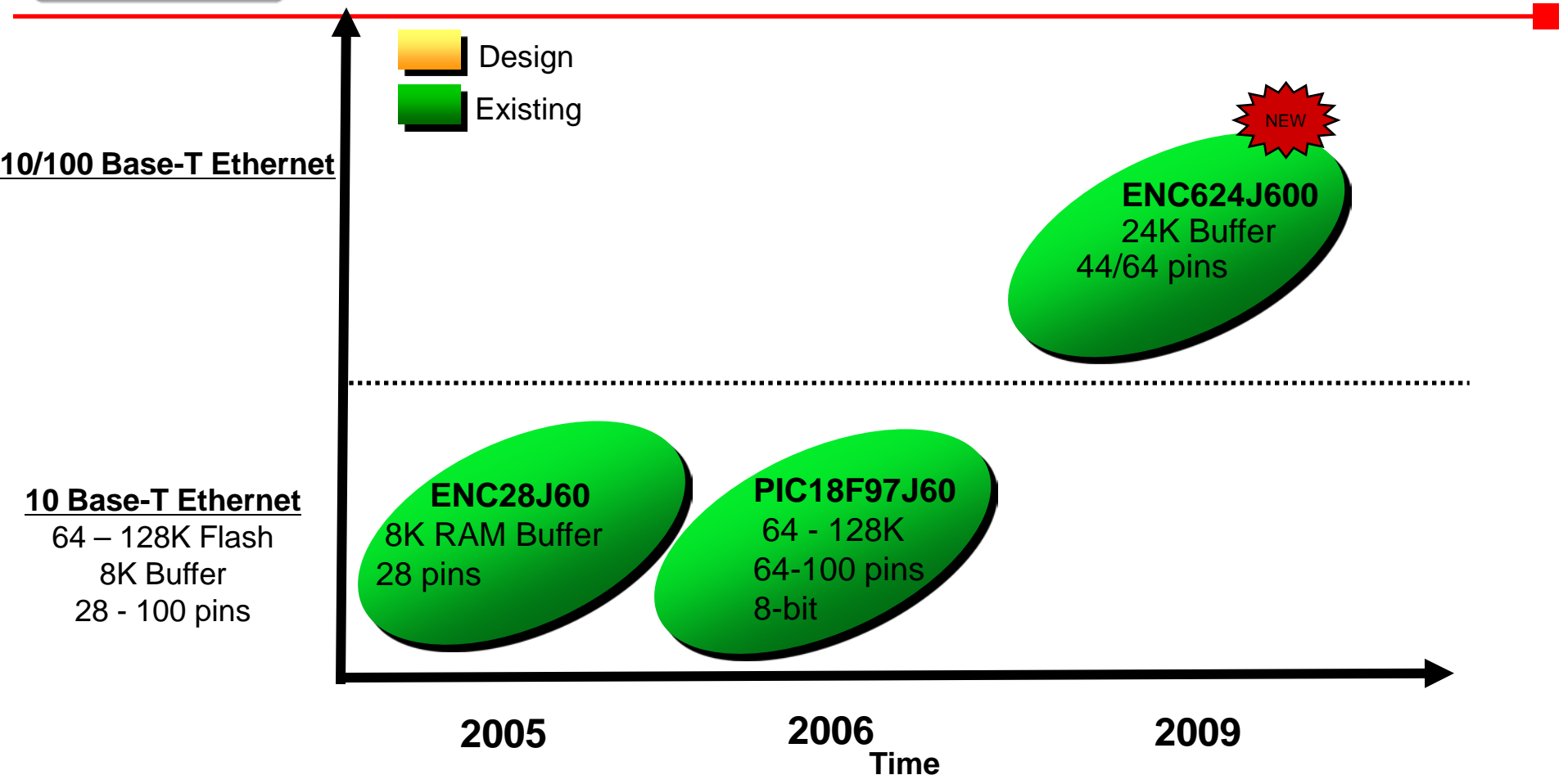
Network Speeds

- **10 BaseT (10 Mbps)**
 - Target applications – low bandwidth
 - Embedded applications behind switch or router
- **100 BaseT (100 Mbps)**
 - Low latency – “real time” delivery
 - High bandwidth needs
 - Voice over Ethernet
 - Remote secure monitoring





Ethernet Family Roadmap



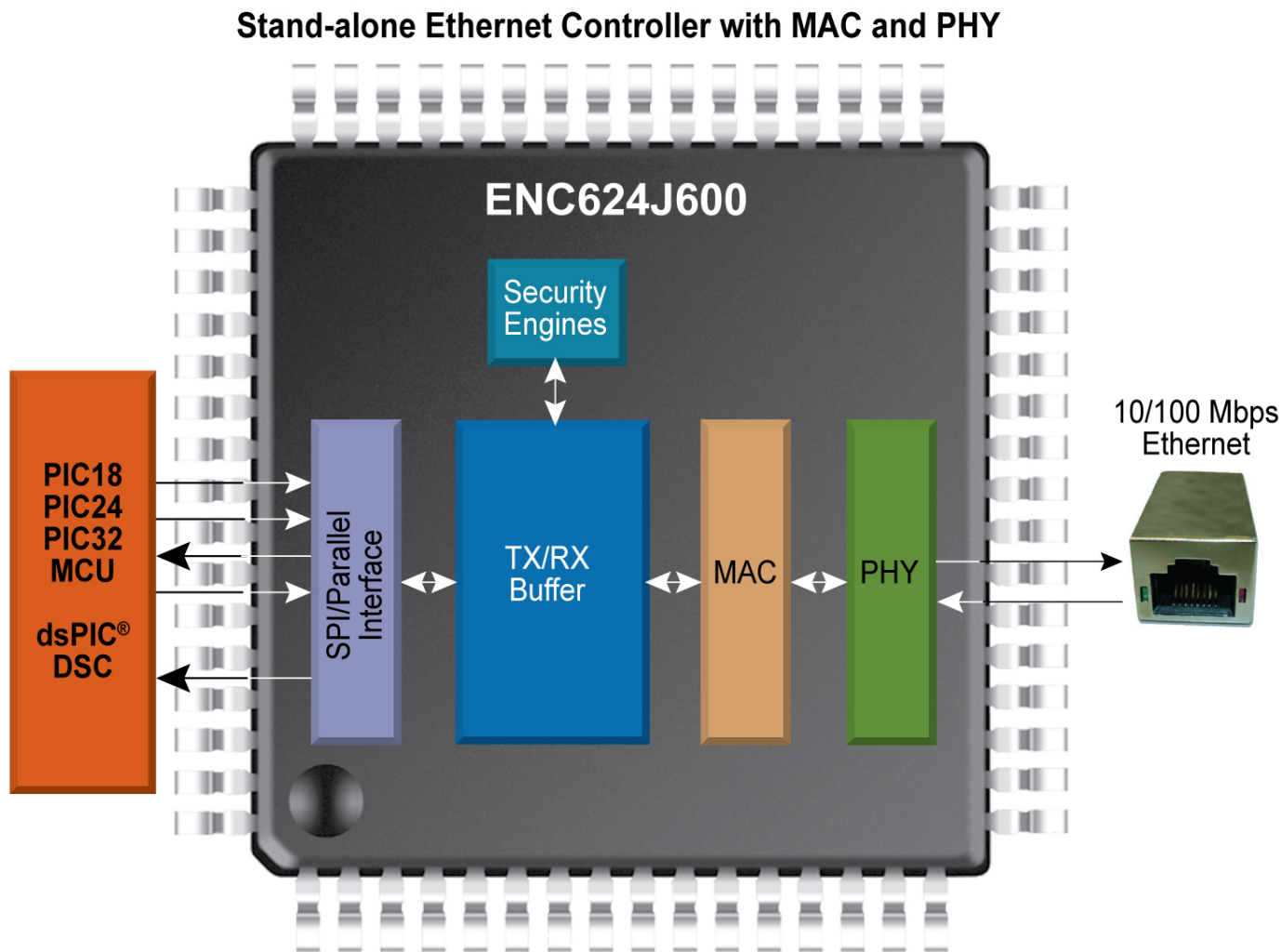
Application Examples

- **Diverse Application areas**
 - Internet radio
 - Telecommunications
 - Inventory management
 - Remote diagnostic / alert
 - Remote sensing/actuators
 - Security
 - Remote data logging / collection





ENC624J600 Stand-alone 10/100 Mbps Ethernet Controller





ENC624J600 Stand-alone 10/100 Mbps Ethernet Controller

Operational Features

- Operating voltage 3.0 to 3.6V
- 24 KB Ethernet Buffer
- Temperature range -40° to 85°C
- Package options
 - 44-pin TQFP and QFN
 - 64-pin TQFP
- 25 MHz Clock
- Clock out pin with programmable frequencies from 50KHz to 33MHz

Hardware Security Engines

- RSA® and Diffie-Hellman Key Exchange Algorithms
- Fast MD5 hash computations
- Fast SHA-1 hash computations

Ethernet Controller Features

- IEEE 802.3 complaint
- Integrated MAC and single port 10/100 Base-T PHY
- Hardware Security Engines
- Factory Preprogrammed Unique MAC Address
- SPI interface
- 8 or 16-bit parallel interface for 44- and 64- pin packages
- MAC
 - Supports unicast, multicast and broadcast packets
 - Programmable receive packet filtering
- PHY
 - Loopback mode
 - Energy Detect power down mode

Availability

- Samples – Now
- Production – Now



Firmware Support TCP/IP Stack

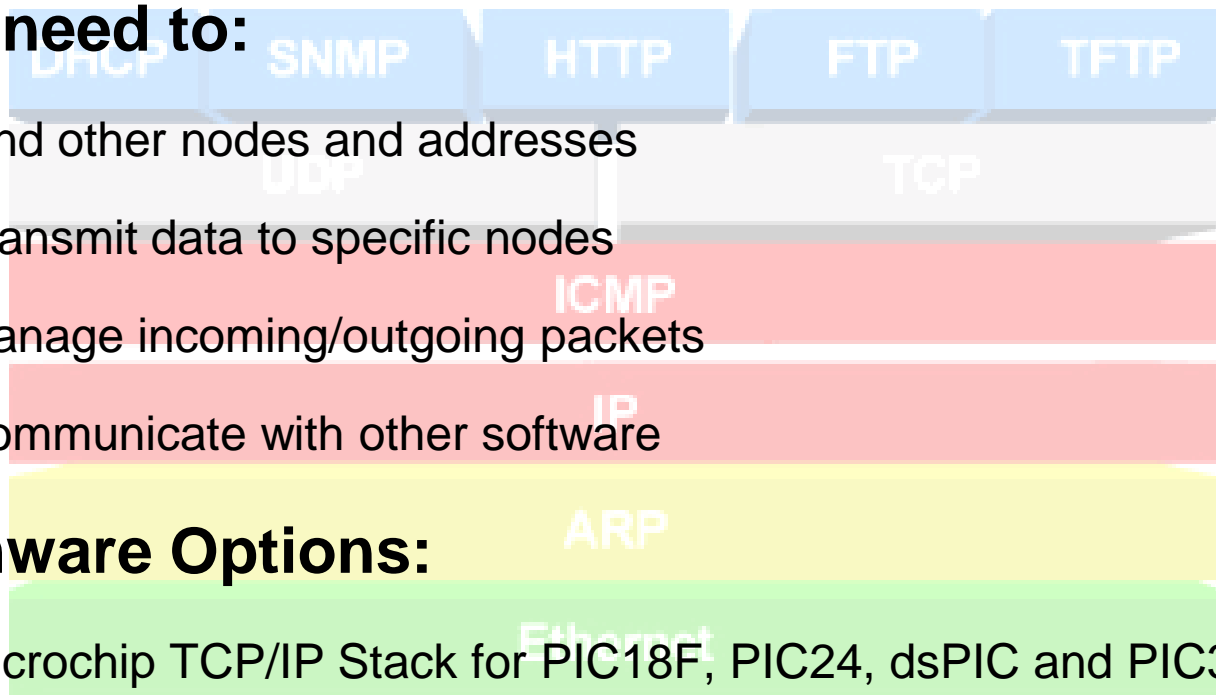
- Hardware just generates the signals

- **Still need to:**

- Find other nodes and addresses
- Transmit data to specific nodes
- Manage incoming/outgoing packets
- Communicate with other software

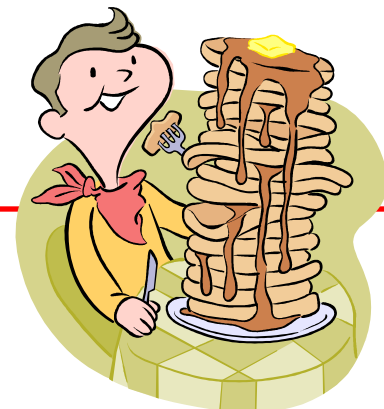
- **Firmware Options:**

- Microchip TCP/IP Stack for PIC18F, PIC24, dsPIC and PIC32MX





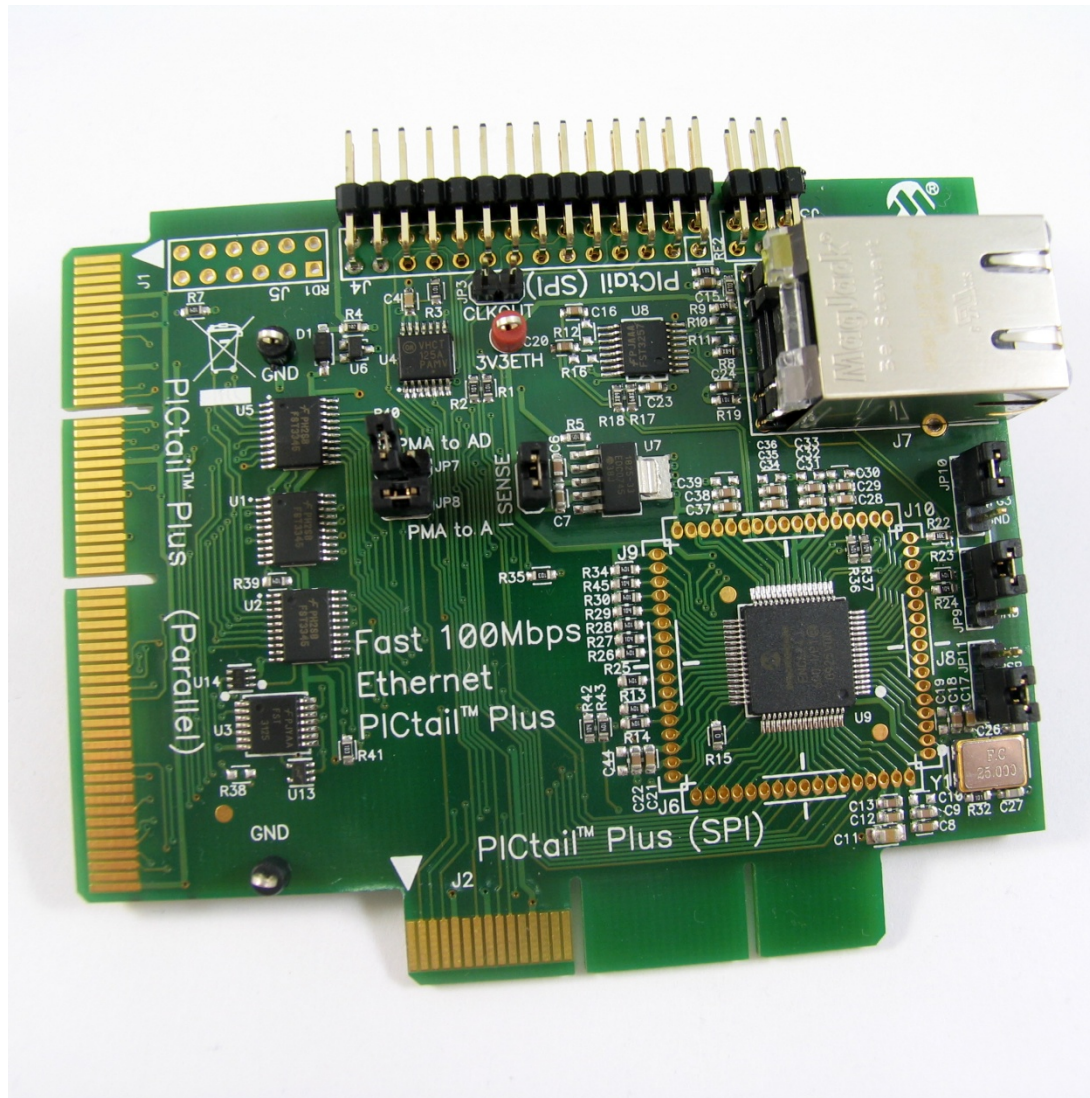
TCP/IP Stack



- **C source code provided**
 - No-fee license agreement
 - Use Microchip PIC® MCU or dsPIC® DSC
 - Only ENC28J60 and ENC624J600 driver files can be ported
 - Download: www.microchip.com/tcpip
- **PIC18, PIC24, dsPIC DSC, PIC32**
- **RTOS independent and modular**
- **Multiple socket connections and transports**
- **Example projects**
- **Configuration and web-page utilities**

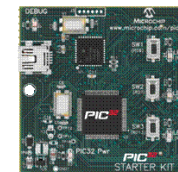
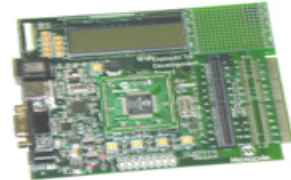


Fast 100 Mbps Ethernet PICtail™ Plus Daughter Board

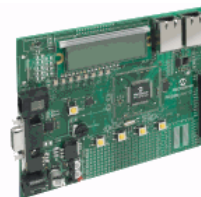


Development Tools

- **Explorer 16 Development Board**
 - DM240001
- **PIC18 Explorer Board**
 - DM183032
- **PIC32 Starter Kit and PIC32 I/O Expansion Board**
 - DM320001 and DM320002
- **PICDEM.net 2**
 - DM163024
- **MPLAB® ICD 3 In-Circuit Debugger**
 - DV164035
- **MPLAB® REAL ICE™ Emulation**
 - DV244005



+





Resources and Training

- www.microchip.com/ethernet
 - Offers information on Ethernet products, development tools, FAQs, etc.
- www.microchip.com/tcpip
 - Provides information on TCP/IP stack download and support
- www.microchip.com/rtc
 - Regional Training Centers offers training facilities to our customers on Microchip's products, tools and applications
- www.microchip.com/support
 - Offers help to customers on 24x7 basis



MICROCHIP

PIC32MX5/6/7 USB/CAN/Ethernet

PIC³²TM

PIC32 Product Marketing Team



PIC32 MCU Continues To Build Momentum

Auto Diagnostics



HVAC Air Handler



Optical Stabilization



Engine Control



Photo ID Management



Home Lighting Control



Server Diagnostic Monitoring



Security System Panel



Power Meter



GPS Tracking



Remote Control



White Goods Graphics



GPS Control



Robotic Vacuum Cleaner



Audio Head Phones



Bar code Scanner





MICROCHIP

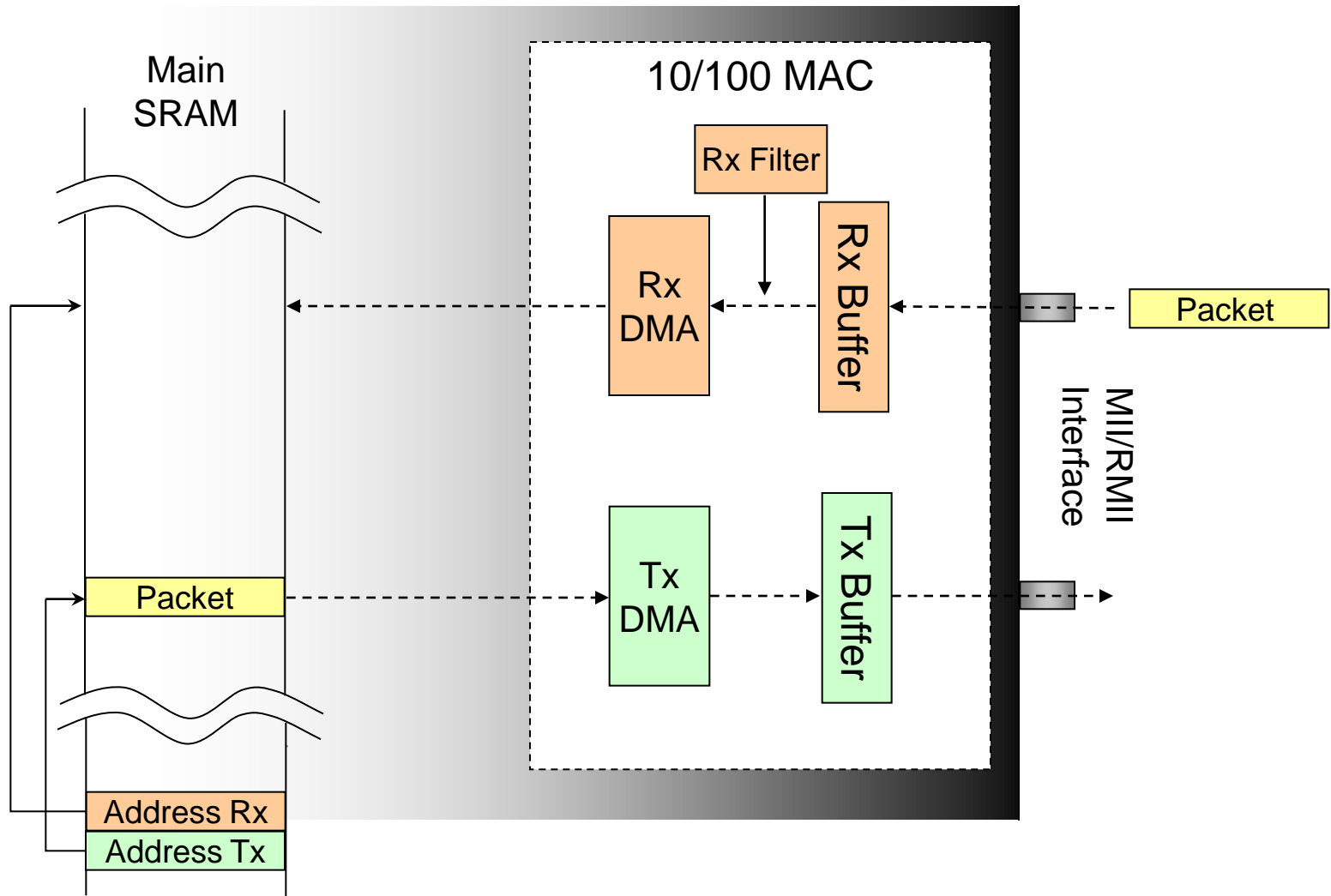
Ethernet



Ethernet Features

- **10/100 802.3 Ethernet MAC**
 - Full and Half Duplex operation
 - Configurable packet filtering
 - Configurable interrupts
 - Manual and Automatic flow control
 - Packet payload checksum
- **Integrated DMA channels for Tx and Rx**
- **RX Filter (RXF)**
- **Industry standard MII or RMII Interface to external PHY**
- **Uses main SRAM for buffers**

Ethernet Packet Flow





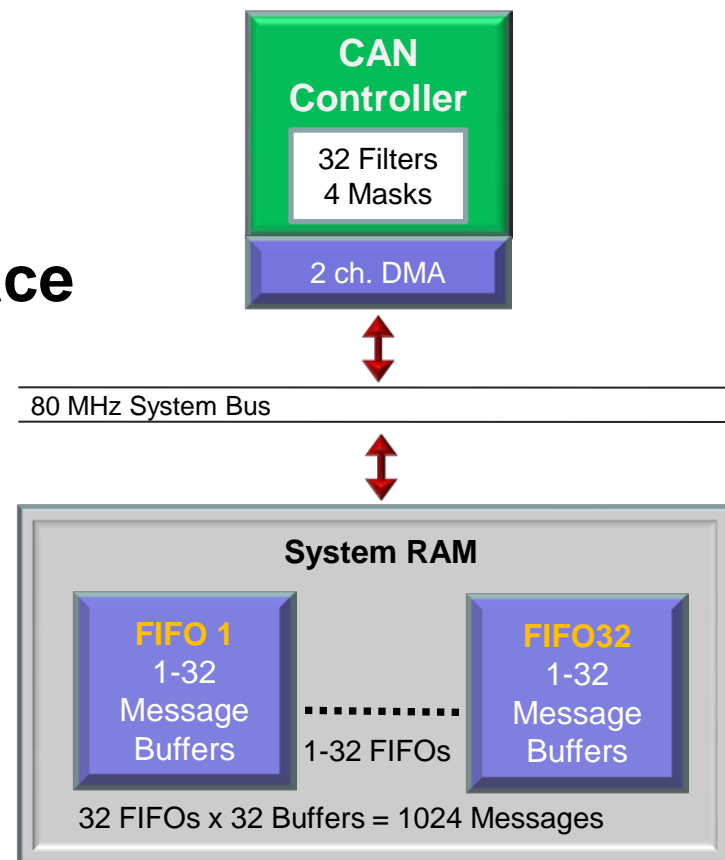
MICROCHIP

CAN 2.0B



Flexible & Easy-to-Use CAN Controllers

- Many customers use own CAN communication scheme
- PIC32 CAN controllers offer flexibility
- Uses system RAM for message storage with built-in DMA interface
- Advanced filtering to simplify message processing
- Industry-standard CAN2.0b
 - Up to 1 Mbps





CAN Details

Message Reception and Transmission:

- 32 message FIFOs
- Each FIFO can have up to 32 messages for a total of 1024 messages
- FIFO can be a transmit message FIFO or a receive message FIFO
- User-defined priority levels for message FIFO's used for transmission
- 32 acceptance filters for message filtering
- Four acceptance filter mask registers for message filtering
- Automatic response to Remote Transmit Request
- DeviceNet™ addressing support

Additional Features:

- Loop-back, Listen All Messages and Listen Only modes for self-test, system diagnostics, and bus monitoring
- Low-power operating modes
- No DMA required - CAN module can read/write directly to system RAM
- Dedicated time stamp timer
- Data-only Message Reception mode – details on next slide



CAN: New Data Only Mode is Great for Bootloaders

String 'Hello World' sent from node 1 to node 2

CAN "overhead" stored in RAM

The string is spread out in memory

Existing CAN Products

SID
EID
DLC=8
D0='H'
D1='e'
D2='l'
D3='l'
D4='o'
D5=' '
D6='W'
D7='o'
SID
EID
DLC=4
D0='r'
D1='l'
D2='d'
D3=0x00

New Data Only Mode

D0='H'
D1='e'
D2='l'
D3='l'
D4='o'
D5=' '
D6='W'
D7='o'
D0='r'
D1='l'
D2='d'
D3=0x00

Data Only Mode strips CAN "Overhead" when storing in memory



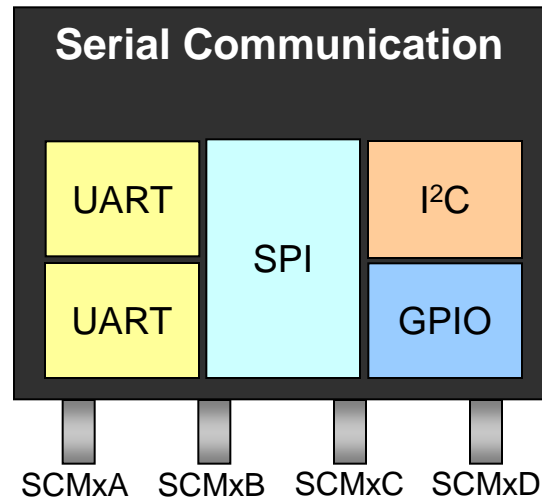
MICROCHIP

Serial Communication Modules

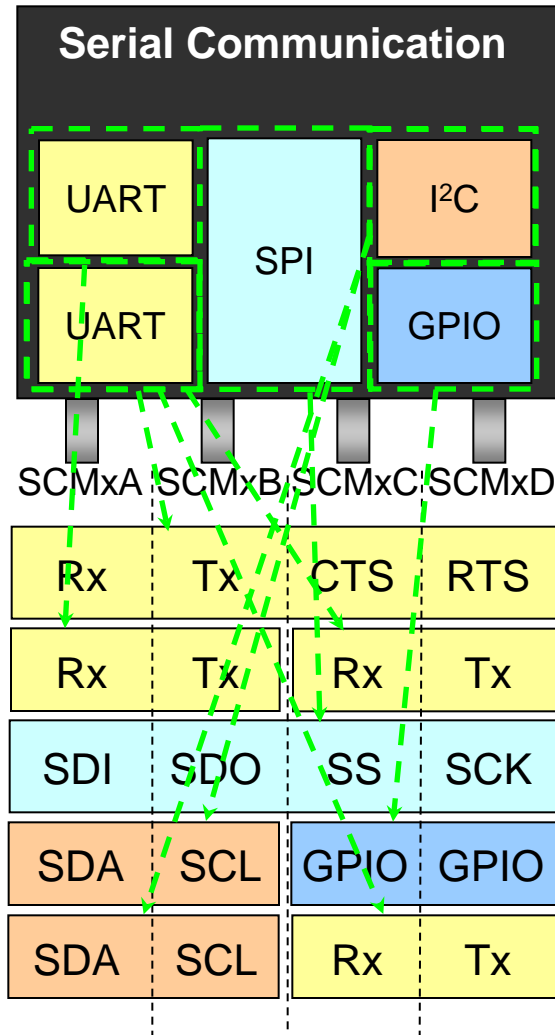


Serial Communications

- **Combined UART, SPI and I²C**
- **User selectable serial communications**
 - More serial communication peripherals available
 - Fewer muxing conflicts with other peripherals
 - Each module is configurable and has 4 i/o pins
- **3 Instantiations on each part**



Configuration Options...



1 x UART with Flow Control

2 x UARTs no Flow Control

1 x SPI

1 x I²C with GPIO

1 x I²C + 1 UART no Flow Control



User Selectable Combinations of Peripherals

Example Configurations

(Select 1 function block from each row)

4 pins	1 UART with RTS & CTS	2 UARTs	1 SPI	1 I ² C	1 I ² C + 1 UART	64-pin Configuration Options
4 pins	1 UART with RTS & CTS	2 UARTs	1 SPI	1 I ² C	1 I ² C + 1 UART	
4 pins	1 UART with RTS & CTS	2 UARTs	1 SPI	1 I ² C	1 I ² C + 1 UART	
SPI			1 SPI			
I ² C				1 I ² C		
I ² C				1 I ² C		

Example 1 = 1 UART (with flow control), 2 UARTs, 2 SPI, 1 I²C (64-pin)



User Selectable Combinations of Peripherals

Example Configurations

(Select 1 function block from each row)

4 pins	1 UART with RTS & CTS	2 UARTs	1 SPI	1 I ² C	1 I ² C + 1 UART
4 pins	1 UART with RTS & CTS	2 UARTs	1 SPI	1 I ² C	1 I ² C + 1 UART
4 pins	1 UART with RTS & CTS	2 UARTs	1 SPI	1 I ² C	1 I ² C + 1 UART
SPI			1 SPI		
I ² C				1 I ² C	
I ² C				1 I ² C	

100-pin Configuration Options

Example 2 = 4 UARTs, 2 SPI, 2 I²C (100-pin)



MICROCHIP

Additional Enhancements



PIC32MX3/4 to PIC32MX5/6/7 Improvements

GP DMA Controller (now up to 8 Channels)

- Transfer size up to 64KB
- Bit and Byte reordering
- IP header checksum support
- CRC and LFSR now support variable data width up to 32-bits
- DMA can operate in debug mode

Interrupts

- Persistent interrupts allow the DMA to service interrupts
- User selectable mapping of shadow register set to interrupt priority

Reclaim unused USB pin

- VBUS can be reclaimed as i/o pin when unused

New Power State

- DREAM mode now enabled
- Peripheral Bus divide ratio can be changed the on the fly



PIC32MX3/4 to PIC32MX5/6/7 Improvements

Debugging

- App-in, App-out, Data-in, Data-out
- Disable and re-allocate unused JTAG pins out of reset

Robustness

- EMC and EMI
- Power, Clock and Reset circuit

UART

- Rx Tx now have 8 character buffers

SPI

- **Added FIFO mode to SPI modules**
- **Improved Audio Codec interface via frame mode**
 - Frame sync pulse width is selectable: 1 SPI clock wide or 1 character length wide
 - One frame may consist of 1/2/4/8/16/32 characters
 - Enhanced buffer mode (RX and TX FIFO) operation
 - Flexible interrupt generation for buffers

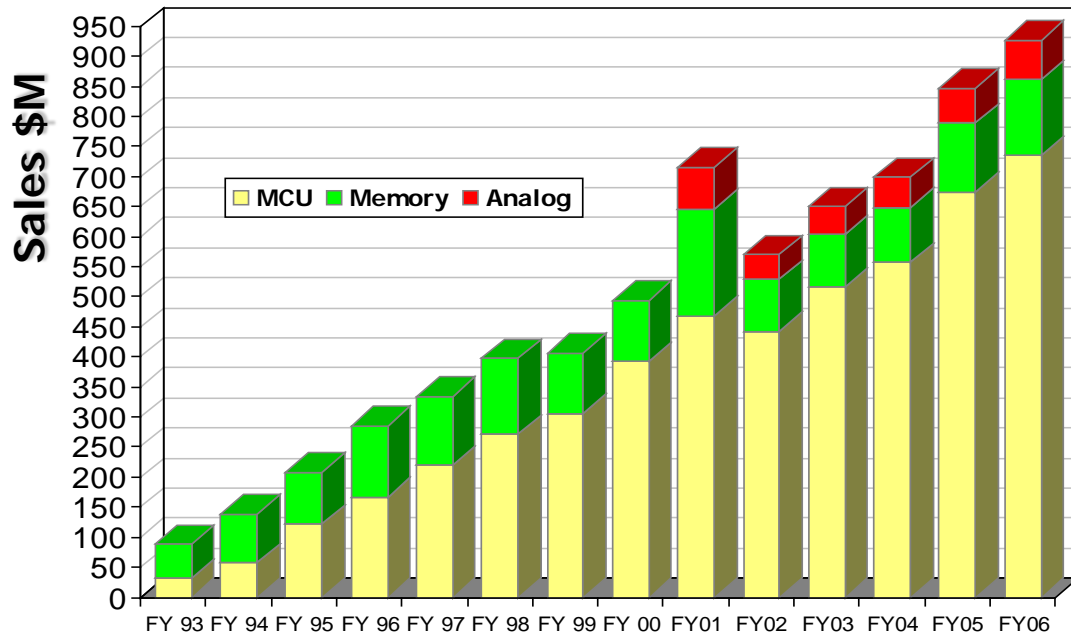


MICROCHIP

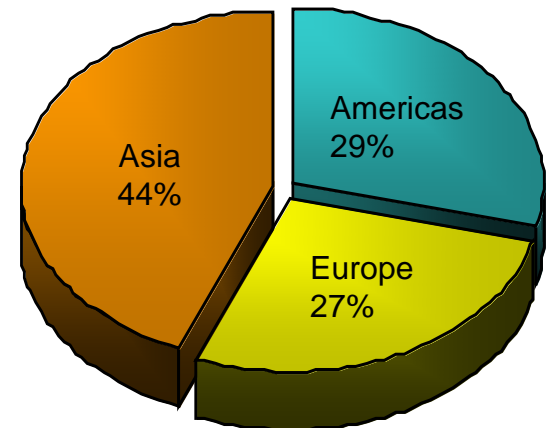
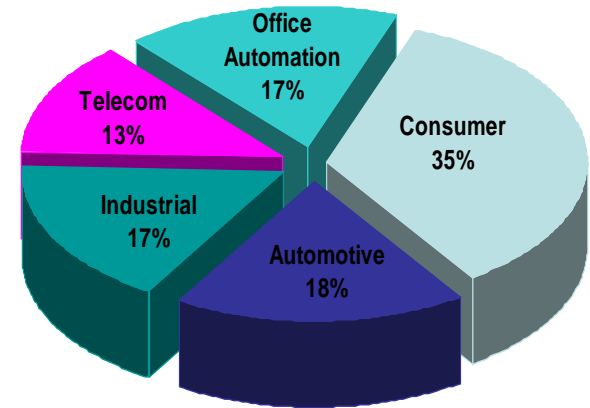
32-bit Microcontrollers

PIC³²TM

Microchip Markets

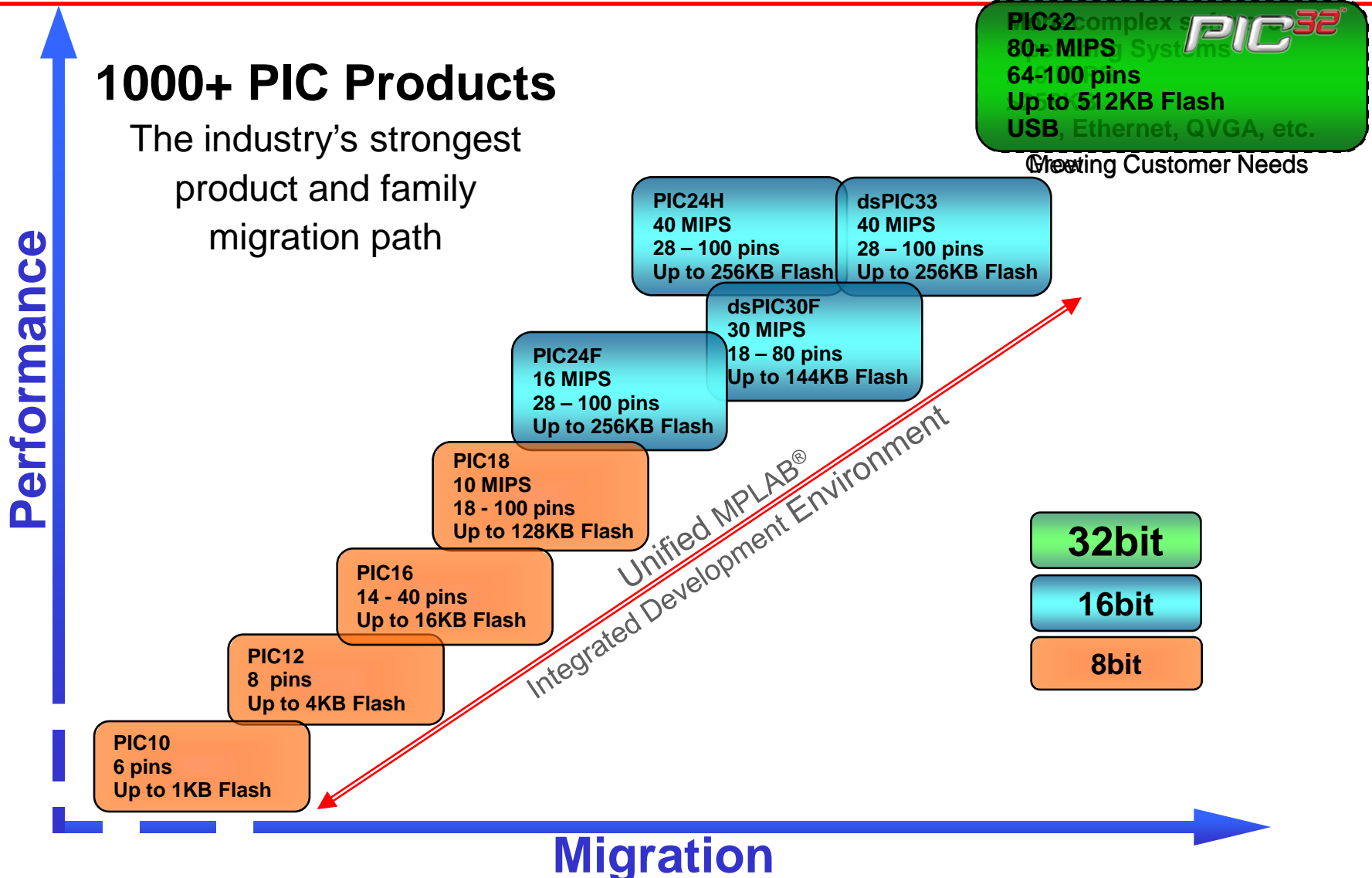


- **Over 60,000 customers worldwide**
 - Not one customer over 3% of MCHP total revenue
- **Complimentary product lines**
 - MCU, Memory, Interface and Analog
- **Worldwide Support and Training**





Microchip Solutions

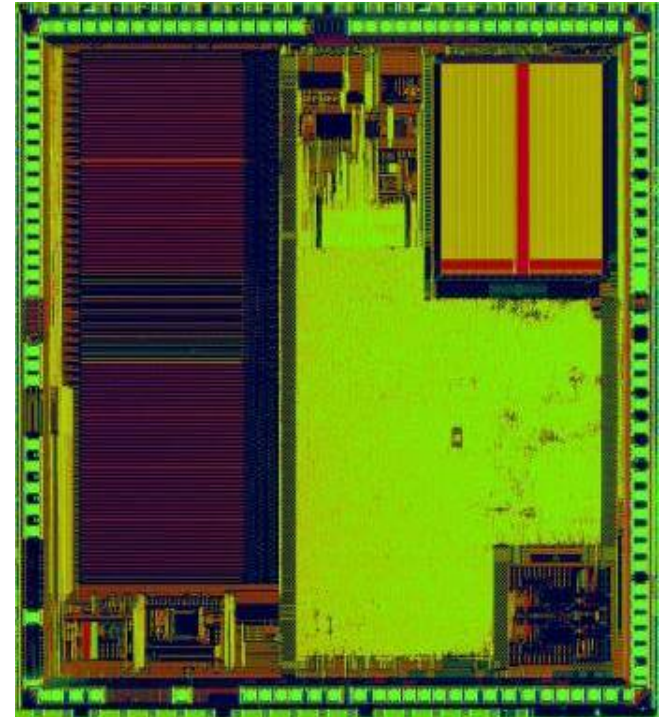




MIPS® M4K® Core

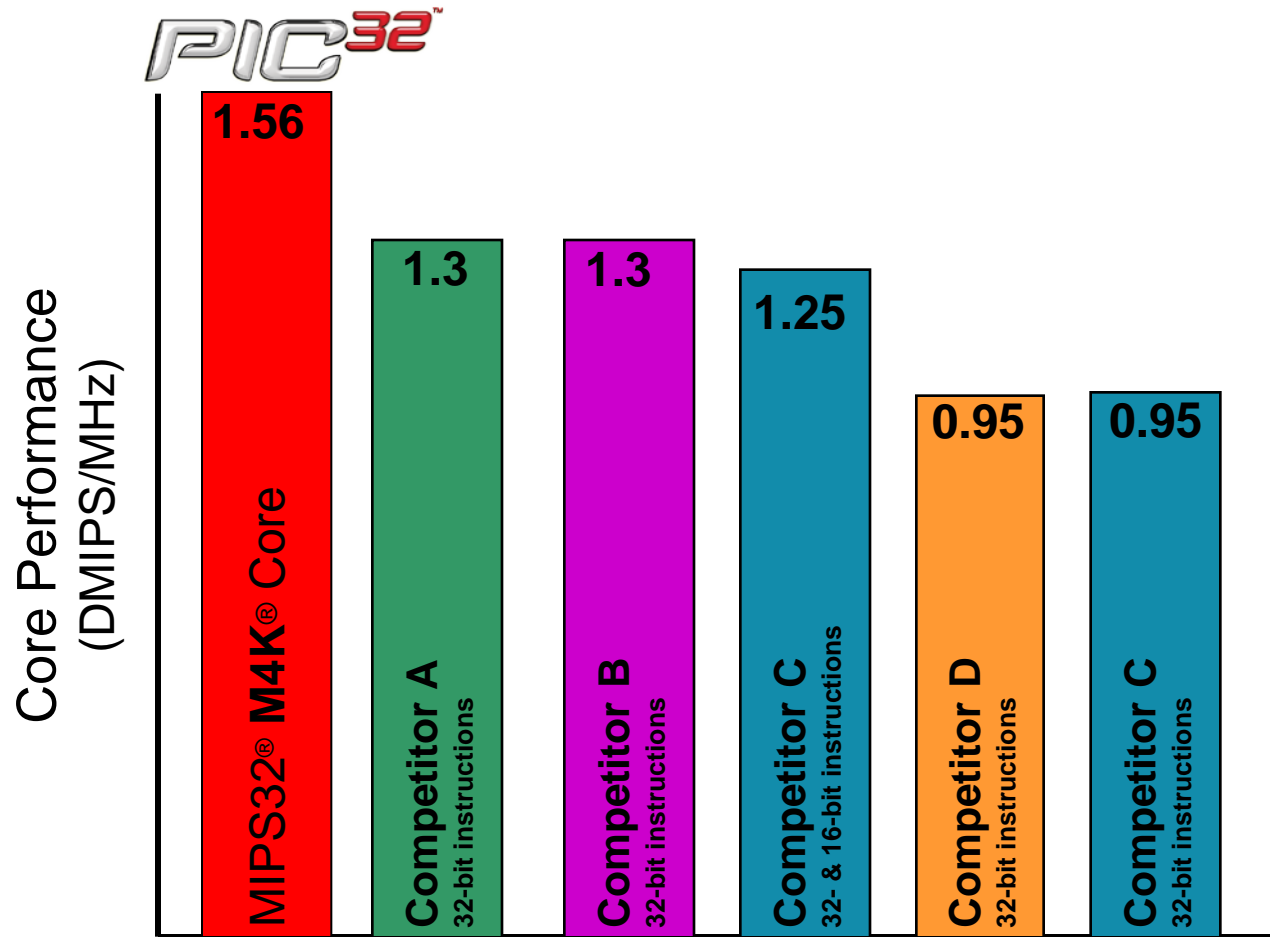
With Microchip Enhancements

- **Start with a great engine**
 - Up to 80MHz
 - 1.56 DMIPS/MHz (*measured*)
 - 32 32-bit core registers with shadow set
 - 32-bit ALU, single cycle MAC
- **Microchip system enhancements for great embedded performance**
 - 256 byte prefetch cache
 - Low-latency vectored interrupt controller
 - Bus Matrix for parallelism
- **And full featured debugging**
 - Hardware Trace with debug support
 - JTAG and Boundary Scan



32-bit instr. mode for best speed
16-bit instr. mode for small code size
Easy to mix modes in single source file

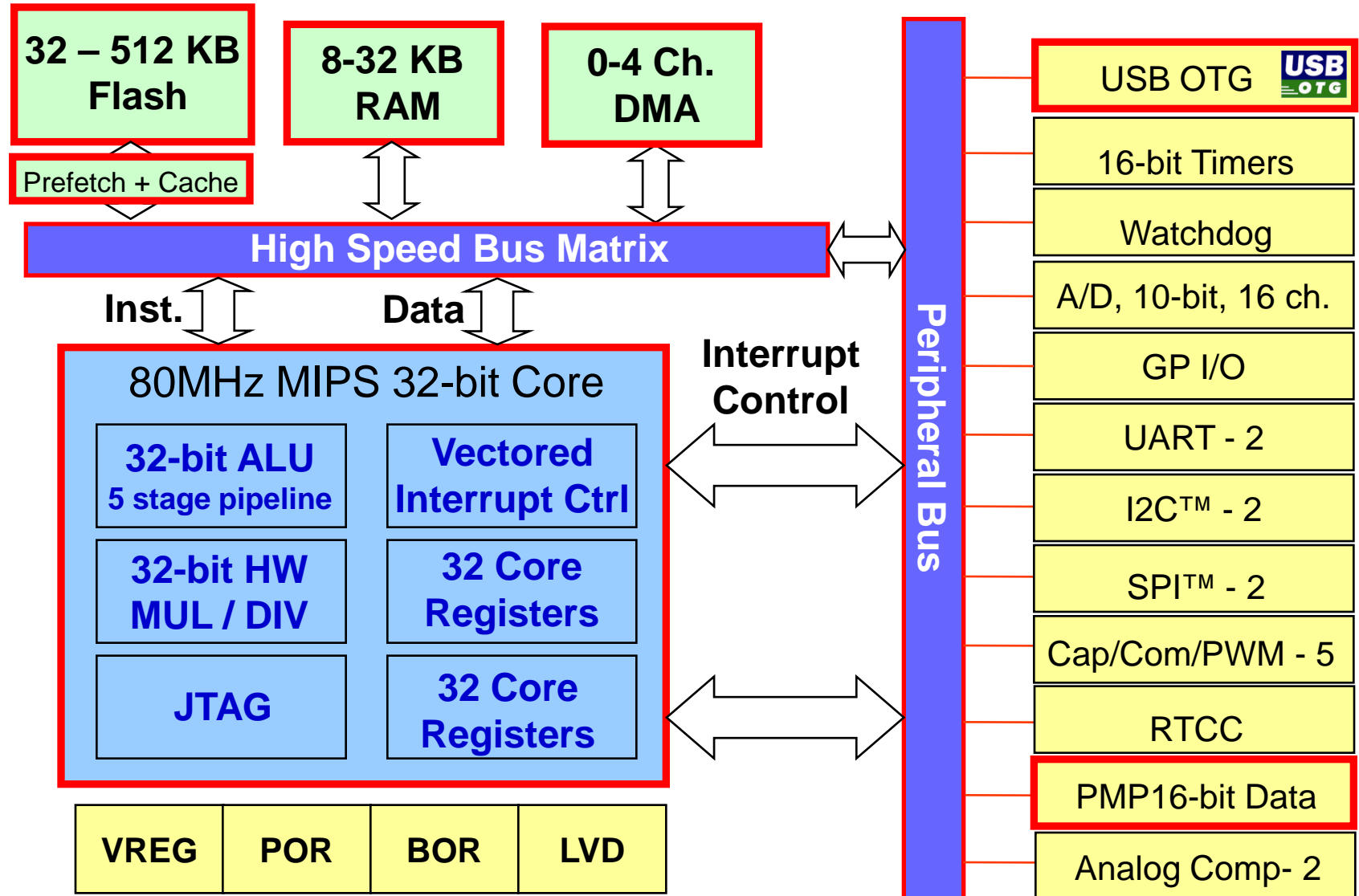
Inherent Performance Advantage



Source: Vendor Published Specifications



PIC32 Family

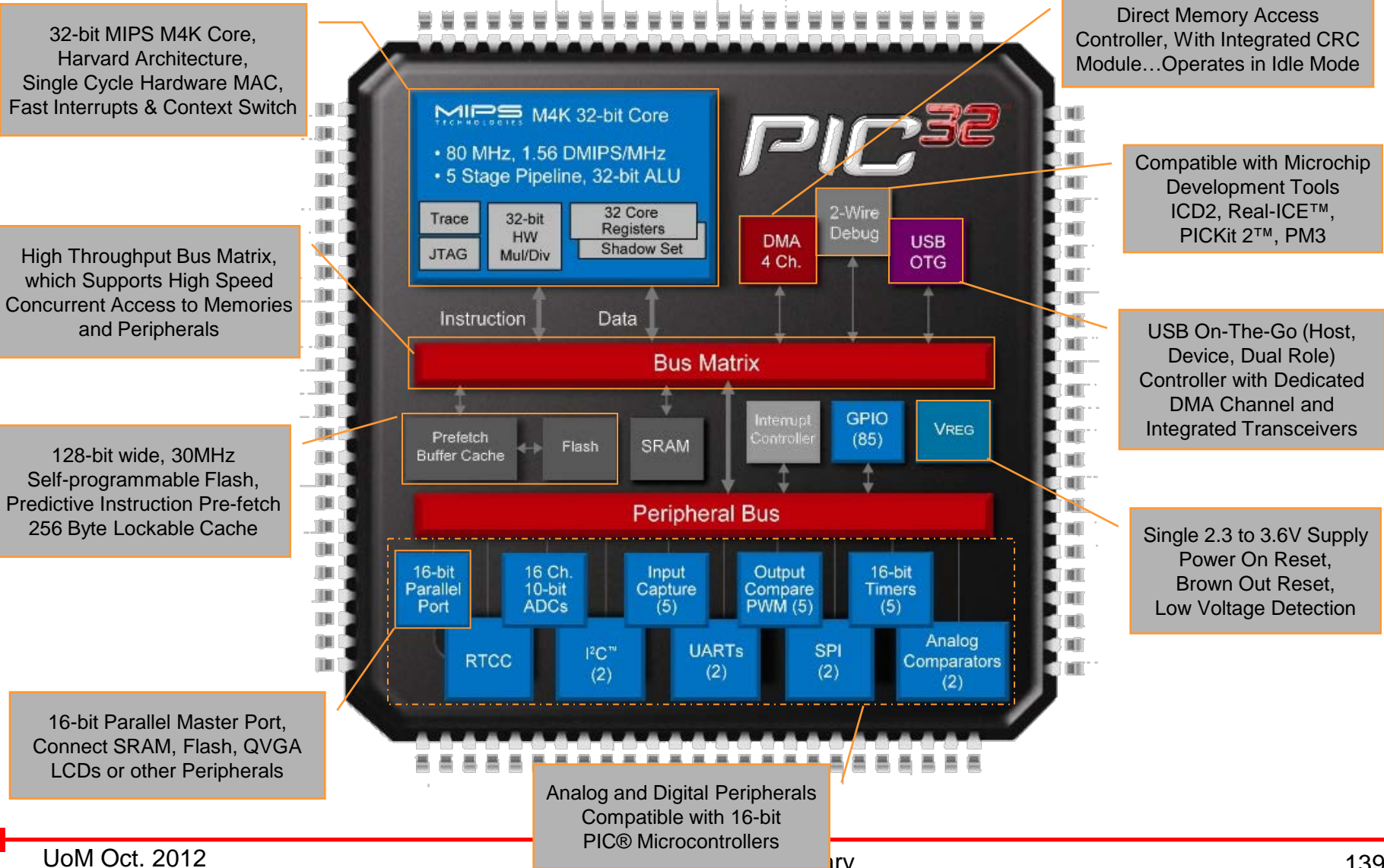




PIC32 Family Overview

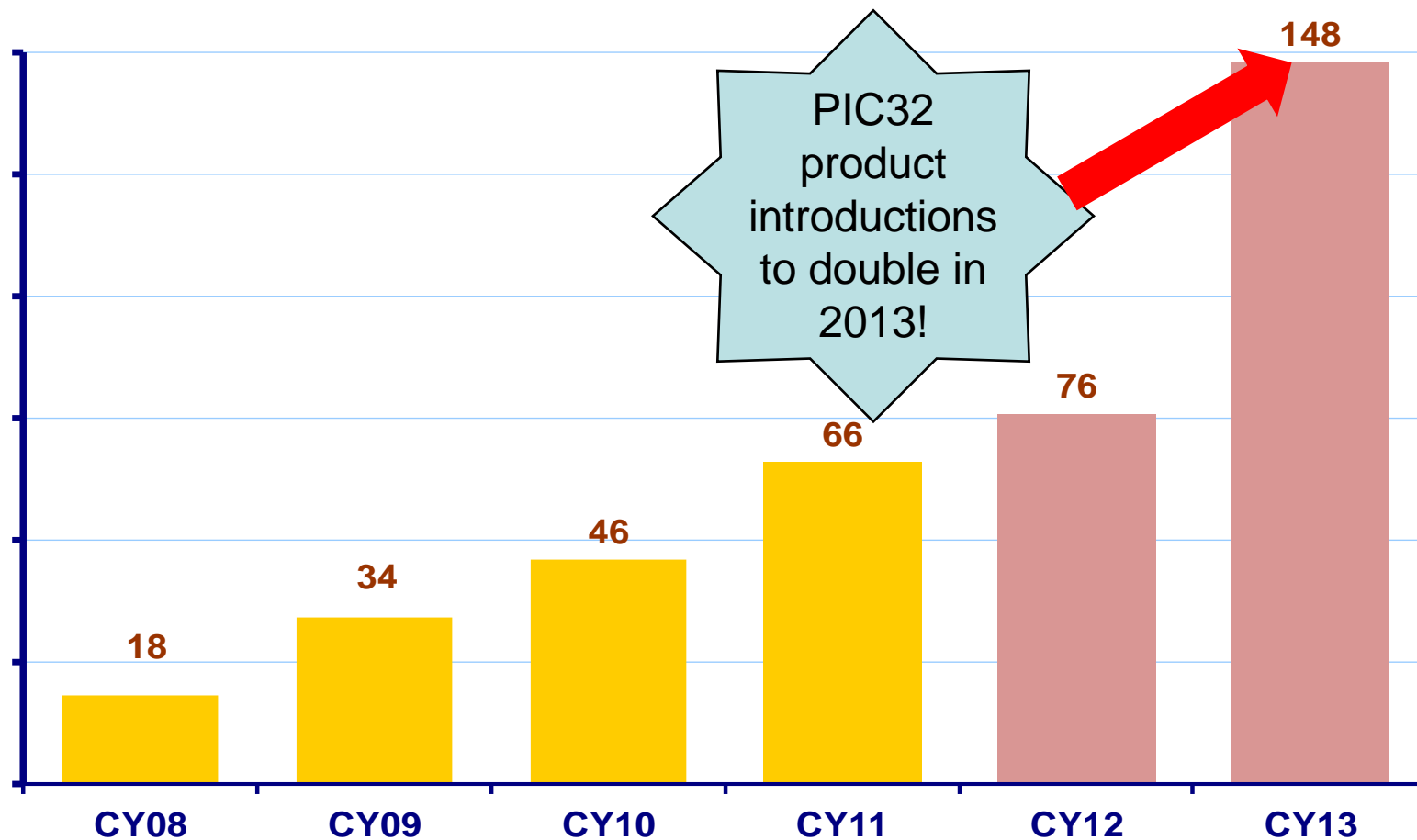
- **PIC32 GP series launched Nov 2007**
- **USB series launched Feb 2008**
- **Portfolio expansion in June 2008**
- **All 17 Parts in Volume production today**
- **New PIC32 Family in Development...**

PIC32 Microcontroller Key Features



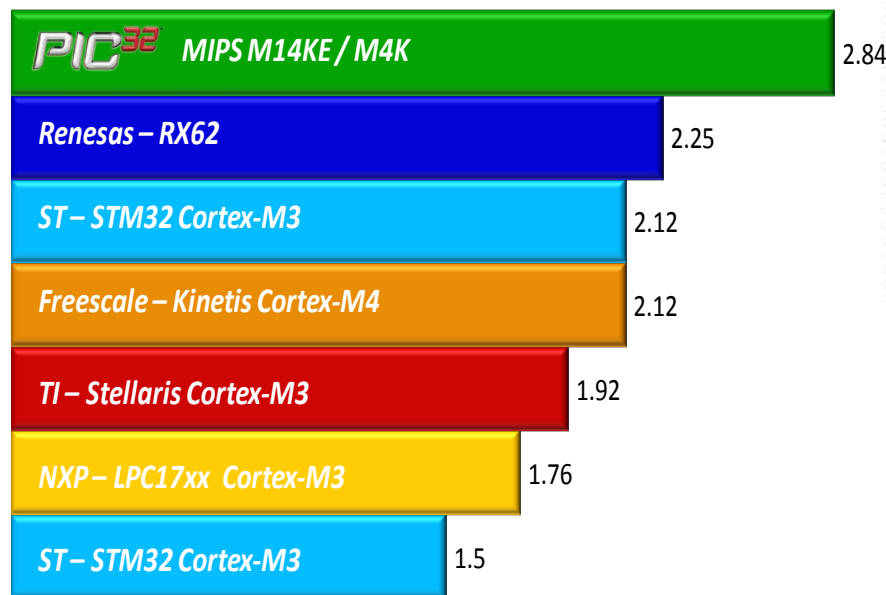


Accelerating investment and commitment to 32 bit market



Performance Comparisons

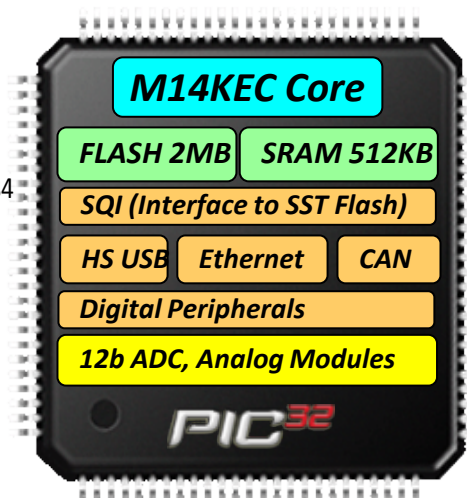
- M4K outperforms the Cortex M3
- Winning Apps on performance



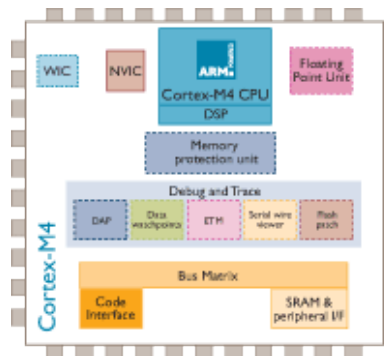
www.coremark.org

CoreMark™ is an independent/public benchmark for core performance
 CoreMark™ is a trademark of The Embedded Microprocessor Benchmark Consortium (EMBC®)
 PIC32 estimate configured for zero wait state Flash performance MIPS32 ISA

- M14KEc will outperform the recently released Cortex M4

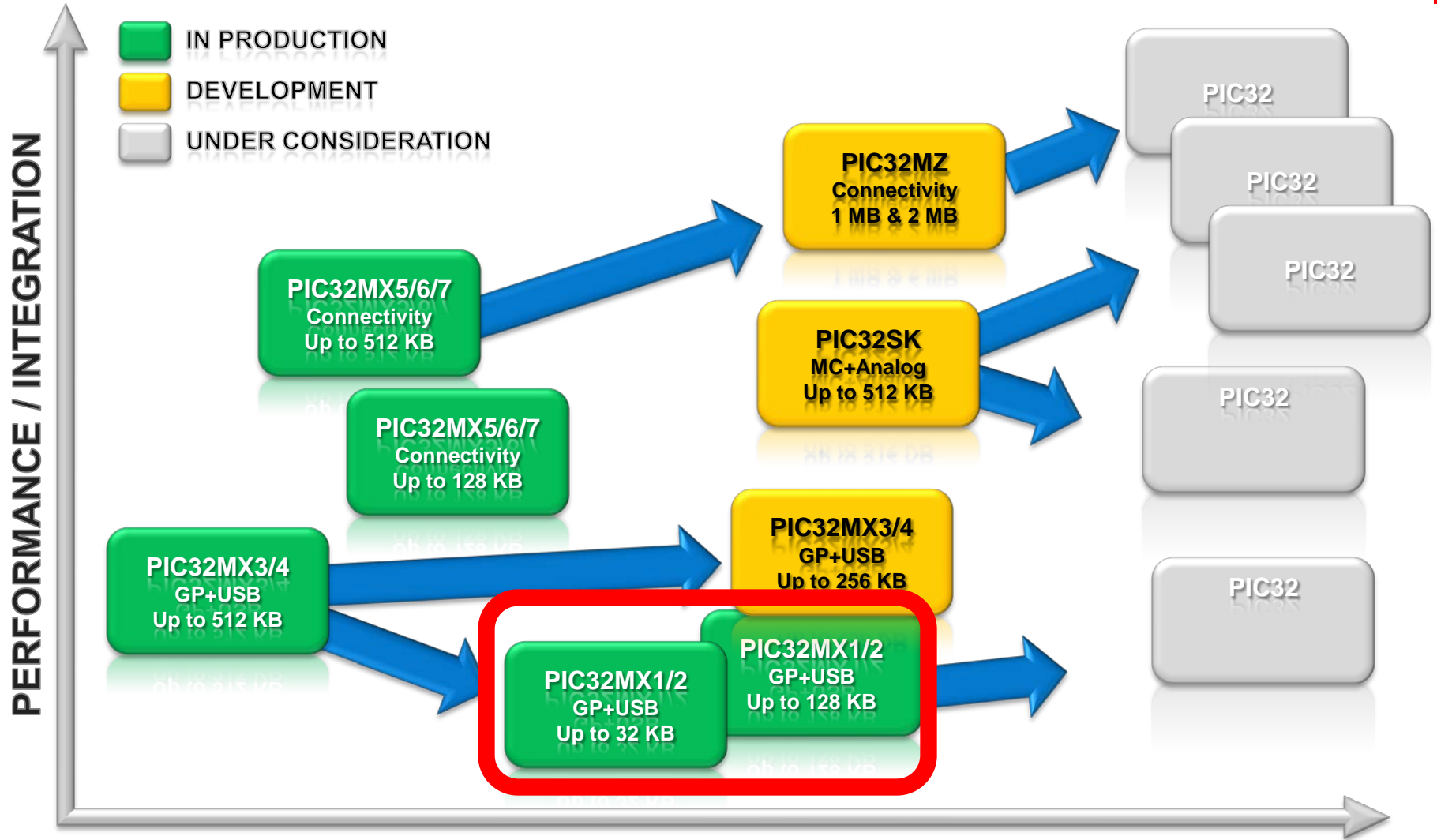


MIPS M14KEc
 200MHz in 90nm
300+ DMIPS!!!!
 DSP



Cortex M4
 150MHz in 90nm
188 DMIPS
 DSP + FPU

PIC32 Roadmap

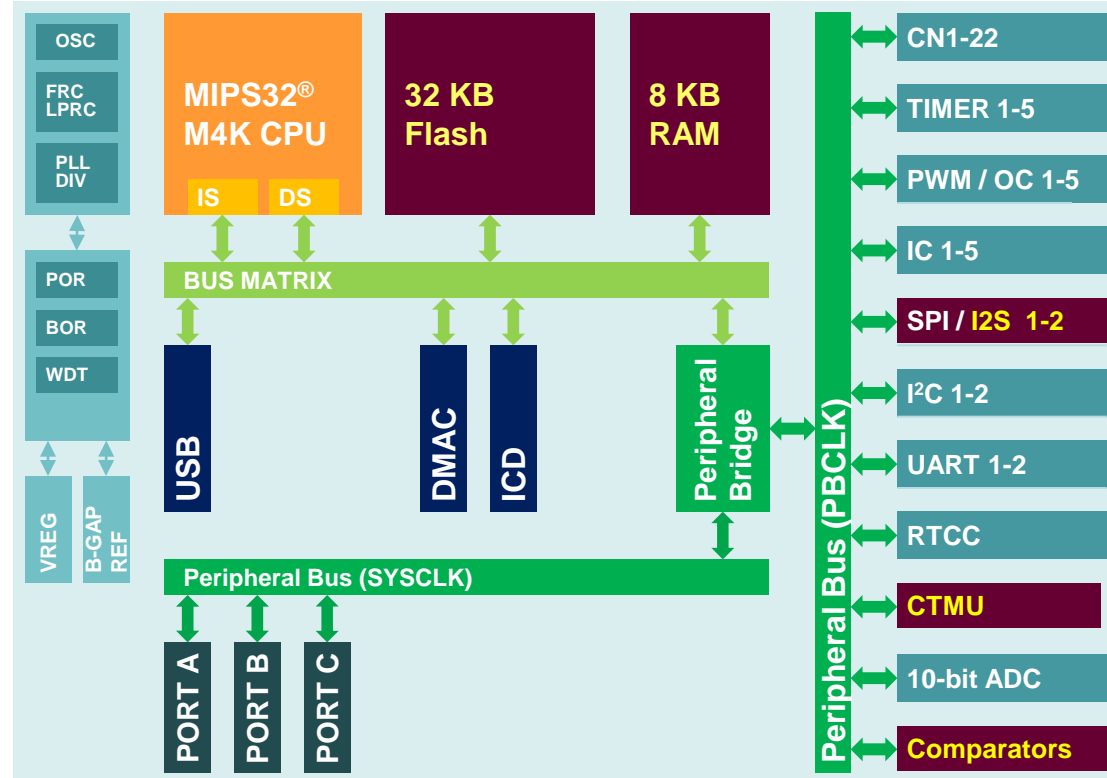




PIC32 MX1/MX2 Family

Low Cost - Low Pin Count

- **16/32KB Flash, 4/8KB RAM**
- 40 MHz / 62 DMIPS
- USB-Device (MX2)
- 2 UART, 2 SPI / **I²S**, 2 I²C
- **3 Analog Comparators**
- **CTMU, Temperature Sensor**
- General Purpose PWM
 - Output Compare, Input Capture
- DMA – 4 channels
- On chip 1% RC oscillator (over voltage/freq)
- **Packages:**
 - **28 SOIC, 28 SSOP, 28 QFN, 28 SPDIP**
 - **36 VTLA**
 - **44 TQFP, 44 QFN, 44 VTLA**

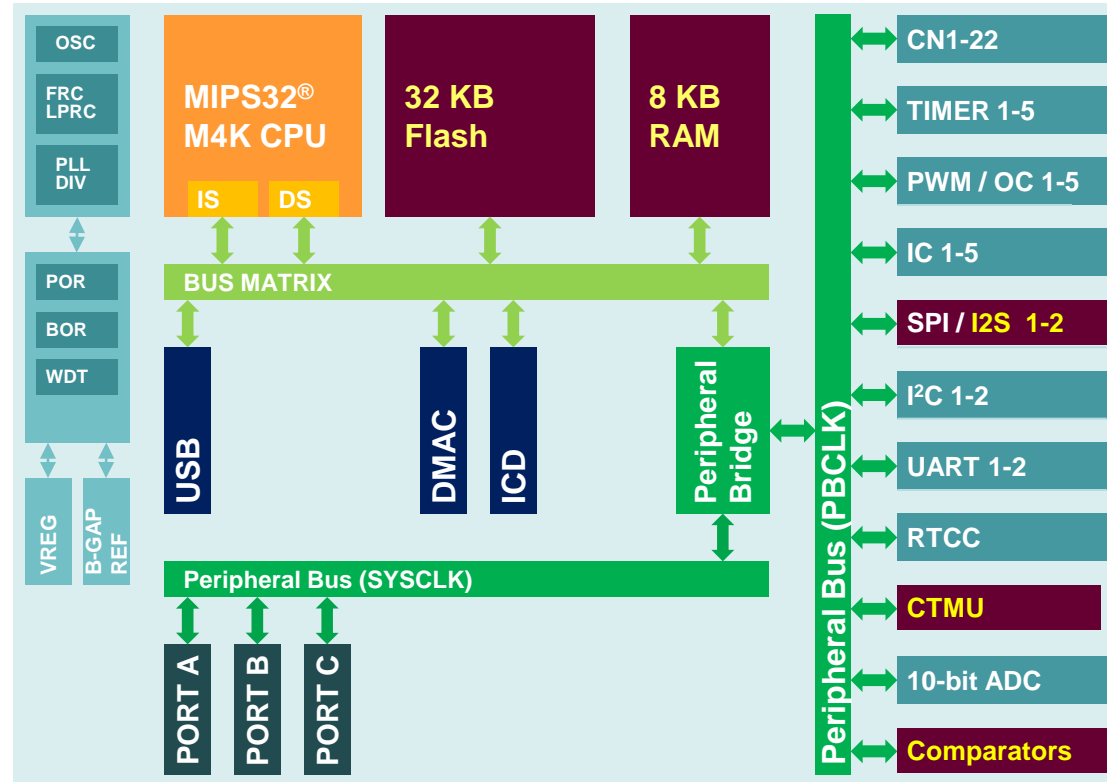


Available Now



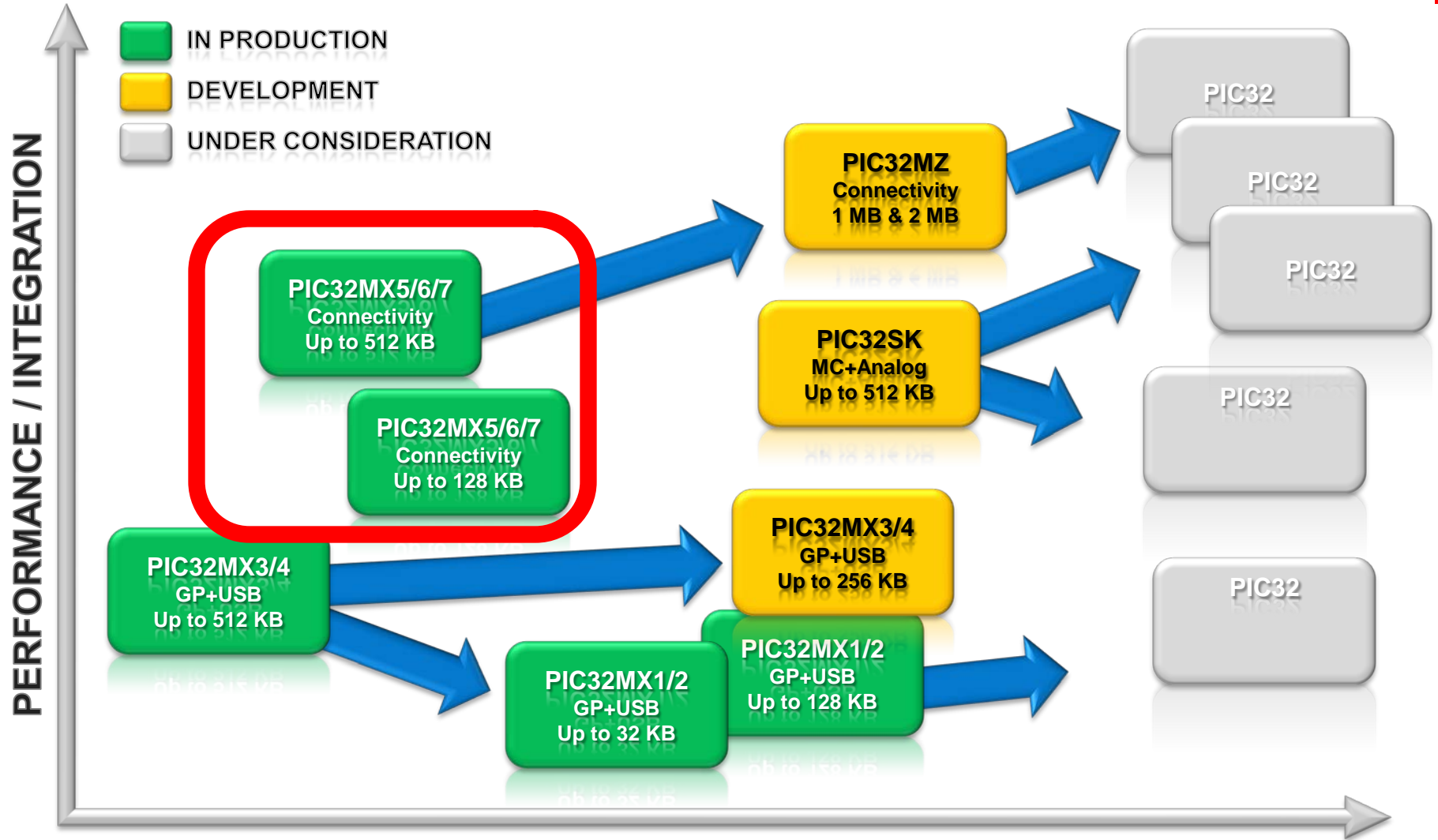
PIC32 MX1/MX2 Family Grows with More Memory Options

- **128KB Flash, 32KB RAM**
- 40 MHz / 62 DMIPS
- USB-**OTG** (MX2)
- 2 UART, 2 SPI / **I²S**, 2 I²C
- **3 Analog Comparators**
- **CTMU, Temperature Sensor**
- General Purpose PWM
 - Output Compare, Input Capture
- DMA – 4 channels
- On chip 1% RC oscillator (over voltage/freq)
- **Packages:**
 - **28 SOIC, 28 SSOP, 28 QFN, 28 SPDIP**
 - **36 VTLA**
 - **44 TQFP, 44 QFN, 44 VTLA**



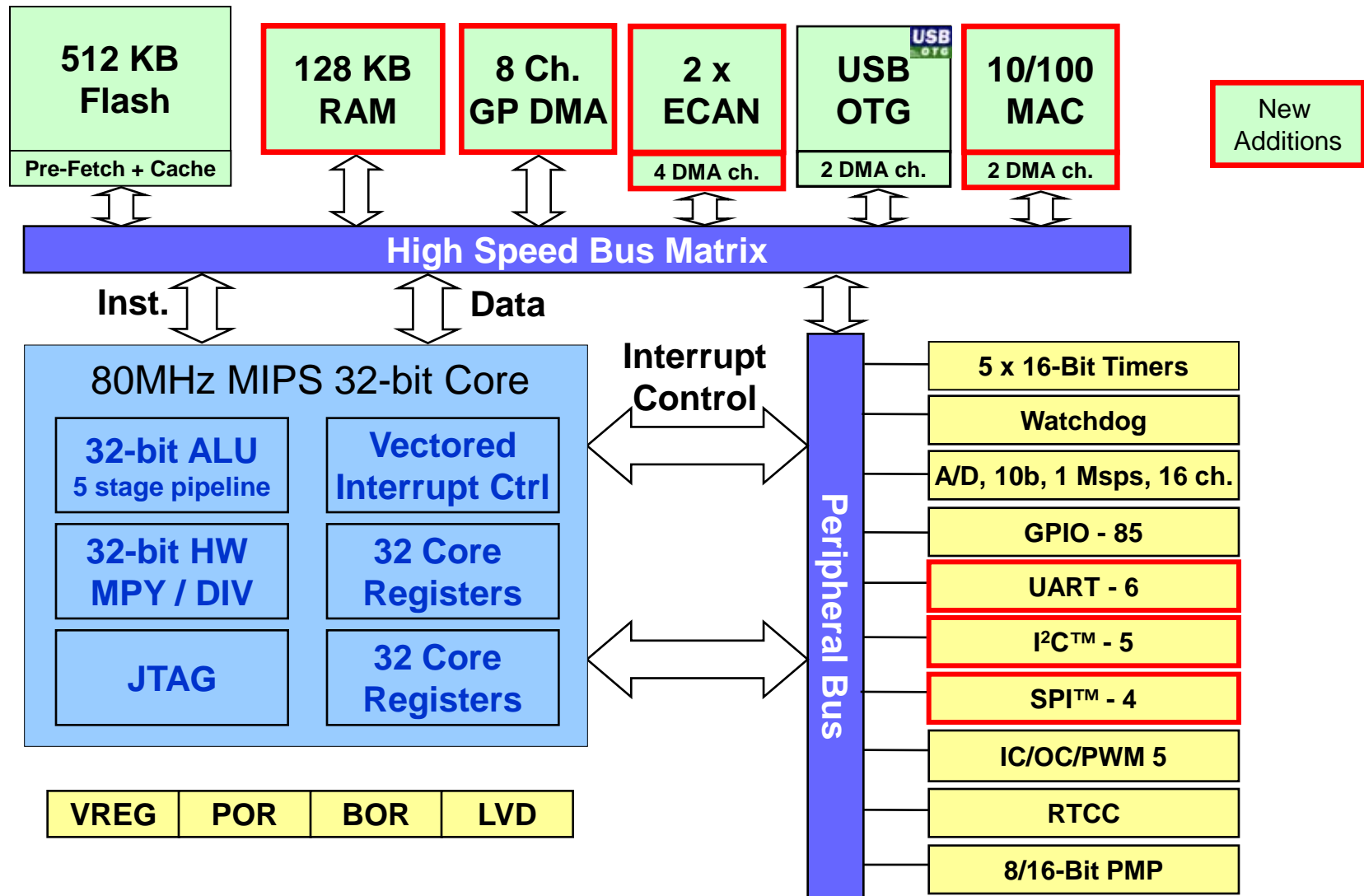
Available Now

PIC32 Roadmap

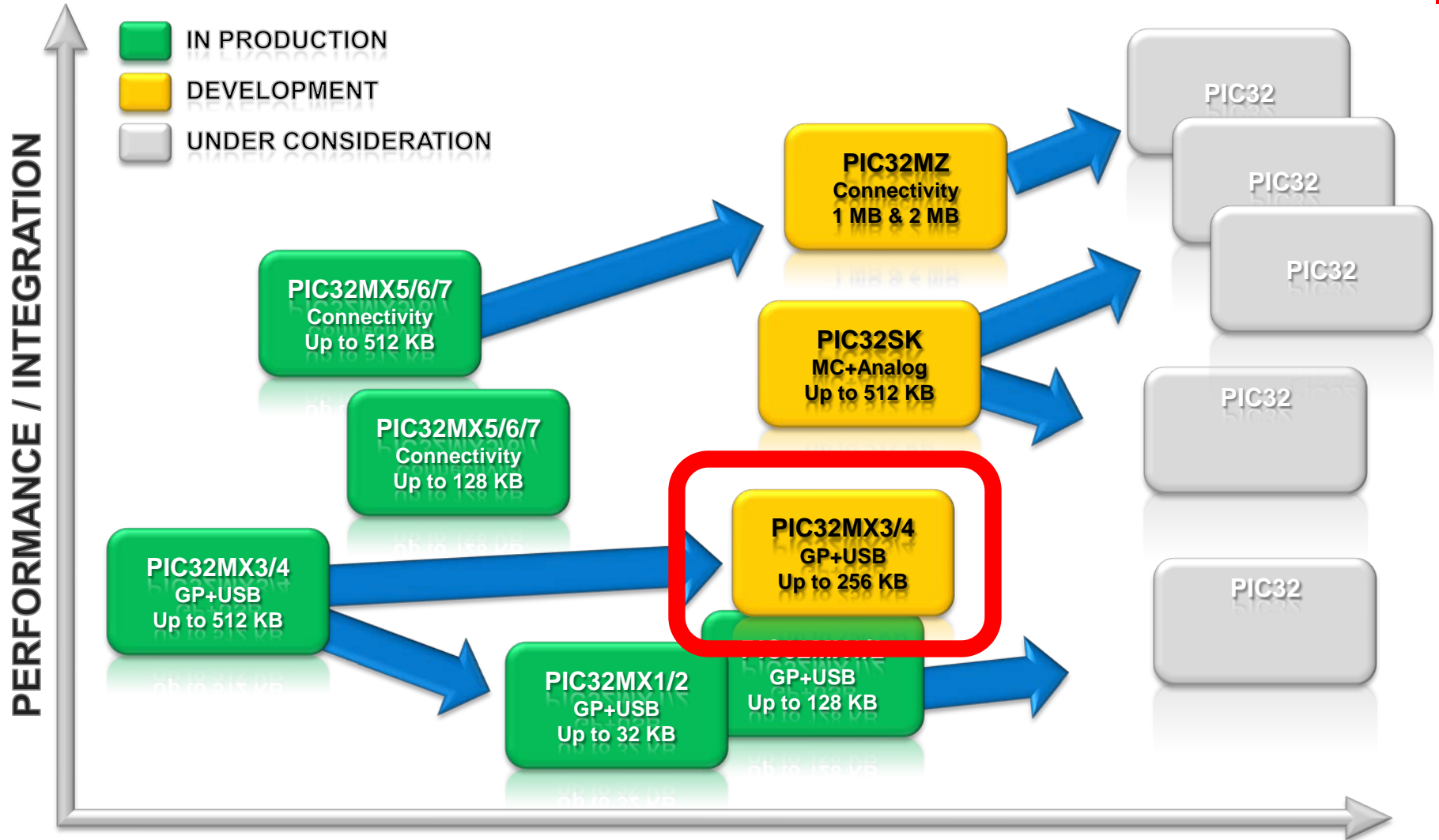




PIC32MX5-6-7 Block Diagram



PIC32 Roadmap





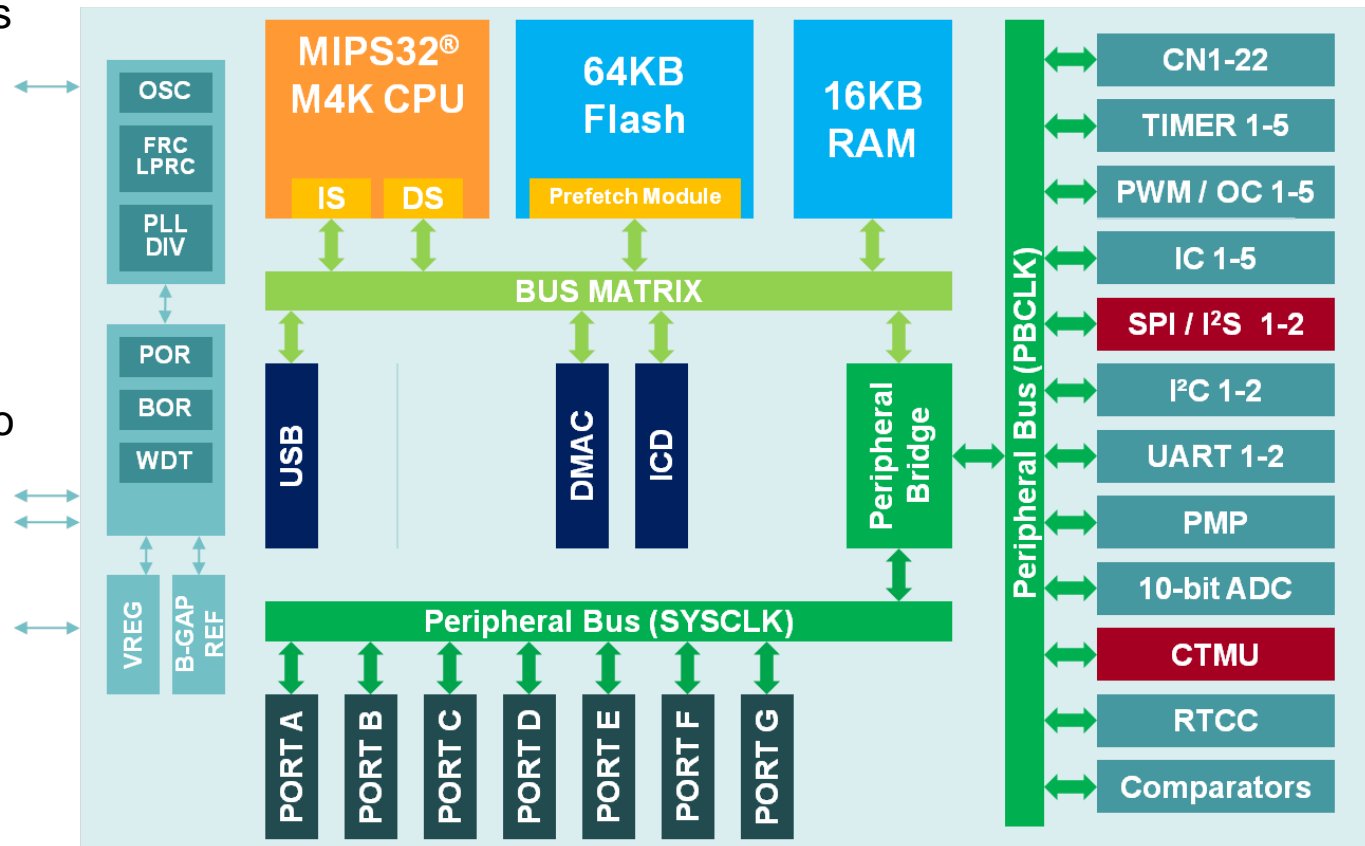
New PIC32MX3/4's

Highlights

- More Serial Peripherals
- I²S Peripheral
- Peripheral Pin Select
- CTMU
- More DMA

Specs

- IND and V Temp (-40 to 105C)



Package Options:





New PIC32 MX3 / MX4 devices

MX3/4 today

512KB Flash / 32KB RAM

2 UART, 2 SPI, 2 I2C
USB

64, 100 pin



New Features:

- 4 UART
- SPI -> SPI / I2S
- Added PPS
- Added CTMU

Dover 256

256KB Flash / 32KB RAM

4 UART, 2 SPI/I2S, 2 I2C
USB

CTMU, PPS

64, 100 pin

Dover 64

64KB Flash / 16KB RAM

4 UART, 2 SPI/I2S, 2 I2C
USB

CTMU, PPS

64, 100 pin



PIC32MX5/6/7 Overview

- **Common with PIC32MX3/4/5/6/7**
 - Pin-out compatible with PIC32MX4
 - 80MHz, 1.56DMIPS/MHz Core
 - Up to 512KB Flash
 - USB2.0 On-The-Go Controller
 - TQFP 64/100, BGA 121, & QFN 64 package options
- **New on PIC32MX5/6/7**
 - More RAM: Up to 128KB
 - More Serial Ports: up to 6 UARTs, 4 SPI and 5 I²C
 - More DMA: up to 16 DMA
 - 10/100 Ethernet MAC
 - Up to 2 x CAN 2.0B Controllers



MICROCHIP

PIC32 Development Resources

Tools, Boards & Software

Easy to Get Started With

PIC32 Ethernet Starter Kit



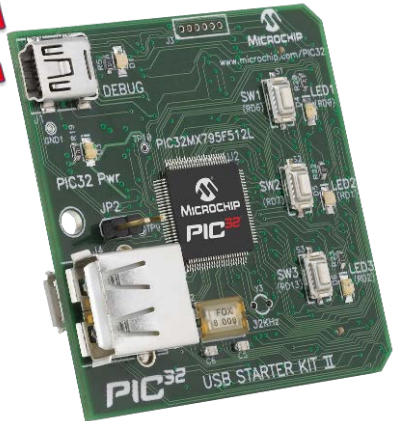
(DM320004, \$72)



Same expansion Connector
for Application Specific
Development

PIC32 USB Starter Kit II

**Updated
Design**



(DM320003-2, \$55)

Ethernet Starter Kit

- Ready for an Ethernet Network
- National DP83848 PHY & RJ45
- USB Host/Device/OTG
- Works with I/O Expansion Board (DM320002)

Both Starter Kits

- PIC32**MX7**95F512L (512k/128k)
- Upgraded debug chip to PIC32 QFN
- Upgraded USB host power supply
- Everything else the same



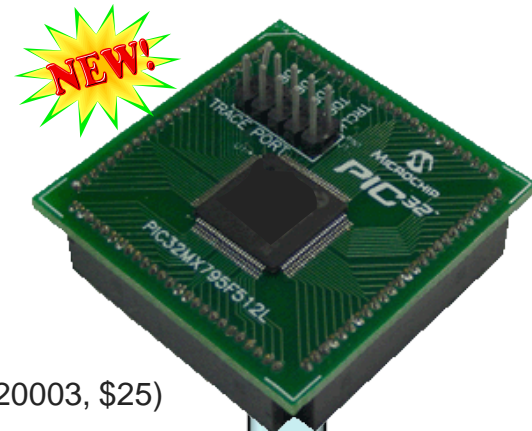
Explorer 16 Support

Available Day of Announcement

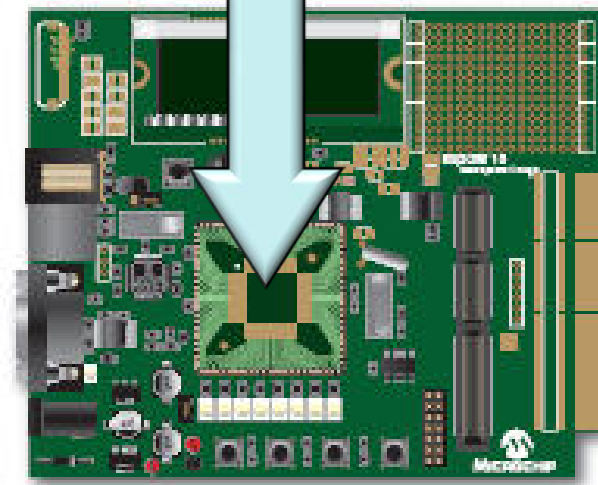
- New Processor Module (PIM) for Explorer 16
 - PIC32**MX**795F512L
 - 512k Flash, 128K RAM
 - 2xCAN – USB - Ethernet**
 - 6 UARTs/5 I2C/4 SPI

**PIM not capable of being a complete Ethernet development platform – details on next slide

Don't Forget Debug/Programming Hardware



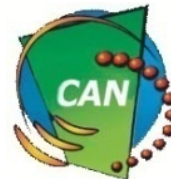
(MA320003, \$25)





New MX5-6-7 Boards by Application

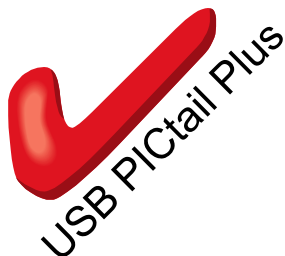
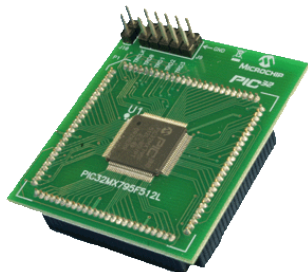
Ethernet Starter Kit



USB Starter Kit II



MX7 PIM for Explorer 16





New Software (Nov 09)

- **Optimized Microchip TCP/IP stacks released**
 - Support for National DP83848, SMSC 8700 PHYs
- **CAN APIs in peripheral library located in Microchip C Compilers**
- **New Unified USB stack 2.x – same host and device stack for all PICs MCUs**
 - PIC32 USB Stack will be deprecated (archived on web and not recommended for new designs)
 - More demos and class drivers
- **Graphics release updated for MX5-6-7**
- **MDD updated for MX5-6-7**



AES Security Software

- Used in connectivity applications to protect transmitted data
- Supports 128, 196, 256-bit Encryption & Decryption
- New library is optimized for 32-bit
- No royalty

	128-bit	196-bit	256-bit
AES Create Session Key (uSec)	46.8	54.4	64.3
AES Encrypt Block (uSec)	23.0	24.6	29.5
AES Decrypt Block (uSec)	20.7	24.6	29.1
AES Encryption* (Kbytes/sec)	764.0	634.4	544.4
AES Decryption* (Kbytes/sec)	764.0	634.4	544.4
*Includes Session Key Creation			

Data Encryption Libraries CD part number SW300052



Enhanced Debug Support

- **Breakpoints: 6 Instruction, 2 Data**
 - AND / OR / Sequential combination
- **Non-Intrusive Instruction Trace**
 - Minimal 5-Wire interface
 - MPLAB IDE performs C code reconstruction of program execution
 - \$79 add-on tool for REAL ICE
- **Traditional Microchip 2-wire Interface**
 - Debug & programming
- **JTAG Debug, Program, and Boundary Scan**



MPLAB Tool-Suite Support

- **MPLAB IDE**

- Completely Free
- Supports all of Microchip's ~500 MCUs and DSCs
- Includes instruction simulator and trace support



- **MPLAB C32 C Compiler – New Student Edition**

- Details on next slide

- **REAL ICE Emulator**

- High-speed debug and programming
- \$499 price, \$80 kit to support Instruction Trace



- **PICkit 2 Programmer**

- **ICD 2 In-circuit Debugger**

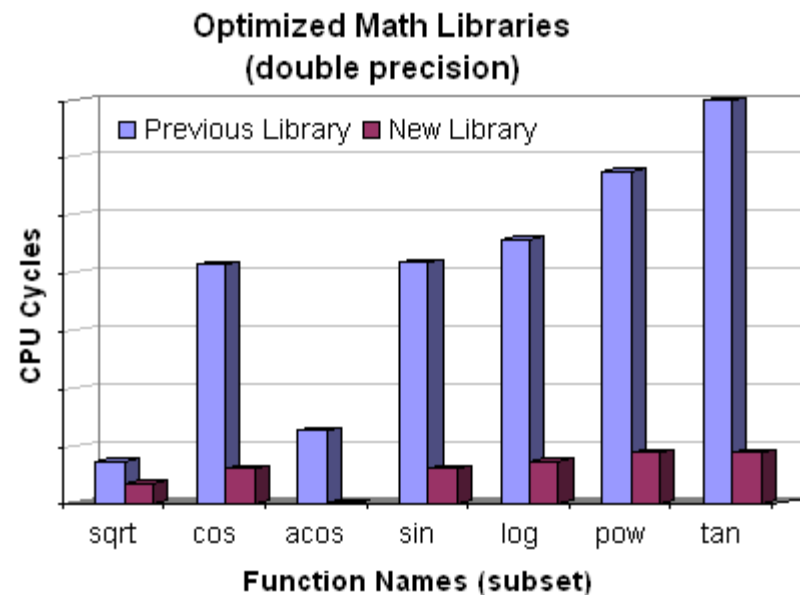
- **PM3 Universal Device Programmer**





Major New Features in v1.03 C Compiler

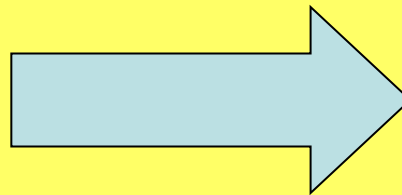
- **No code size limit** in new Student Edition
- **Full optimizations for 60 days**
 - -02, -03, -Os disabled after 60 days
- **22 new hand tuned math library functions**
- **New math functions include single and double precision**
 - Double = Best accuracy
 - Single = Substantial cycle count savings





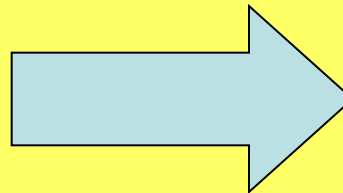
Selecting Your 1st PIC32 Dev Board

**New to Microchip?
New to 32-bit?
Need low cost?**



**Purchase a
PIC32 Starter
Board**

**Have Explorer 16?
Have Real ICE, ICD 2?**



Purchase a PIM



PIC32 Starter Board Options

PIC32 Starter Kit



- DM320001
- Integrated debugger/programmer
- All the software needed - IDE, Compiler, and sample projects
- Expansion capability (next slide)

PIC32 USB Starter Board



- DM320003
- Integrated debugger/programmer
- USB host, device, Dual Role and OTG
- On-line tools & software download
- Expansion capability (next slide)

Windows XP and Windows Vista (32-bit) Support

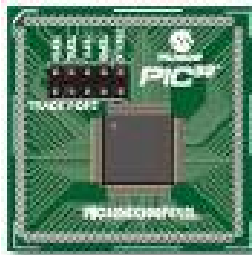


-
- MICROCHIP**
www.microchip.com/PIC32
- 9-15V DC
- +3.3V PWR
- +5V PWR
- PICtail™ Plus



Adapting Explorer 16 for PIC32

PIC32 GP PIM



- MA320001
- Trace header

PIC32 USB PIM



- MA320002
- USB PICtail Plus Board (AC164131)

Requires Explorer 16 and
1 External Probe



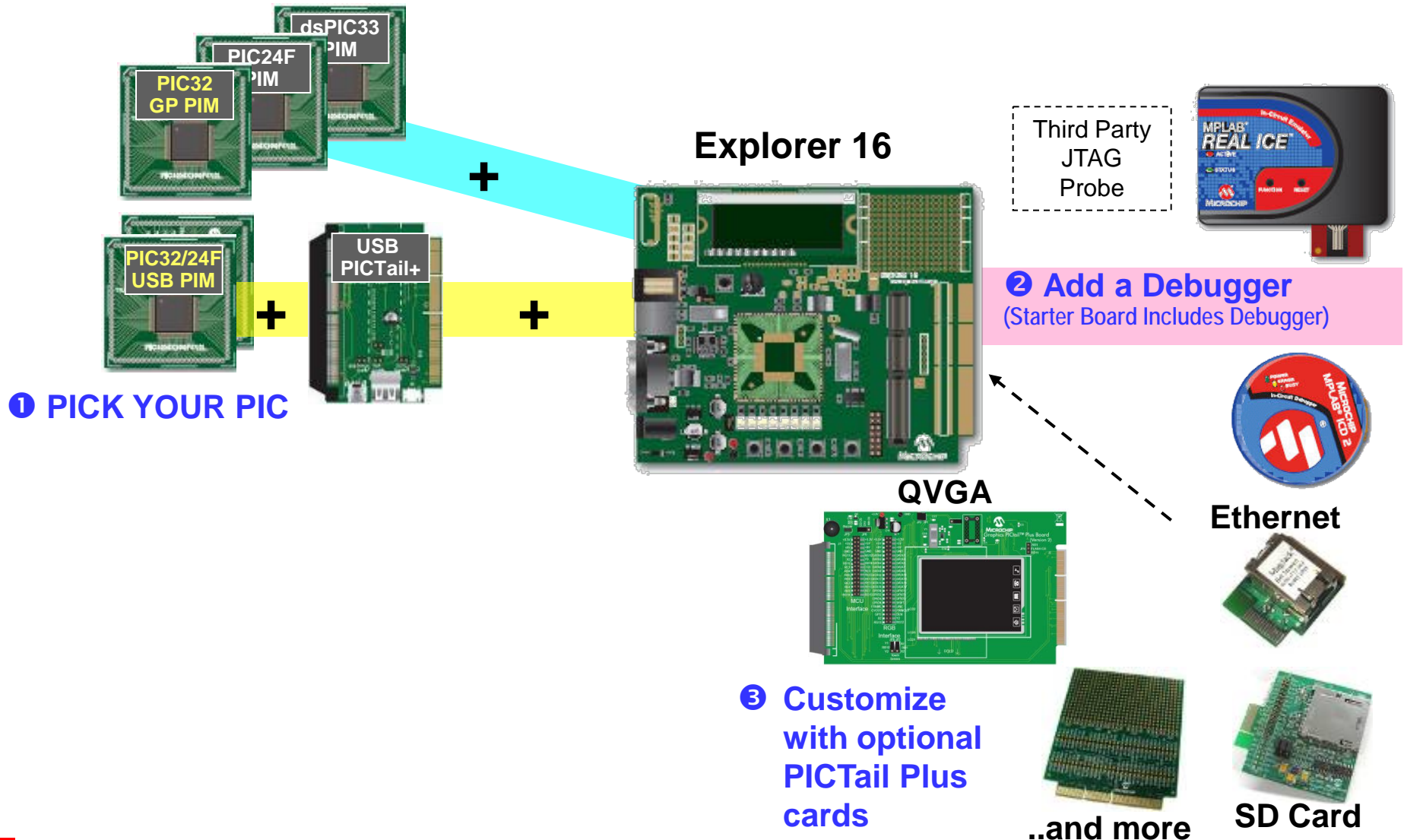
Explorer 16
(DM24000x)



Real ICE or
ICD 2



Explorer 16 Compatibility Overview





New Wi-Fi Comm Demo Board

- **Wireless Module**
 - MRF24WMB0MA
- **MCU**
 - PIC32MX695F512H
- **WiFi solution compatible with IEEE 802.11 b/g/n Access Points**
- **Supports Infrastructure and Ad hoc networks**
- **MRF24WB0MA module is FCC, IC, Wi-Fi® certified and ETSI compliant**
- **Powered by 2 AAA batteries**
- **Supports WEP, WPA and WPA2 security protocols**
- **Sensor I/O interface enabling application specific demos**
- **Complete s/w and h/w including schematics and reference source code**



Wi-Fi® Comm Demo Board
(Part # DV102411)

Orderable Now!!!

PIC32MX1/MX2 Tools

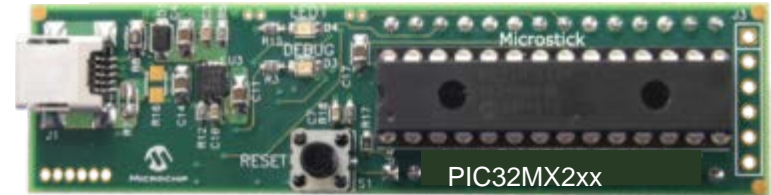
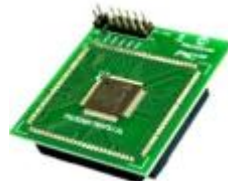


IPLAB® Starter Kit for PIC32MX1XX/2XX Microcontrollers
(Part # DM320013)

PIC32MX1/MX2 Starter Kit

- Integrated Programmer Debugger
- USB Powered
- 2" Color TFT Display
- SD Card Storage
- mTouch slider and buttons
- 24-bit Audio playback

PIC32MX220F32D PIM – DM320011



Microstick II – DM330012-2

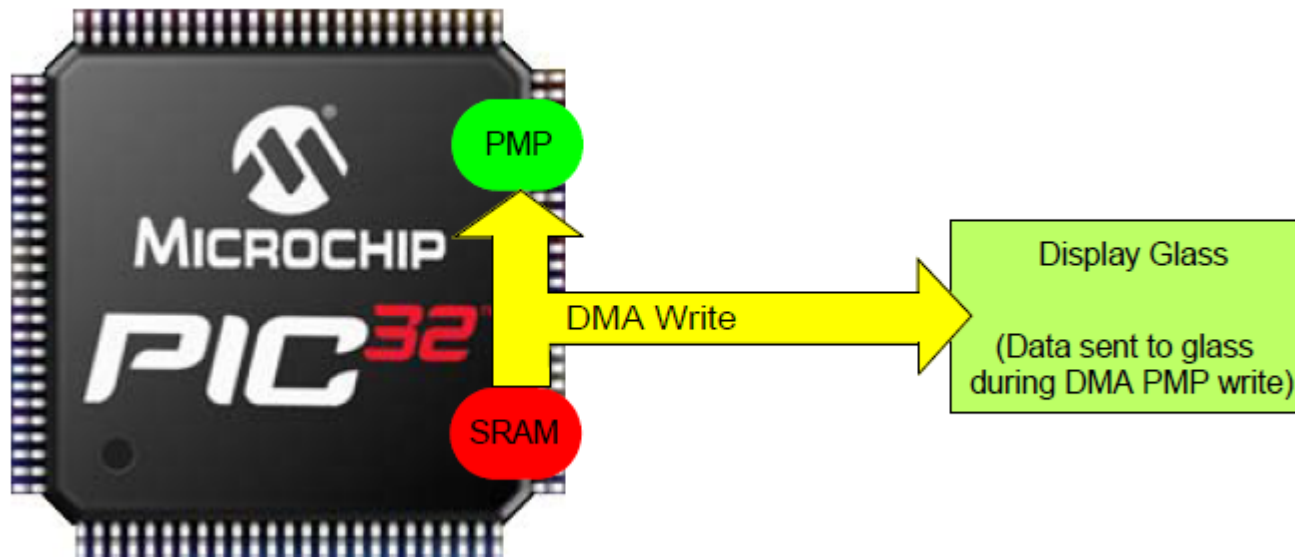
- Integrated Programmer Debugger
- USB Powered
- Access to all pins
- Header for prototyping board insertion

PIC32MX CTMU Evaluation Board

- Soon to have MX2 128KB PIC32
- PICkit serial interface via ICSP header
- Integrated Programmer Debugger
- USB connector (for power)
- 16-bit LED display



Controllerless Graphics: How it is done



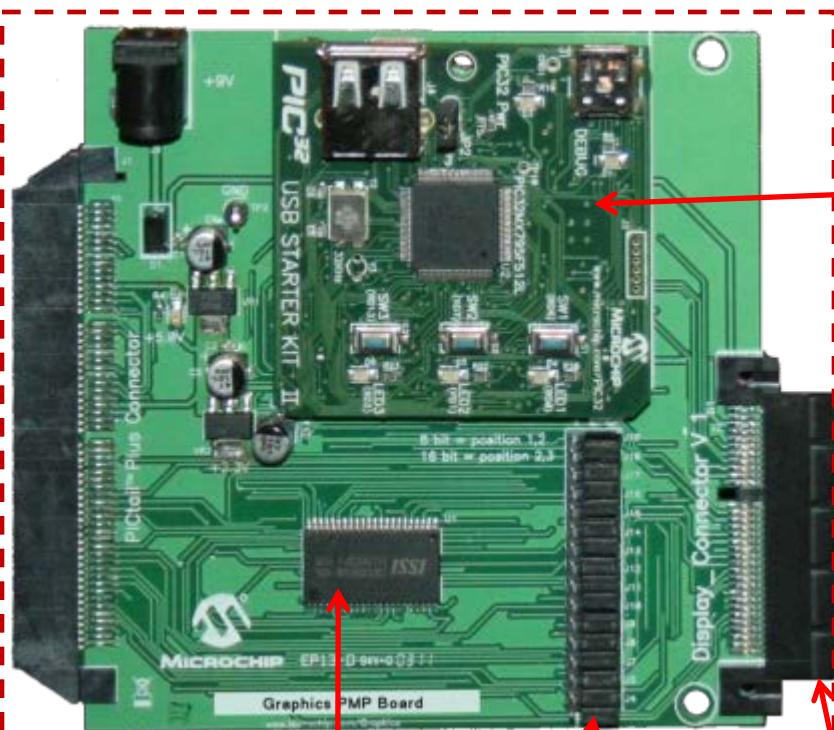
- **DMA + PMP continuously reads bytes of frame lines**
 - Background Task (no CPU bandwidth used)
- **DMA uses a “trigger” to continuously read bytes**
 - PMP or Timer interrupt used
- **After DMA reads entire frame line, timing signals are updated**



LCC (Low-Cost Controllerless) Graphics Board

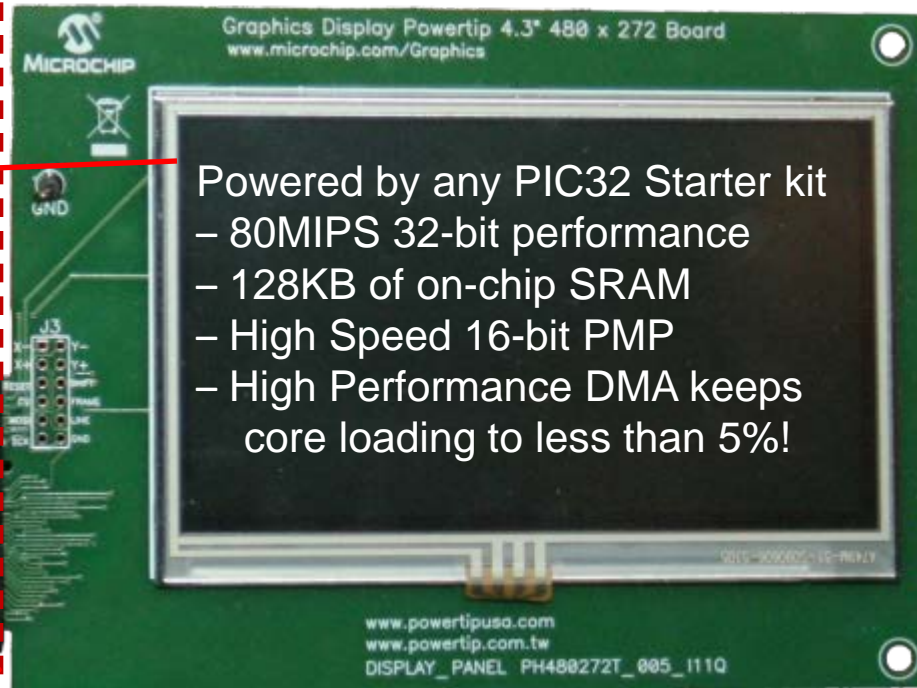
Driving Graphics Displays without a Graphics Controller

Interfaces to Microchip Explorer 16



On Board 512KB SRAM

Can be "Jumpered" in or out



Powered by any PIC32 Starter kit
– 80MIPS 32-bit performance
– 128KB of on-chip SRAM
– High Speed 16-bit PMP
– High Performance DMA keeps core loading to less than 5%!

- Support for up to WQVGA @ 16bpp color
- PIC32 alone can drive VGA @ 8bpp color

Interfaces to Microchip Display modules

Part No: AC164144

Graphics Software Tools



Graphics Library

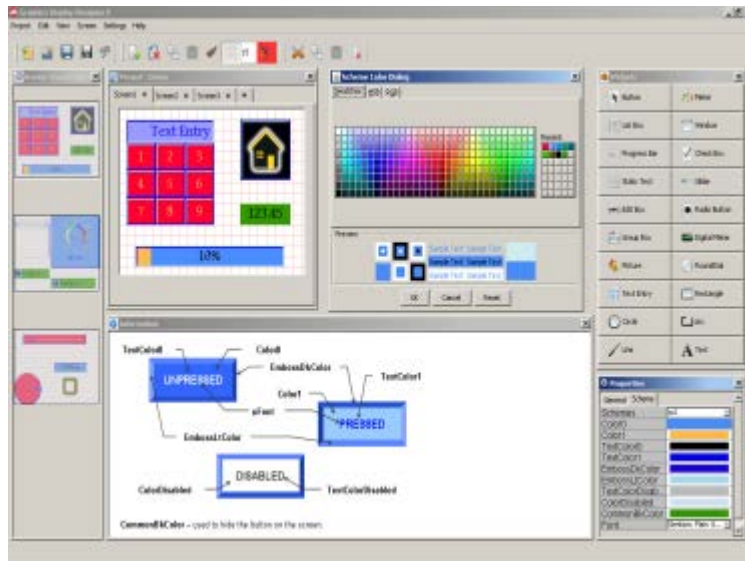


- Pre-made graphics objects – buttons, sliders, etc
- Multiple fonts and languages
- Compatible with 16-/32-bit PIC MCUs

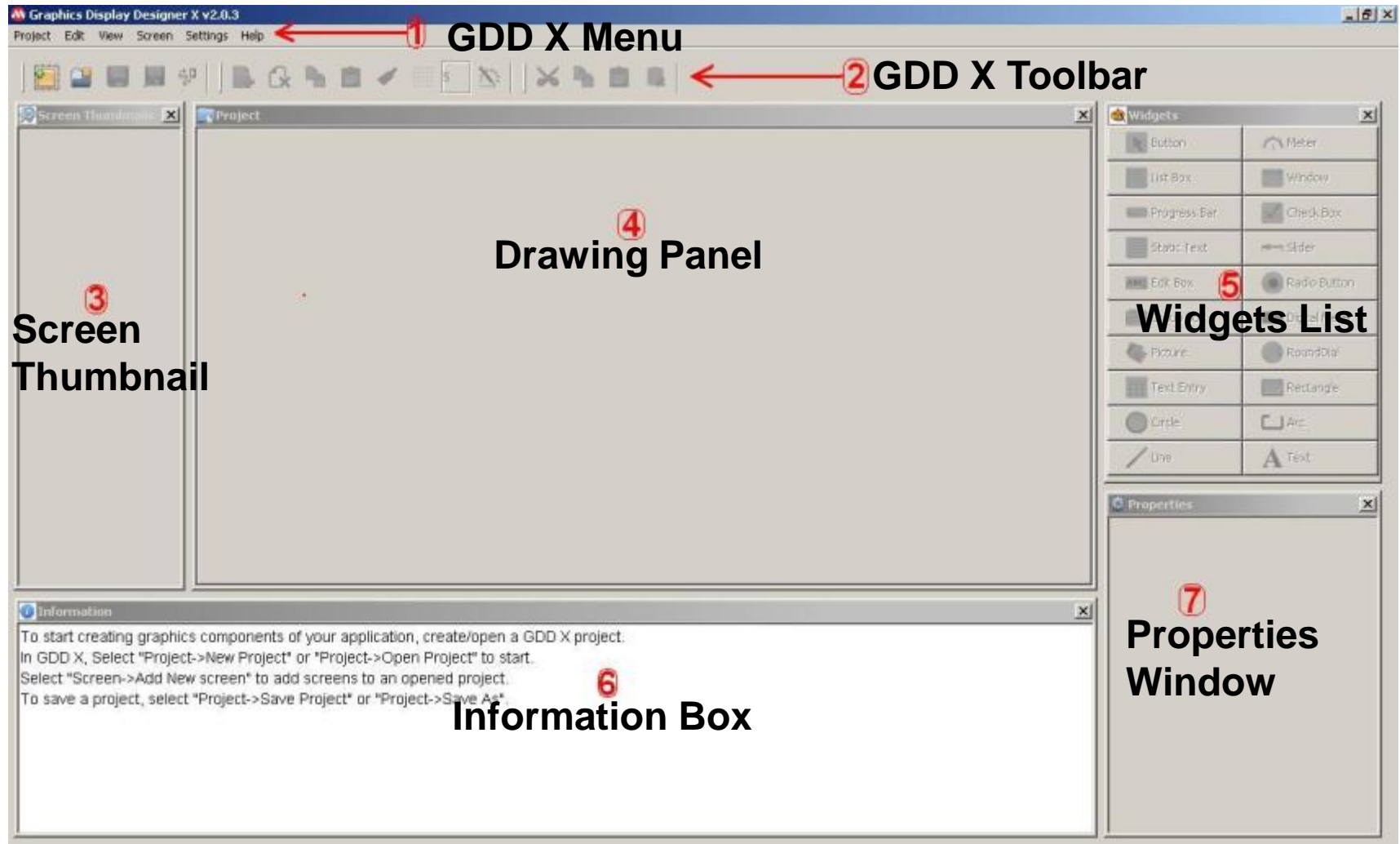


Graphics Display Designer (GDD)

- Visual Design Tool
- Provides GUI design wizard
- Works with Graphics Library
- www.microchip.com/GDD

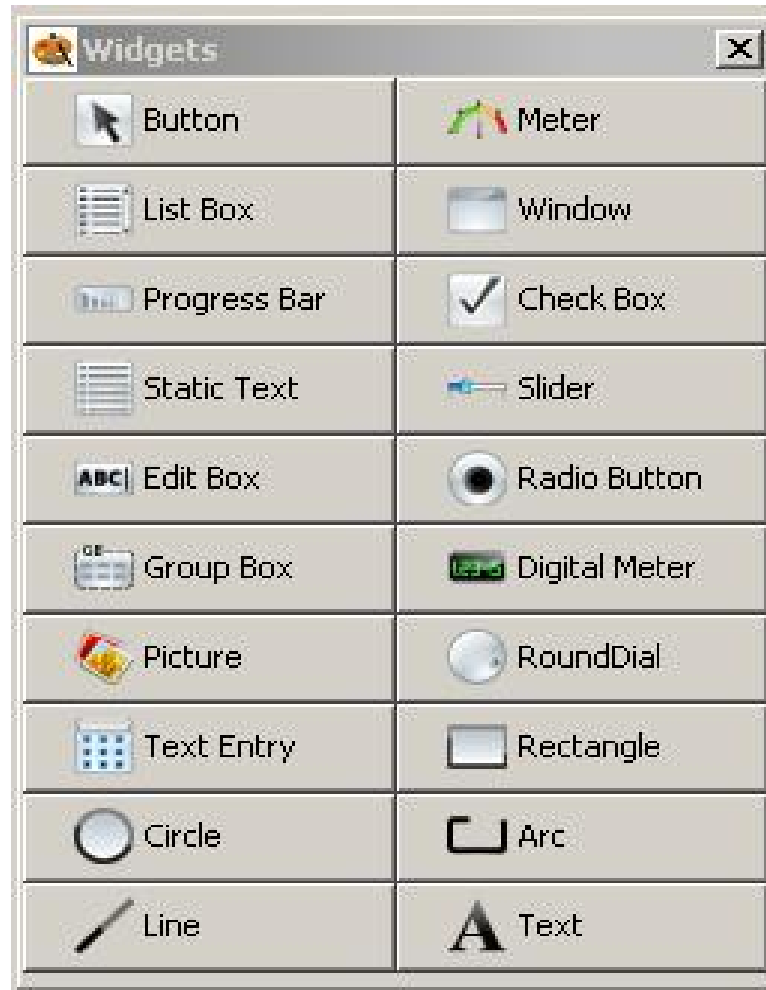


GDD X components





List of available widgets on GDD X





Key GDD X Features

- Resize, align and move widgets, create color schemes, add fonts and images to your App
- Generates source code ready for PIC24, dsPIC and PIC32 devices
- Provides the user with the same visual representation of the embedded screen to draw objects on the PC screen, this is referred to as “what you see, is what you get” (WYSIWYG)
- Eliminates the need to manually calculate the (x, y) coordinates for on-screen object placements

Dev Tools

PIC32 Audio Mixer Boards

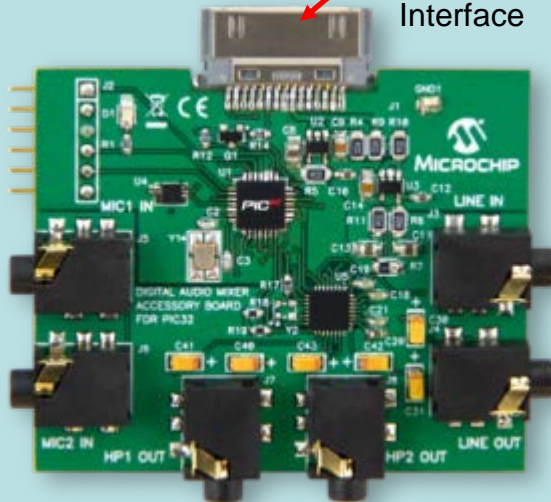
- Mix your instruments and voice with streaming portable music player USB digital audio out
- High Quality 24bit Audio playback for Musicians and for Karaoke applications

MFI Board

P/N: DM320413

- PIC32MX220F128
- Mic_In x2
- Line_In
- Line_Out
- Headphone_Out x2
- iPod Record capability

Apple™ Proprietary
USB Digital Audio
Interface



- Available from MFI Authorized Distributor

USB Board

P/N: DM320014

- PIC32MX220F128
- Mic_In x2
- Line_In
- Line_Out
- Headphone_Out
- Volume pot
- 3 general purpose buttons

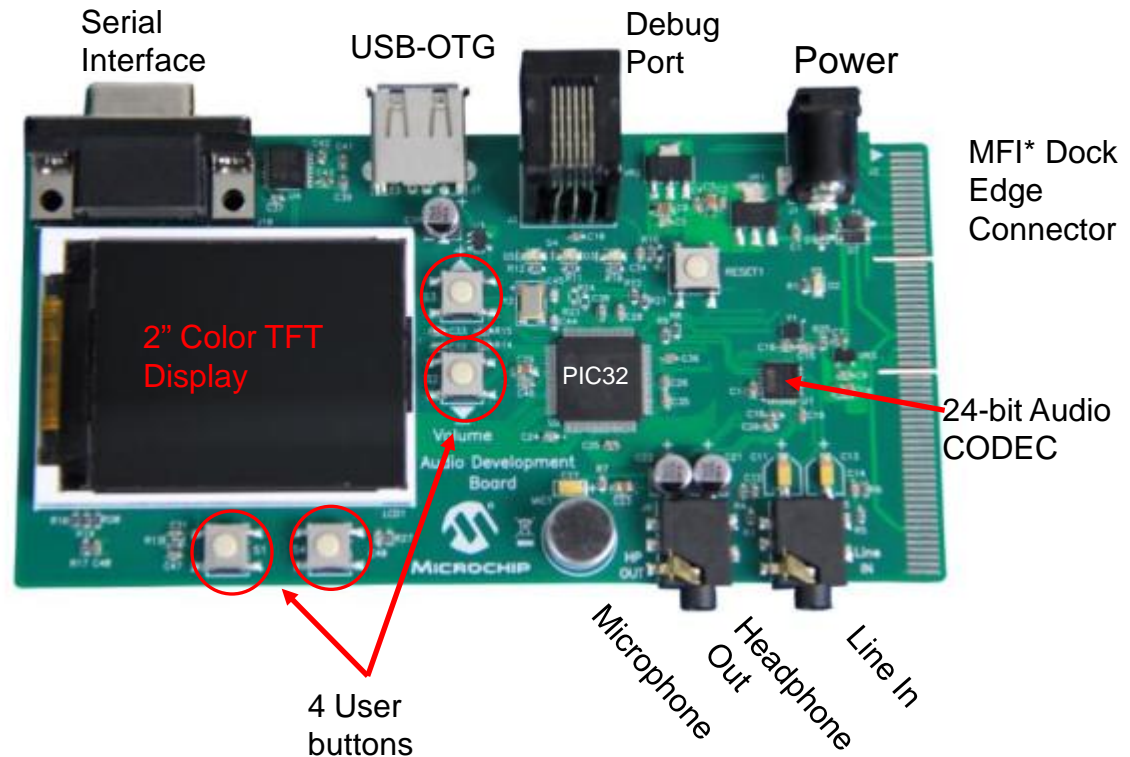
USB Mini-B Digital
Audio Input



* Apple™ MFI Certification could delay release until Q3.

Audio Development Board for PIC32

- PIC32MX795F512L
 - 80MIPS 32-bit MCU with 512KB Flash and 128KB RAM
- Processing power to:
 - Decode MP3 Music
 - WMA, AAC Decode – 2H'12
 - Complete audio SRC (Sample Rate Conversion)
 - Manage MFI digital audio stack
 - Display 16-bit color images
- Interface to Microchip's Accessory Development platform for iPod/iPhone*



* Interfaces to Microchip's accessory development platform for iPod® and iPhone® available to MFI licensees through Apple's authorized distributor.

PIC32 MX1xx/MX2xx Starter Kit (DM320013)

- PIC32MX220F032 with 32KB of Flash, 8KB RAM
- Integrated Programmer Debugger
- USB Powered
- 2" Color TFT 220 x 176 pixel Display
- SD Card Storage
- mTouch Slider and buttons
- 24Bit Audio playback
- A great tool to learn about the I²S Audio CODEC interface, Basic LCD graphics and mTouch™





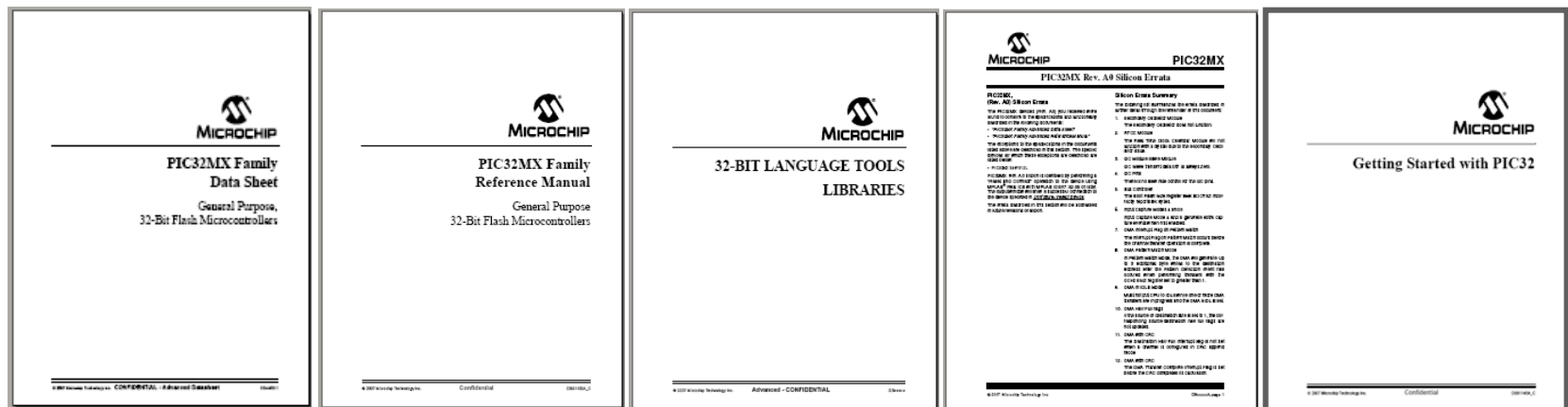
Software Building Blocks

USB Host & Device	Released	
USB Dual Role and On-The-Go	Beta Now : Future Release	
Serial Port Bootloader	Released	
TCP/IP Stack with SSL & BSD	Released	
Graphics Library (with JPEG support)	Released	
Standalone CAN Library	Released	
MiWi™ Wireless Networking (802.15.4)	Released	
Audio Library – SPEEX, PCM, ADPCM (WAV)	Released	
16-bit & 32-bit File Systems	Released	
EEPROM Emulation Library	Released	
DSP Library (C32 Compiler v1.04)	Released (doc release in early Nov)	
DMA UART library	Beta Now	Release: CQ4
Soft SPI Library	Beta Now	Release: CQ4

Provided in [source form](#) at ***no charge, no royalty, no maintenance costs***

PIC32 Available Documentation

- Family Datasheet
- Getting Started Guide
- Family Reference Manual
- C32 Compiler User Guide, C32 Library guide
- Errata sheet
- Application Notes:
 - 9 USB related
 - Maximize SW Portability
 - 16/32-bit File System
 - TCP/IP
 - Web server
 - SNMP Agent
 - FTP Server



www.microchip.com/pic32docs

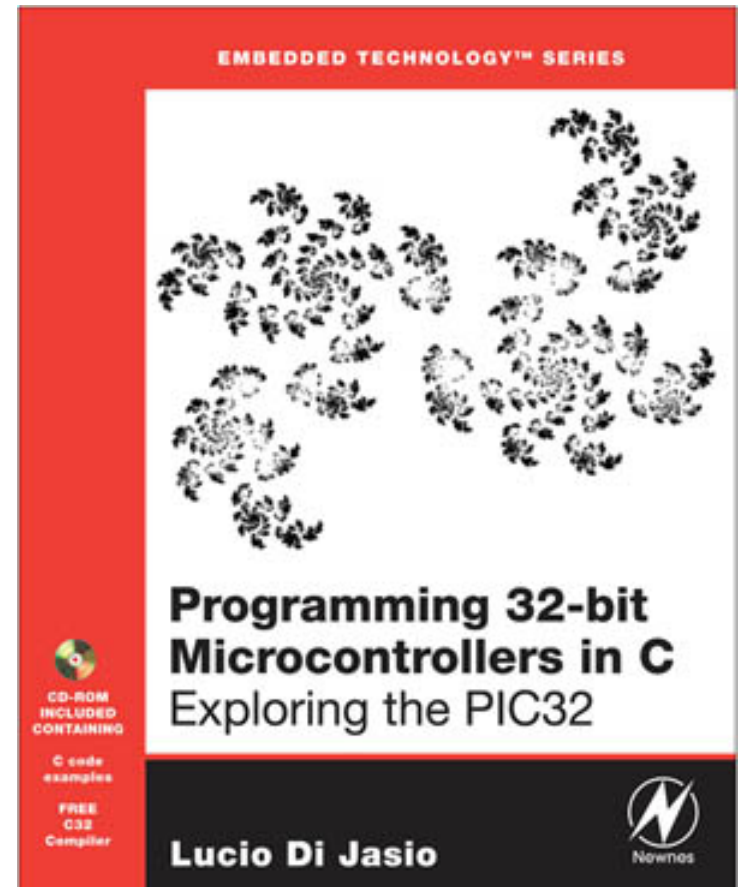
Programming 32-bit Microcontrollers in C: Exploring the PIC32

- Accelerate the learning curve
- Experience the simplicity of PIC32
- Utilize the compatibility with PIC24

A sample of the 15 projects:

- Basic timing and I/O operation
- Debugging methods
- Multitasking using the PIC32 interrupts
- New hardware peripherals
- How to control LCD displays
- Accessing mass-storage media
- Generating audio & video

Written by long-time Microchip
employee & a member of the
PIC32 team





PIC32 Third Party Support

IDE, C/C++ Compiler and Debugger



Embedded RTOS Support



Graphics GUI Support





Summary

- **Compatible upgrade path**
 - Up to 512KB of Flash and 32KB of RAM
 - 80MHz of 32-bit Performance
 - Re-use Microchip development tools & Explorer 16
 - Industry Tools support from 14 Key Industry 3rd Parties, and growing
- **USB OTG Parts Now in Production**
- **USB/CAN/Ethernet products in development**
- **Silicon, Tools, Docs, Software and low cost Starter Kits are available now**



About CMX Systems

- **Founded in 1990, Based in Jacksonville, FL**
- **Core business - provides RTOSes, TCP/IP Stack, Flash File Systems, USB and CANopen stacks**
- **Renowned for service and support**
- **Widely used with PIC/dsPIC MCU's**
- **www.cmx.com**



CMX-RTX Real Time Operating System

- **Smallest footprint and fastest context switch times in industry**
- **Truly Preemptive**
- **Low Interrupt latency**
- **Nested Interrupts**
- **Scalable - User configurable**
- **Widely deployed in over 50 processor families**
- **No Royalties , Full source code**



CMX-MicroNet TCP/IP Stack

- **Optimized for extremely small RAM/ROM**
- **Operates with or without RTOS**
- **Easy-to-use GUI for configuration**
- **Support for : TCP, IP, UDP, PPP, PAP/CHAP, WebServer, DHCP, FTP, TFTP, SMTP, SNTP, POP3, DNS, SNMP, ICMP, Multicasting and Fragmentation**
- **Ethernet, Dial Up and Wireless connectivity**
- **Portable Drivers for Ethernet controllers**



ThreadX

- ThreadX is Express Logic's [real-time operating system](#) (RTOS) for embedded, real-time applications running on Microchip PIC32 processors
 - Multithreading, priority-based, preemptive scheduling, deterministic
 - Queues, timers, memory pools, event chaining, logging
- ThreadX is optimized to be [small](#) in size, [fast](#) in performance, and [easy to use](#)
 - As small as 4KB, 2 μ s context switch, 60 services
- ThreadX is [royalty-free](#), making it especially attractive for high-volume, cost-sensitive products
 - Low up-front cost, no royalties, full source code



Who's Already Using ThreadX?

- Over 450 million devices deployed as of April, 2007
 - Consumer Devices
 - Wireless networking 802.11b/g/a, Bluetooth (Intel, Marvell, Broadcom)
 - Ink-jet Printers, All-In-One (HP)
 - DSC Cameras (HP, Pentax, Kodak, Zoran SoC users - many)
 - DVD Players, DTV (Zoran SoC users – many)
 - Medical electronics – Welch-Allyn, Medtronic
 - Defibrillators
 - Ventilators
 - Blood analyzers
 - Industrial Automation
 - 3M
 - Horner
 - Ingersoll-Rand
- See www.rtos.com for more



Express Logic's Business Model

- Royalty-Free Licensing
 - No per-unit charges for binary copies
- Full Source Code
 - For security and better understanding
- Project Licensing
 - Technology licensed for use in a project (single product, product line, family, processor, OEM)
- Developer Licensing
 - Technology licensed for use per developer, per site
- Support
 - Support contracts assure updates, bug-fixes and hand-holding



Who is Micrium?

- **Provider of: High Quality Embedded Software Components**
 - Some products are FAA/FDA certifiable
 - Outstanding documentation
- **Code provided in source form**
 - Cleanest Source Code in the Industry
 - Follow strict coding standards and practices
 - Style
 - Comments
 - Naming conventions
 - Directories
 - Encapsulation
- **Outstanding customer support**



Micrium Products

- **μC/OS-II**
 - Embedded RTOS
 - **μC/OS-View**
 - Run-time Task Profiler
- **μC/GUI**
 - Embedded Graphical User Interface
- **μC/FS**
 - Embedded File System
- **μC/BuildingBlocks**
 - Software time-of-day clock (**μC/CLK**)
 - Character-based LCD (**μC/LCD**)
- **μC/TCP-IP**
 - Embedded TCP/IP v4 stack
 - DHCPc, DNSc, FTP, HTTPs, POP3c, SMTPc, SNTpc, etc.
- **μC/USB-Device**
 - Bulk-device stack
 - Mass-Storage Class
- **μC/USB-Host**
 - HID
 - CDC
 - Mass-Storage Class
- **μC/Modbus**
 - Modbus Master or Slave
 - RS-232C or RS-485
 - ASCII or RTU
- **μC/CAN**
 - CAN Framework
- **μC/Probe**
 - Run-Time Data Monitor



Micrium Licensing

- **Most of our products are Royalty-Free.**
- **Licensed on a ‘per-end-product’ basis.**
 - Perpetual use on that end-product
 - Unlimited number of units
- **Each ‘different’ product that embeds our software requires a license.**
- **If a product has multiple CPUs then each CPU running a different binary requires a license.**
- **Other licensing schemes are available:**
 - Product Line (i.e. Family)
 - Per-CPU type (ARM, ColdFire, SH, etc.)
 - Site

FREE

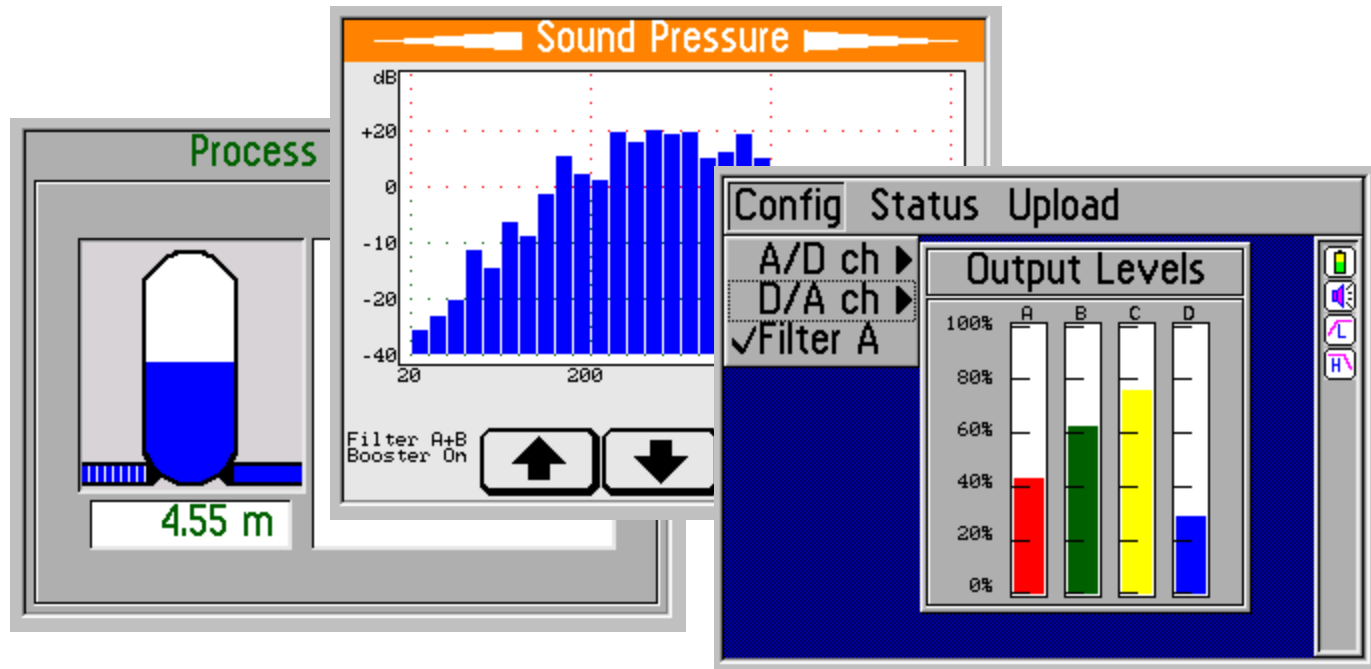
45-DAY **SOURCE CODE EVALUATION**

• **μC/OS-II** → *The Real-Time Kernel* • **μC/TCP-IP** → *Protocol Stack*

30-DAY **TRIAL EVALUATION**

• **μC/Probe** → *Run-Time Monitoring*

RAMTEX Graphic Display Driver Libraries for PIC32



- **Embedded GUI application development made simple with C source libraries from RAMTEX International ApS**
- **Support use of PIC32 with more than 100 display controller types**
- **Contact RAMTEX for detailed information: www.ramtex.dk**



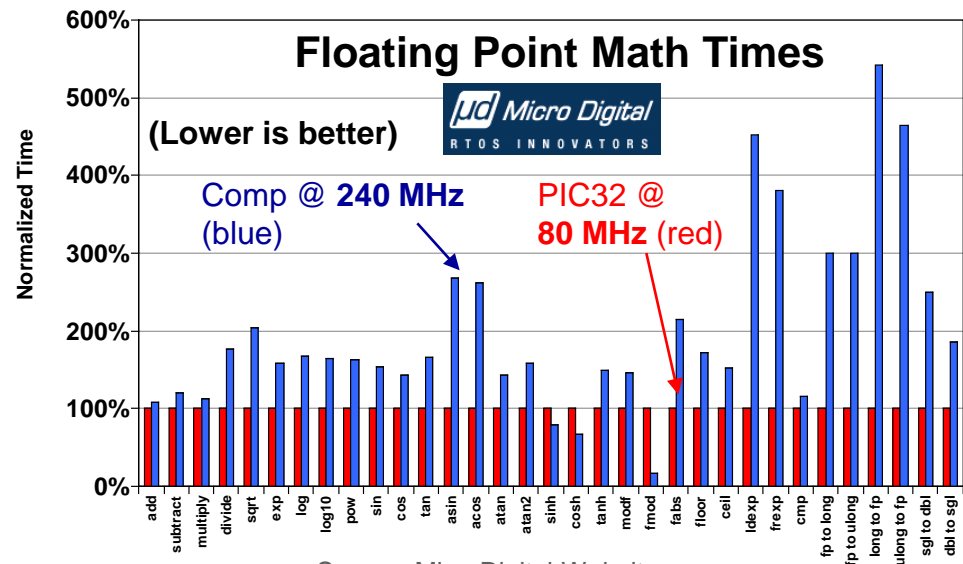
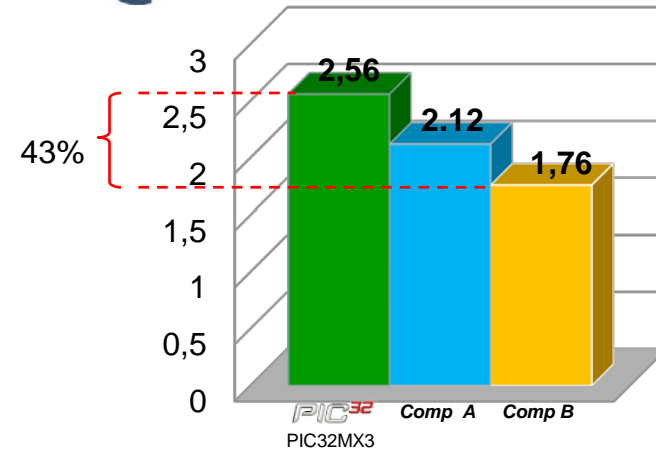
PIC32 Key Advantages

- **Best-in-Class performance per MHz**
- **Many Connectivity Options**
- **Scalable Memory Options up to 512KB**
- **Innovative Peripherals:**
 - **Peripheral Pin Select** – flexible pin-remapping for design flexibility
 - **Charge Time Measurement Unit (CTMU)** – for precise measurements and implementing capacitive touch sense keypads and sliders
 - **8/16-bit Parallel Master Port** – for connection of external peripherals like graphics controllers, memory, etc.
 - **I²S Codec** – digital audio interface with adjustable clocking for streaming digital audio applications

Designed for Performance

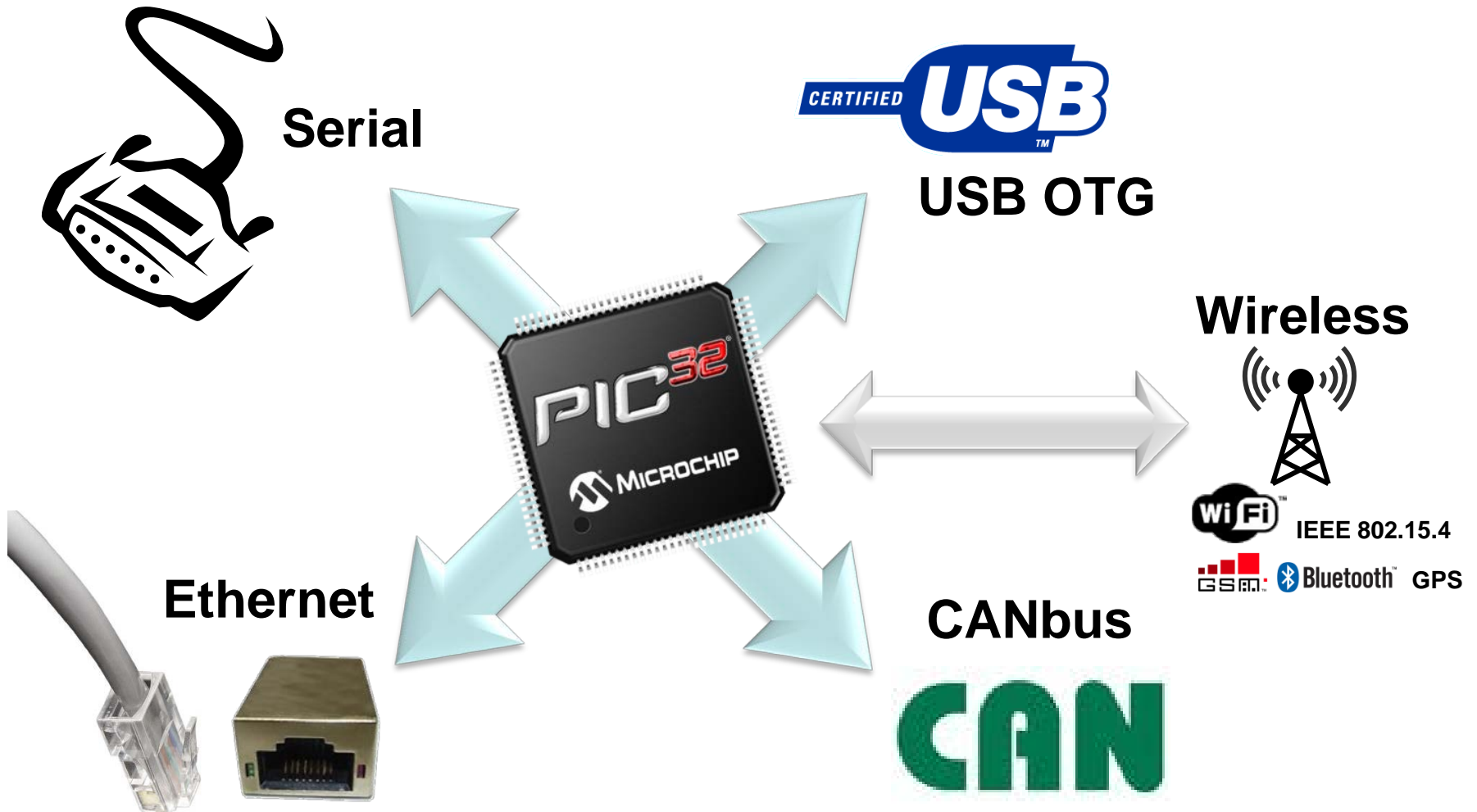
- **More processing capability per MHz**
 - MIPS® M4K® core with best-in-class 1.65 DMIPs/MHz ratings
 - Two sets of 32 Core registers
 - Can perform math operations in parallel with instruction execution
- **Chip architecture targets maximum performance**
 - Instruction caching for 1:1 linear code execution
 - Dedicated DMA on key peripherals
 - Up to 80 MHz internal busses

COREMARK™ by EEMBC®



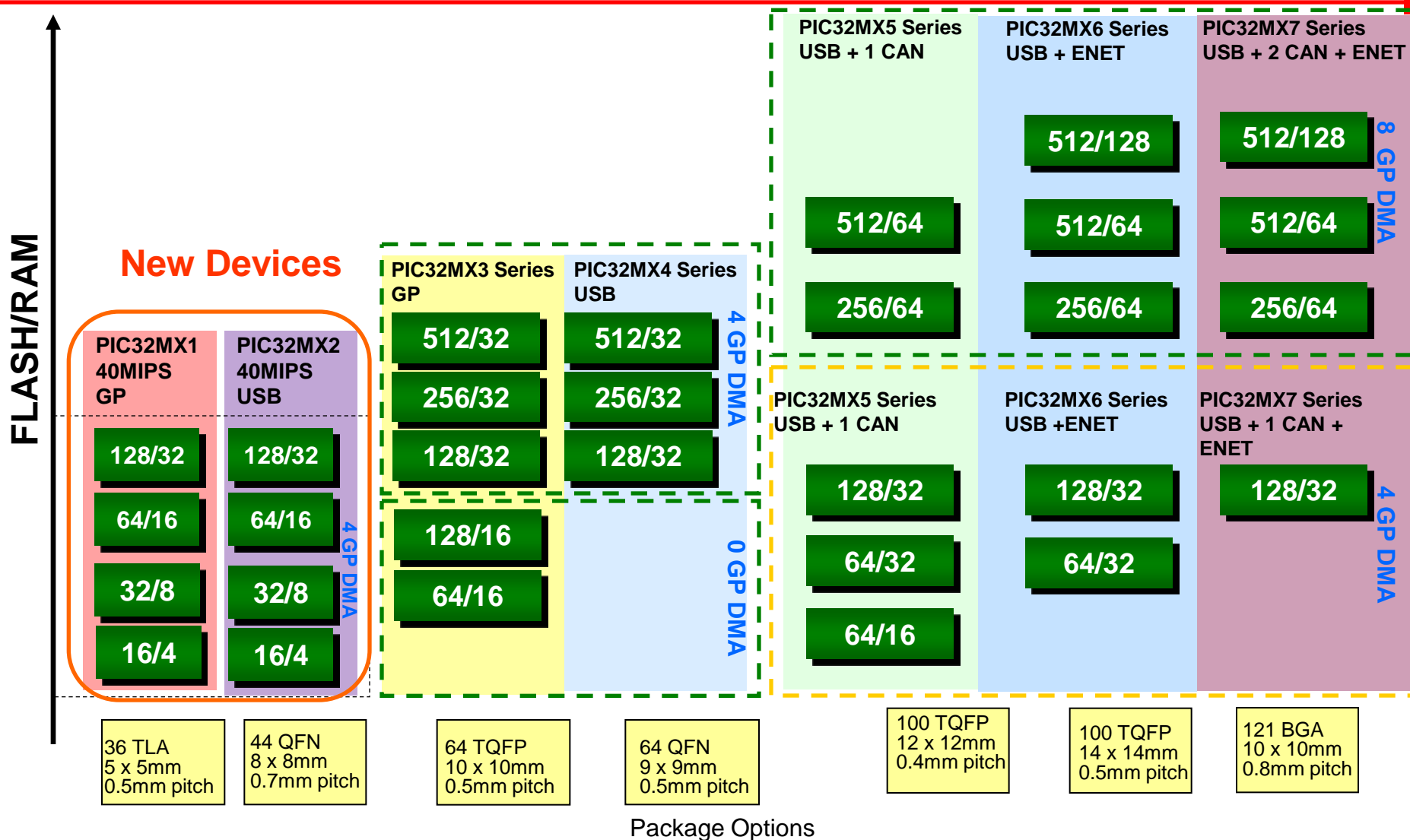
Source: MicroDigital Website

Connectivity Options





PIC32 MCUs In Production





Popular Applications

- **Industrial Automation**
 - Networked communication hubs
 - GUI based control panels
- **Appliance/Smart Energy**
 - Metering
 - Automated coffee makers
 - Commercial HVAC control
 - Security systems
- **Medical**
 - Glucose monitors
 - Networked monitoring devices
 - Cardiac monitoring
- **Commercial**
 - Automotive diagnostic equipment
 - Bar code Scanners
 - GPS vehicle trackers
- **Consumer**
 - Fitness Equipment
 - Remote controls
 - PC servers (diagnostic functions)
 - MP3 capability

Easy to Get Started

Starter Kit Platform: Easiest and Lowest Cost



Ethernet + USB
128K Ram
DM320004



USB
128K Ram
DM320003-2



General Purpose
32K Ram
DM320001

Starter Kits Includes:

- Free Compiler
- Example Software
- Expansion Connector
- Integrated Programmer & Debugger

Explorer 16 Platform: Compatible with 16-bit MCUs



Processor Module
(MA32000x)

+



Explorer 16 Board
(DM240001)

+



Debugger of Choice

PIC32 Starter Kits

- Plug directly into the Multimedia Expansion Board or one of several graphics development boards
- Integrated programmer / debugger
- USB Powered



General Purpose
32 Kbytes RAM
Part #: [DM320001](#)



USB
128 Kbytes RAM
Part #: [DM320003-2](#)



Ethernet + USB
128 Kbytes RAM
Part #: [DM320004](#)

PIC32MX1/MX2 Tools



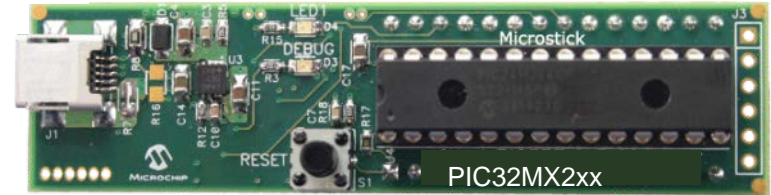
IPLAB® Starter Kit for PIC32MX1XX/2XX Microcontrollers
(Part # DM320013)

PIC32MX1/MX2 Starter Kit

- Integrated Programmer/Debugger
- USB Powered
- 2" Color TFT Display
- SD Card Storage
- mTouch™ Capacitive slider and buttons
- 24-bit Audio playback

PIC32MX220F32D PIM

- DM320011



Microstick II – DM330012-2

- Integrated Programmer /Debugger
- USB Powered
- Access to all pins
- Header for prototyping board insertion

PIC32MX CTMU Evaluation Board

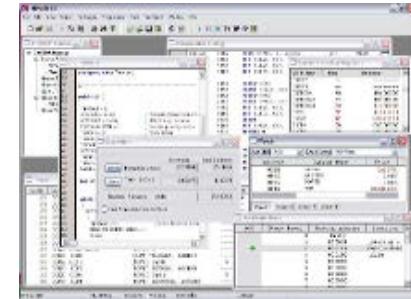
- PIC32MX2 128KB PIC32
- PICkit serial interface via ICSP header
- Integrated Programmer Debugger
- USB connector (for power)
- 16-bit LED display





Complete PIC32 Tool Chain Supports Rapid Development

- **MPLAB® IDE Tool Suite**
 - Single version for all 8/16/32-bit PIC® MCUs
 - Enhanced for 32-bit development
 - Works With Existing MPLAB® ICD 3 and MPLAB REAL ICE™ Debug Probes
 - Still Free & Supports all ~600 PIC MCUs
- **MPLAB® C Compiler for PIC32**
 - Based on MIPS® Technologies' Proven Compiler Technology
 - Compatible Peripheral Libraries
 - Common API set with 16-bit
- **MPLAB® Debuggers, Emulators and Programmers are also available**





Free Microchip Software and 3rd Party Software are Available

Microchip Software Libraries

- Two TCP/IP Libraries
- AES 128-, 196- and 256-bit Encryption Library
- Full Peripheral Library in C Compilers
- Advanced Graphics Library
- USB Embedded Host, Device and On-the-Go Library
- MiWi™ Wireless Protocol Stack (802.15.4)
- Two File System libraries
- Audio Library
- Bootloaders
- DSP Library*
- Floating Point Library*

Free & Source-Code Form

(* Binary only)

**supported by
Microchip**

Microchip Tools

MPLAB® IDE (free)

MPLAB C Compiler

HI-TECH C® Compiler

Third Party Software



Micrium
Empowering Embedded Systems



expresslogic

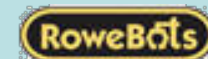


RAMEX
International A/S

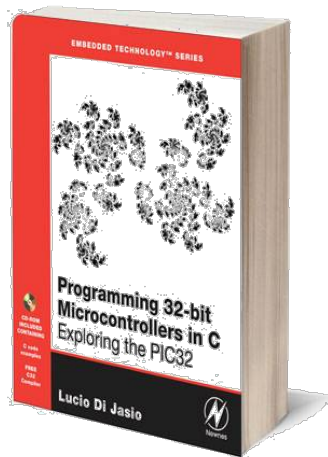


LAUTERBACH

Macraigor Systems
Complete JTAG Debug Support



Additional Resources are Available to Assist in the Design Process



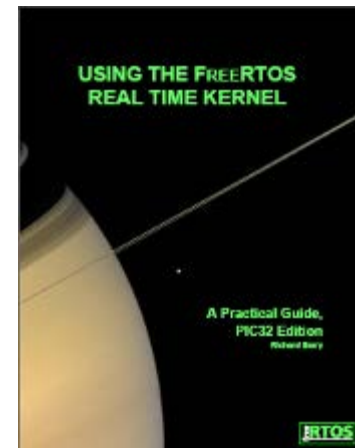
Programming 32-bit Microcontrollers in C

- Accelerate the learning curve
- Experience the simplicity of PIC32
- 15 Projects

Using the FreeRTOS™ Real-Time Kernel with PIC32



Real-Time Multithreading using ThreadX and MIPS®





MICROCHIP

V-TEMP

**Wider Operational
Temperature Range
-40°C to +105°C**



Wider Temperature Range

- **PIC32 MCUs can operate from -40 C to 105 C designated as V-Temp**
- **Designed for applications across various market segments**
 - ❖ Communications
 - ❖ Industrial
 - ❖ Medical
 - ❖ Automotive
 - ❖ Appliance
 - ❖ Renewable energy



V-Temp MCUs with various features eases the designs

- **PIC32 V-Temp MCUs provide many popular features including**
 - ❖ Connectivity
 - ❖ Graphics
 - ❖ Audio
 - ❖ Touch Sensing
 - ❖ Industrial CAN
 - ❖ USB OTG
- **Meets the demands of applications that need variety of features and higher temperature operation as well**



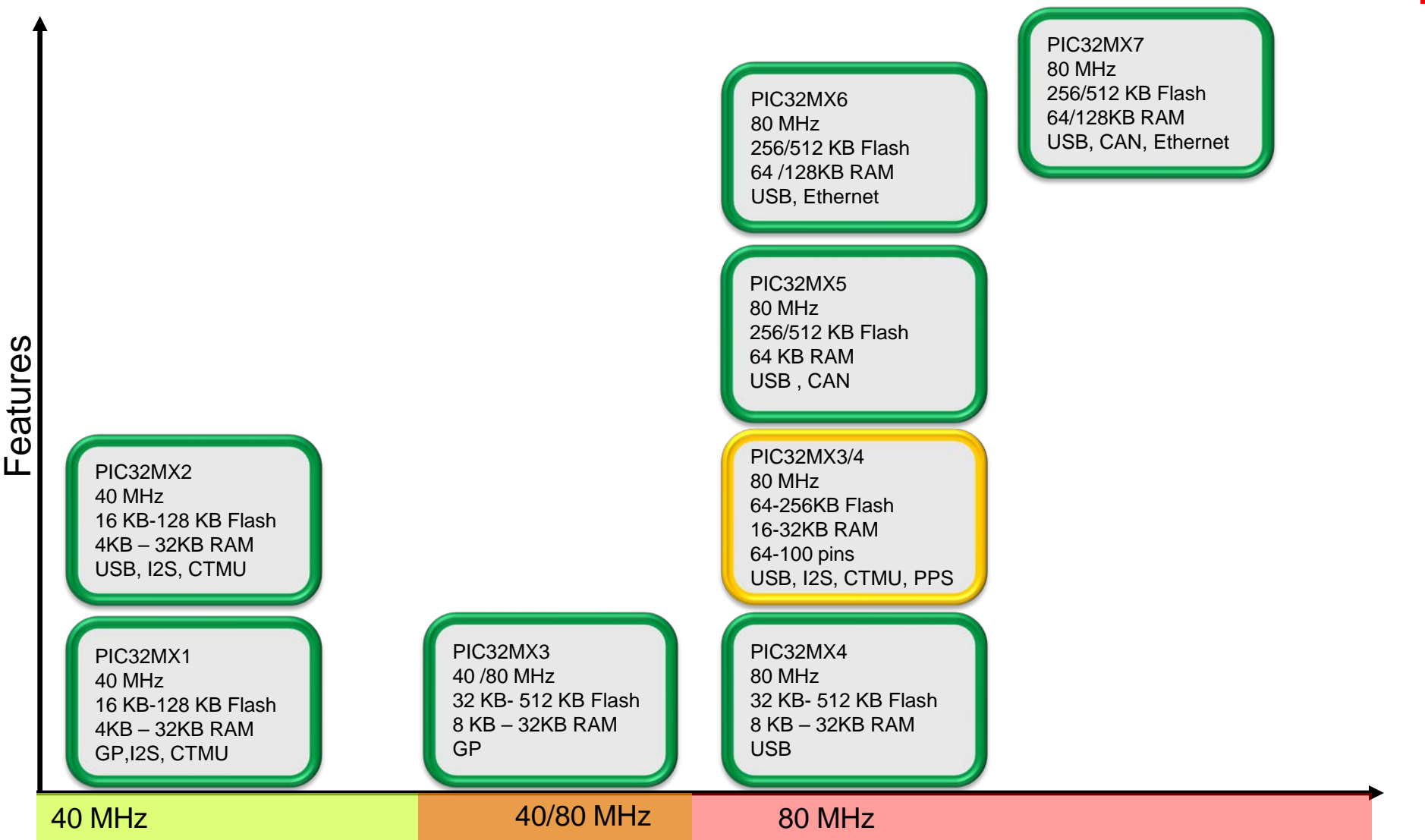
PIC32 V-Temp Devices

- **PIC32MX5/MX6/MX7 256/512KB Flash**
 - Ethernet, CAN, PMP for GFX & USB-OTG
- **All PIC32MX3/MX4**
 - General Purpose , PMP for GFX & USB-OTG
- **40 MHz PIC32MX1/MX2**
 - Audio, Touch sensing, USB-OTG & PMP for GFX





PIC32 V-Temp Roadmap





MICROCHIP

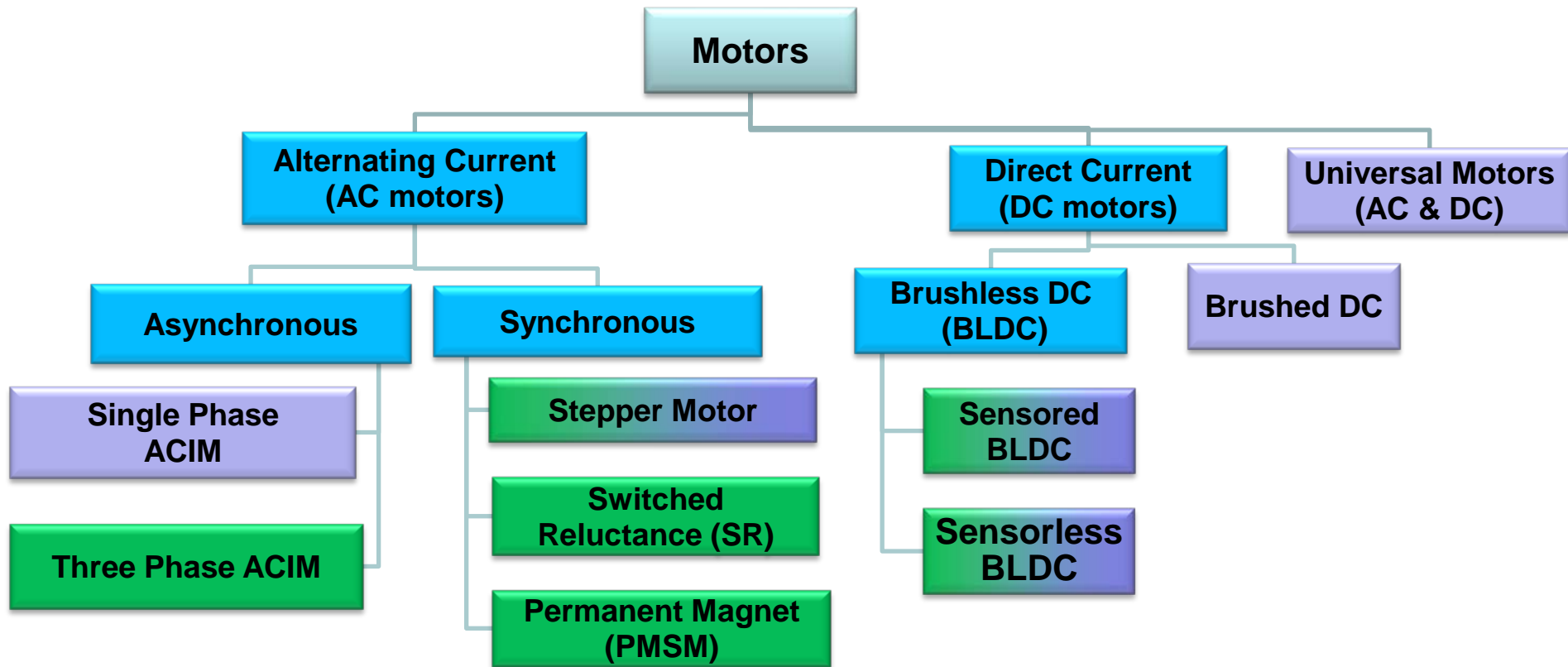
**High-Performance, 70 MIPS
16-bit Products**

**New dsPIC Motor Control and
General Purpose Devices**

The new additions to the dsPIC33EP and PIC24EP families bring new features and cost benefits to **motor control** and **general-purpose** applications



dsPIC Motor Control Applications



Any PIC[®] MCU w/ Capture and Compare (CCP) or Enhanced CCP PWM

dsPIC Digital Signal Controllers are best suited



Brushless DC Motors

Sensored BLDC

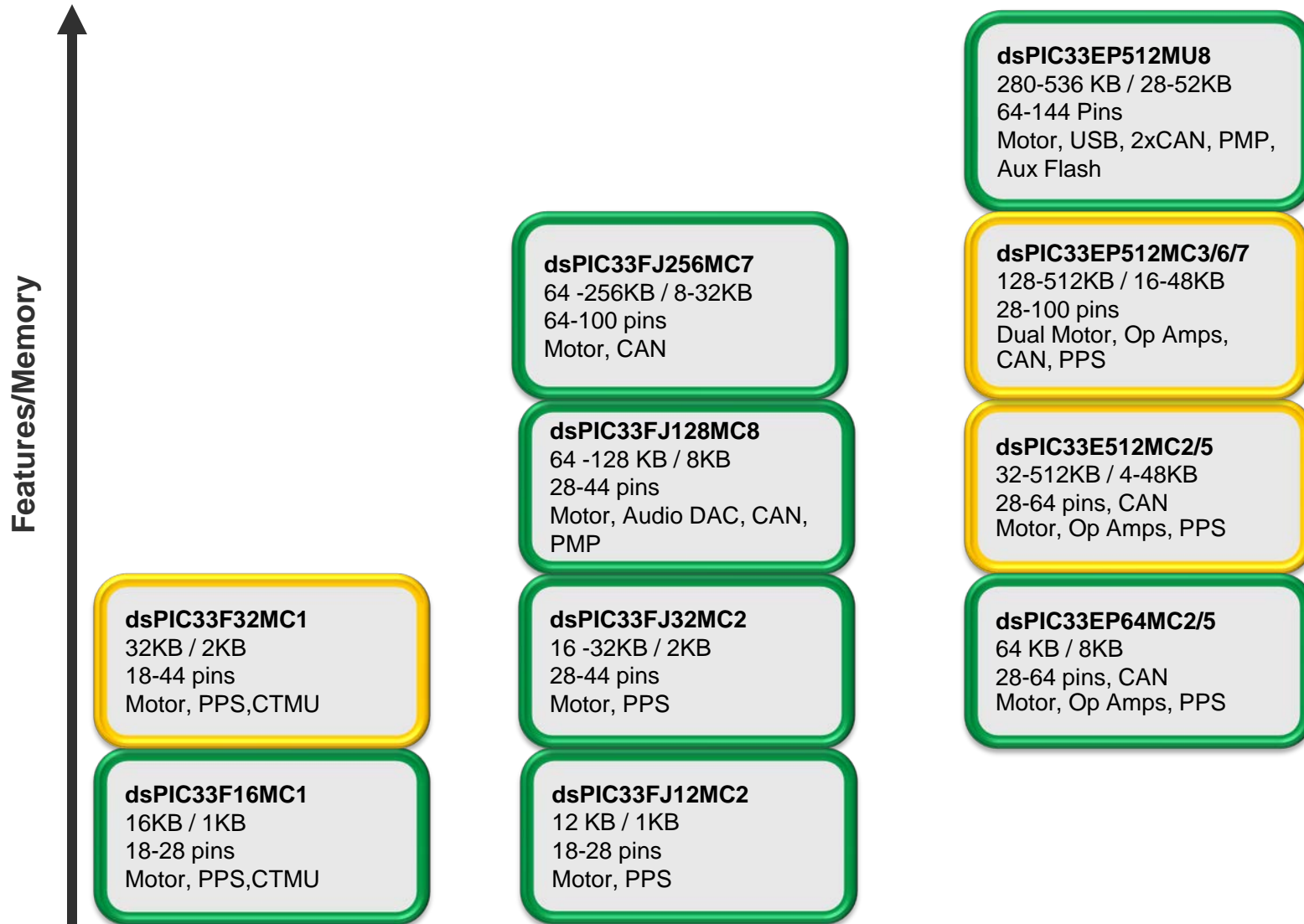
- **Microchip analog controllers, 8-bit PIC's, and 16-bit PIC24F's provide excellent sensored BLDC control solutions**
- **dsPIC offers precise control such as:**
 - Variable speed with constant torque, speed and torque control using PI controllers, field oriented control for greater efficiency, minimal torque ripple, and quiet operation

Sensorless BLDC

- **Microchip analog controllers, 8-bit PIC's, and 16-bit PIC24F's can implement sensorless control when few features are required**
- **dsPIC offers precise control such as:**
 - Variable speed with constant torque, speed and torque control using PI controllers, digital filtering of sensorless inputs, field oriented control for greater efficiency, minimal torque ripple, and quiet operation

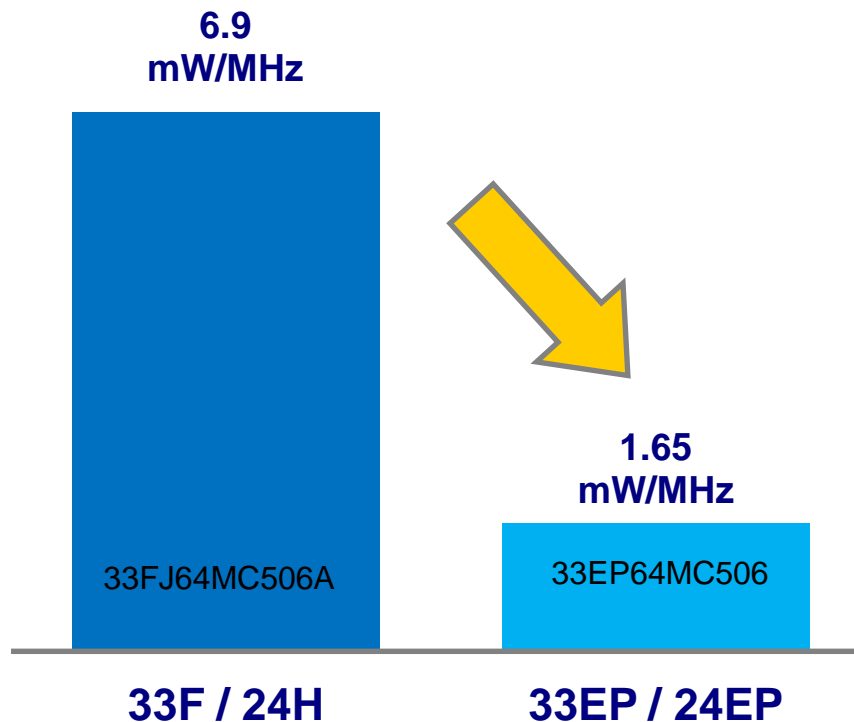


16-bit Motor Control





New dsPIC “EP” Family



76% Lower
Power Consumption

I_{dd} @ 3.3V / 25° C with CPU executing basic code (e.g. loop). Peripherals off & no I/O current included.



Code Compatibility

New dsPIC33E code compatible with dsPIC33F

dsPIC33E Performance Guide shows how to optimize code for the new core! (DS70637)



dsPIC33F
40 MIPS

Code Compatible!

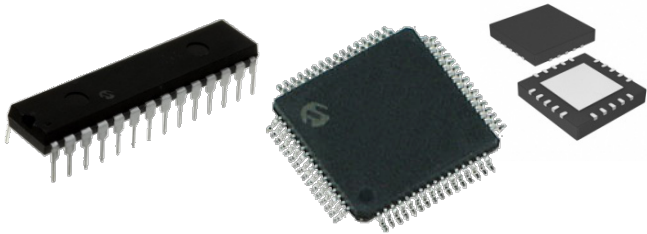


dsPIC33E
70 MIPS

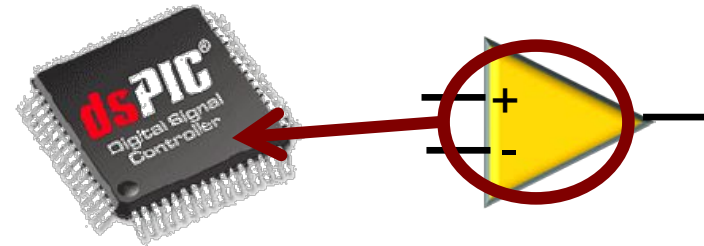


dsPIC “EP” Features

Multiple package options
ranging from 28 to 64 pins
including new 5x5mm
36-pin VTLA package



Integrated Op Amps reduce the
need for external components,
typically saves ~\$1 in costs



CTMU peripheral for touch
sensing or temp measurement

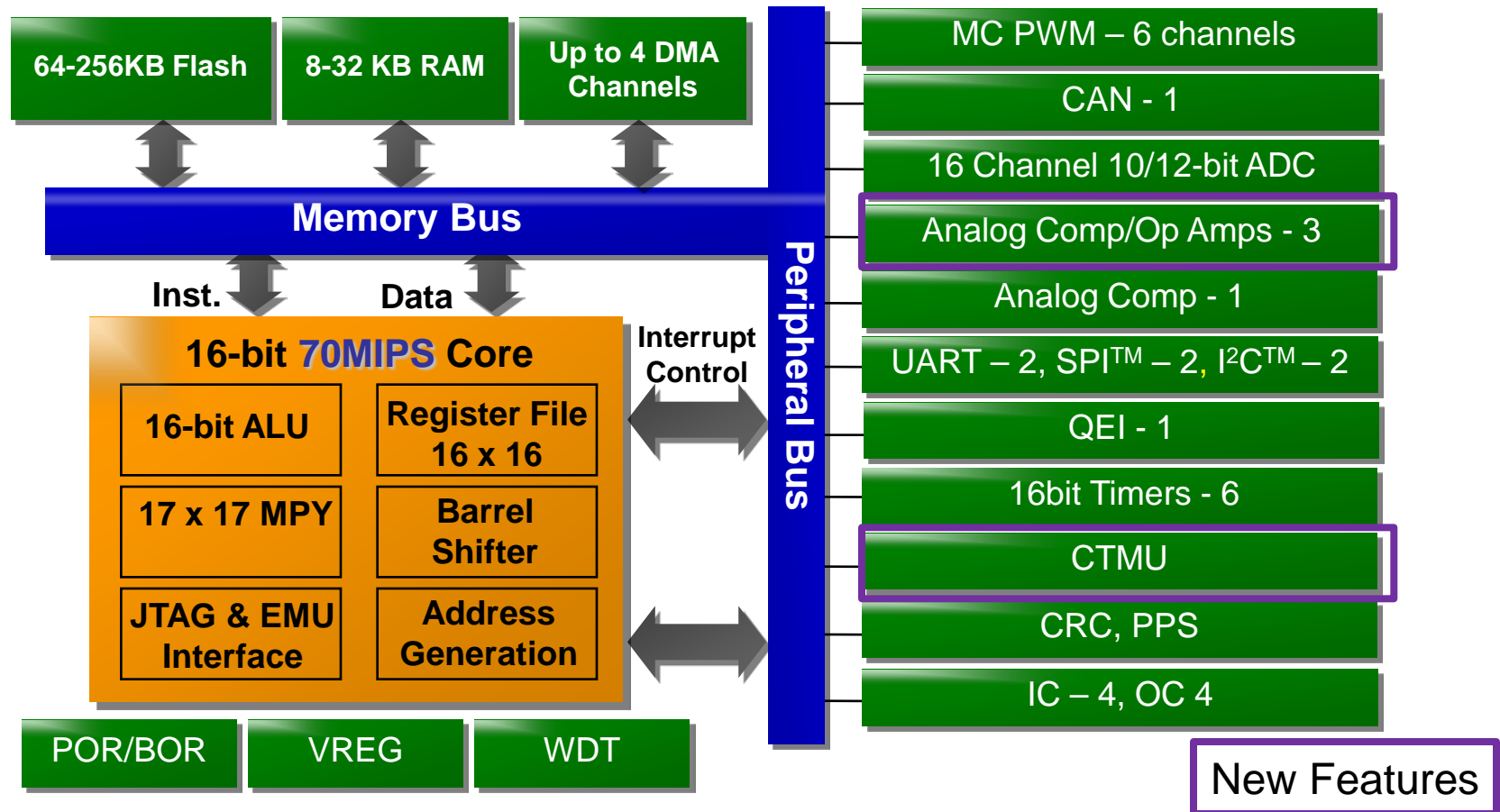


Industry leading PWM
module designed for
motor control





Single Motor Control dsPIC33EP256MC



- 64 and 128KB devices RTP'd and samples available
- 256KB devices RTP-ing by end of the month



dsPIC33EP256GP or MC

2/5

Device	Pins	Flash	RAM	DMA	Timer	IC	OC	MC PWM	QEI	ADC	Comparators	OpAmps	UART	SPI	I2C	eCAN	Other
dsPIC33EPxxxMC202	28	64, 128, 256KB	8, 16, 32KB	4	5	4	4	6	1	6 ch	1 + 2*	2	2	2	1		CRC, PPS, PTG, CTMU, Temp Sensor, OpAmp, 1%FRC, AREF
dsPIC33EPxxxMC502	28	64, 128, 256KB	8, 16, 32KB	4	5	4	4	6	1	6 ch	1 + 2*	2	2	2	1	1	
dsPIC33EPxxxMC203	36	64, 128, 256KB	8, 16, 32KB	4	5	4	4	6	1	8 ch	1 + 3*	3	2	2	1		
dsPIC33EPxxxMC503	36	64, 128, 256KB	8, 16, 32KB	4	5	4	4	6	1	8 ch	1 + 3*	3	2	2	1	1	
dsPIC33EPxxxMC204	44	64, 128, 256KB	8, 16, 32KB	4	5	4	4	6	1	9 ch	1 + 3*	3	2	2	1		
dsPIC33EPxxxMC504	44	64, 128, 256KB	8, 16, 32KB	4	5	4	4	6	1	9 ch	1 + 3*	3	2	2	1	1	
dsPIC33EPxxxMC206	64	64, 128, 256KB	8, 16, 32KB	4	5	4	4	6	1	16 ch	1 + 3*	3	2	2	1		
dsPIC33EPxxxMC506	64	64, 128, 256KB	8, 16, 32KB	4	5	4	4	6	1	16 ch	1 + 3*	3	2	2	1	1	
dsPIC33EPxxxGP502	28	64, 128, 256KB	8, 16, 32KB	4	5	4	4		1	6 ch	1 + 2*	2	2	2	1	1	
dsPIC33EPxxxGP503	36	64, 128, 256KB	8, 16, 32KB	4	5	4	4		1	8 ch	1 + 3*	3	2	2	1	1	
dsPIC33EPxxxGP504	44	64, 128, 256KB	8, 16, 32KB	4	5	4	4		1	9 ch	1 + 3*	3	2	2	1	1	
dsPIC33EPxxxGP506	64	64, 128, 256KB	8, 16, 32KB	4	5	4	4		1	16 ch	1 + 3*	3	2	2	1	1	

* - OpAmps can be configured as comparators



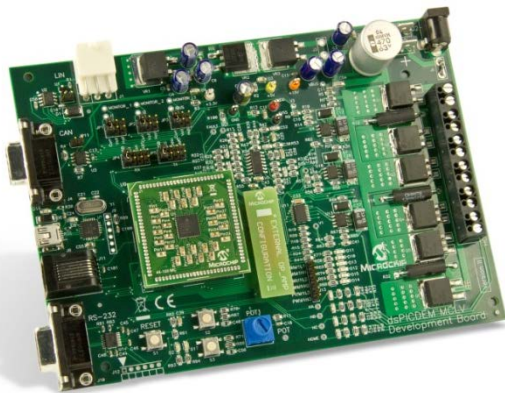
PIC24EP256GP/MC2/5

Device	Pins	Flash	RAM	DMA	Timer	IC	OC	MC PWM	QEI	ADC	Comparators	OpAmps	UART	SPI	I2C	eCAN	Other
PIC24EPxxxMC202	28	64, 128, 256KB	8, 16, 32KB	4	5	4	4	6	1	6 ch	1 +2*	2	2	2	1		CRC, PPS, PTG, CTMU, Temp Sensor, OpAmp, 1%FRC, AREF
PIC24EPxxxMC203	36	64, 128, 256KB	8, 16, 32KB	4	5	4	4	6	1	8 ch	1 +3*	3	2	2	1		
PIC24EPxxxMC204	44	64, 128, 256KB	8, 16, 32KB	4	5	4	4	6	1	9 ch	1 +3*	3	2	2	1		
PIC24EPxxxMC206	64	64, 128, 256KB	8, 16, 32KB	4	5	4	4	6	1	16 ch	1 +3*	3	2	2	1		
PIC24EPxxxGP202	28	64, 128, 256KB	8, 16, 32KB	4	5	4	4		1	6 ch	1 +2*	2	2	2	1		
PIC24EPxxxGP203	36	64, 128, 256KB	8, 16, 32KB	4	5	4	4		1	8 ch	1 +3*	3	2	2	1		
PIC24EPxxxGP204	44	64, 128, 256KB	8, 16, 32KB	4	5	4	4		1	9 ch	1 +3*	3	2	2	1		
PIC24EPxxxGP206	64	64, 128, 256KB	8, 16, 32KB	4	5	4	4		1	16 ch	1 +3*	3	2	2	1		

* - OpAmps can be configured as comparators

Upcoming MC Dev Tools

- New MCLV-2 and MCHV-2 boards will enable customers to use the internal OpAmps on the new dsPIC33EP devices



**MCLV-2
DM330021-2**



**PIM for using internal OpAmps
MA330031**



**PIM for using external OpAmps
MA330031-2**



**MCHV-2
DM330023-2**

Available



Motor Control Software

Over 25 motor control app notes & tuning guides:

Sensorless BLDC and PMSM App Notes

AN1160	Sensorless BLDC control with Back EMF
AN1078	Sensorless Field Oriented Control (FOC) with SMO estimator
AN1292	Dual Shunt Sensorless Field Oriented Control with PLL and Field Weakening
AN1299	Single Shunt Sensorless FOC with SMO sensorless estimator

Sensorless ACIM App Notes

AN1162	Sensorless FOC
AN1206	Sensorless FOC with field weakening

Motor Tuning Guides

AN1160	Sensorless BLDC Back EMF
AN1078/1292	Sensorless PMSM/BLDC FOC with SMO or PLL estimator



MICROCHIP

The dsPIC33F “GS” Series



Igniting the Digital Power Market

Digital Power Benefits

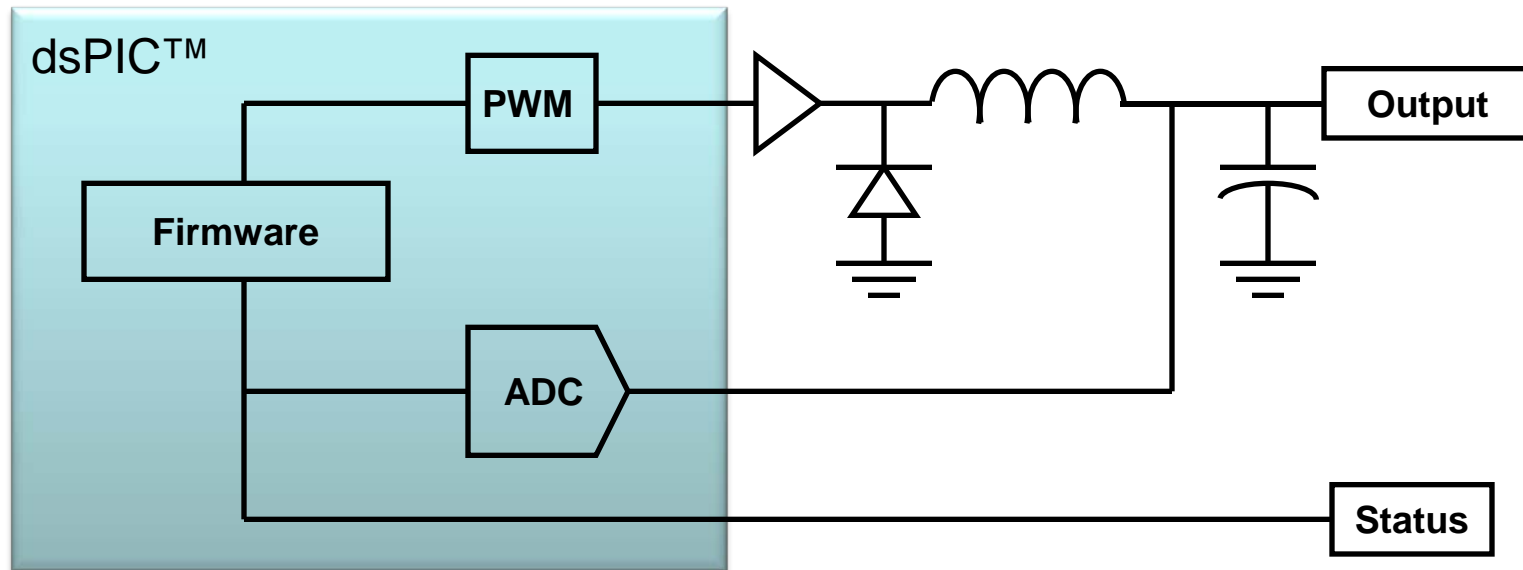
Accelerating Worldwide Adoption

- **Higher Energy Efficiency**
 - Green Design
- **Lower Cost**
 - Fewer components on the board
- **Higher Reliability**
- **Improved Intellectual Property Protection**
 - Hard to copy a full digital control design
- **Improved Transient Response**
- **Flexible design through software**





Digital Loop Architecture Speeding Innovation



- **Analog control is removed and replaced with a fully customizable digital control algorithm**
 - Enables Product Differentiation & IP Protection
 - Increased Efficiency
 - Reduced Cost



Optimized for Digital Power

What Controller Features are needed for Digital Power?

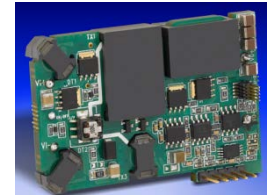
- **DSP Resources + MCU = Digital Signal Controller**

- Low Cost
- Small Size
 - √ As small as 6x6 mm Footprint (Industry's smallest DSC)
- Optimized Peripherals and Flexible Interconnect
 - √ PWM with SMPS Modes, High Resolution, and HW override
 - √ Software-Configurable Peripherals
 - √ Fast (20 ns) Comparators
 - √ Optimal ADC with multiple S&Hs for simultaneous samples

Ability to Adapt to New Innovation is Key!

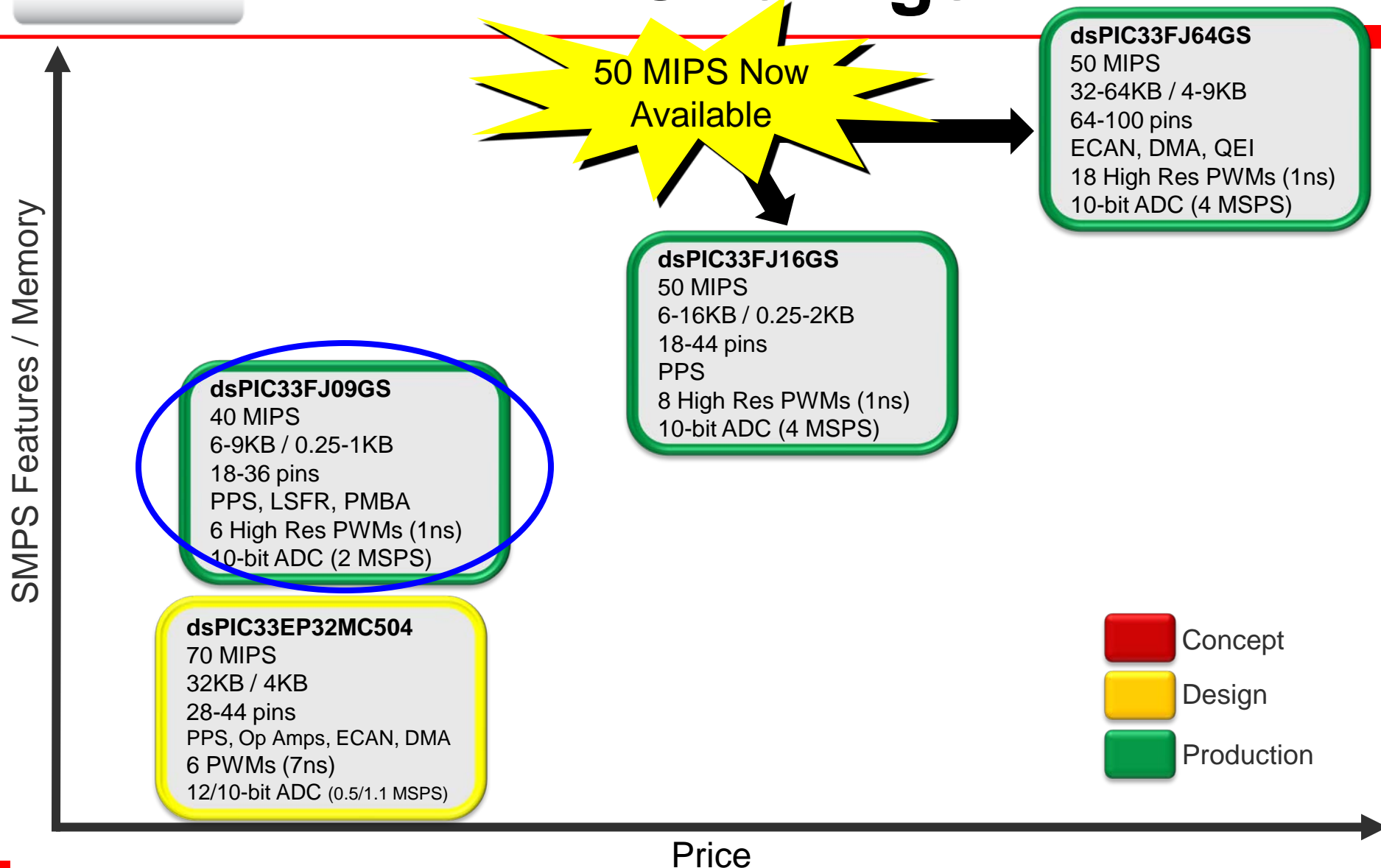
Target Markets & Applications

- **AC – DC Power Supplies**
 - Multi-loop digital switch mode
 - 200W and above
 - Power factor correction (primary-side)
 - Secondary-side digital control
- **DC – DC Power Supplies**
 - ¼ Brick and other small form factors
 - Point-of-load supplies
- **HID & LED Lighting**
 - Projectors
 - Industrial & commercial lighting
 - Automotive
- **Other**
 - Solar inverters
 - Battery chargers
 - Welders
 - Uninterruptible power supplies (UPS)
 - Circuit breakers / arc fault detection





dsPIC Digital Power Offerings





GS Family Expansion

dsPIC33FJ09

- **Five new 40 MIPS devices**
 - 3 overlap dsPIC33FJ06GS devices: will be denoted with “A” suffix
 - 2 new variants (GS001 and GS302)
 - New and improved features
 - Lower power improves system efficiency
 - New 36-pin 5x5 mm VTLA package for compact board designs
 - Lower cost options
 - New MPLAB Starter Kit for Digital Power
 - Uses new GS302

Digital Power for cost-sensitive, low-wattage applications



New Features

dsPIC33FJ09

- **Rail-to-rail inputs for analog comparators**
- **Programmable comparator hysteresis**
- **Extended reference DAC voltage range**
 - Improves signal to noise ratio
- **10 uA current source for PM-Bus address selection**
 - Reduces external components
- **LFSR (random number generator) for dithering PWM**
 - Reduces peak EMI emissions
- **Reduced power consumption**
- **Errata fixes relative to the GS101/102/202**



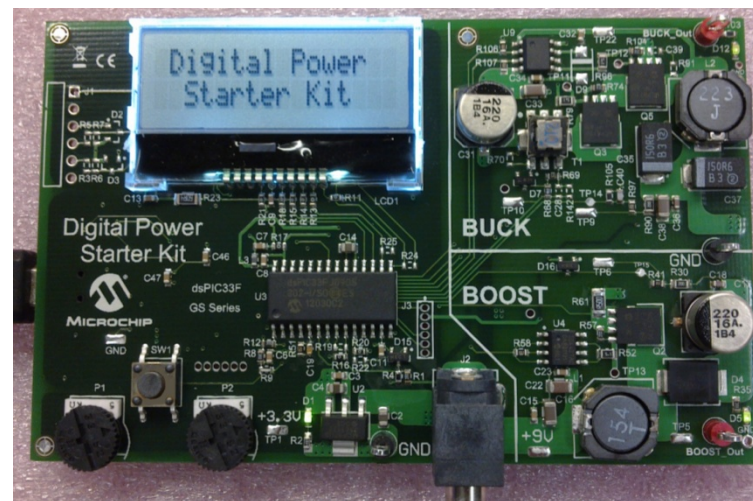
Digital Power Starter Kit

Features:

- Fully Controlled with a Single dsPIC33FJ09GS302-I/SO
- Implements Buck and Boost DC/DC converters
- On-board debugging / Programming via USB
- LED power-on indicator
- On-board Measurement Display, Potentiometers, Resistive Loads & Temperature sensor
- Connector for I2C (PICKit Serial Analyzer)
- Features Microchip Analog components including new Fast MOFETs, Op Amps, and Gate Drivers.

Package Contents:

- Starter Kit PCB (Dimensions 4 x 2.5 inches)
- Info Sheet
- Mini USB cable
- 9V Power Supply

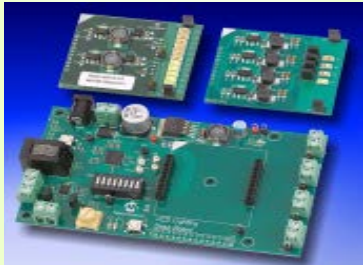


DM330017

SMPS Tools, Libraries and EVMs

Get to Market Quickly

LED Lighting



45W Buck/Boost



300W AC/DC



Solar Micro Inverter



Free PMBus Software



1KW Off-Line UPS



**350W Interleaved
PFC**



**DC/DC LLC
Resonant**

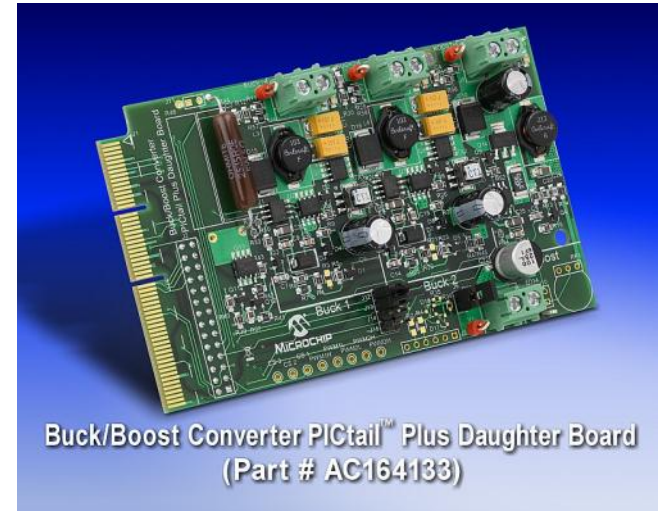


Quarter Brick DC/DC



Buck/Boost Converter Low Cost Development

- PN: **AC164133**
- Prototyping platform to investigate digital power conversion and digital SMPS design
- Supports dual-buck and single-boost stage conversion
- Includes example software for implementing digital dual-synchronous buck converter and boost converter



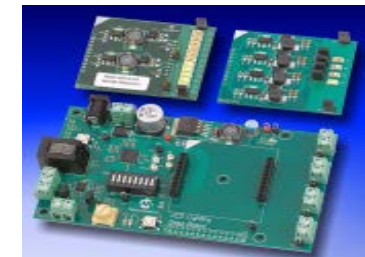
Daughter Board for:

- 16-bit 28-Pin Starter Board
- As well as the modular Explorer 16 Board



Royalty Free Reference Designs

- **All Documentation Online**
 - User Guides
 - Source code
 - BOM, Schematics, Gerber files
- **Digital Pure Sine Wave UPS**
 - Offline UPS system
- **Digital Power Interleaved PFC**
 - Two phase interleaved PFC stage
- **300W AC/DC Power Supply**
 - Digitally controlled AC/DC converter
- **DC/DC LLC Resonant Converter**
 - LLC resonant converter over 95% efficient
- **Quarter Brick DC/DC Converter**
 - Phase shifted full bridge converter in industry standard quarter brick size
- **Solar Micro Inverter**
 - 220Watt grid tied solar inverter
- **LED Lighting**
 - Buck or boost digital LED control system



For more information visit www.microchip.com/smpps



Summary

- Digital power is rapidly growing
- The technology is rapidly evolving requiring a flexible controller
- The dsPIC33F “GS” Series provides the optimal Digital Power solution
 - Power Optimized Features
 - Small Footprint devices available
 - Reference Designs
 - Low Cost Pricing
 - Free Design Tool Software
 - Code Examples
- Microchip MCUs, reference designs, software, and support accelerate any digital power design!

For more information visit www.microchip.com/smpps



GS Family Members

Part Number	P i n s	F l a s h	R A M	M I P S	P W M s	PWM Resolution	I C	O C	ADC Resolution	ADC (MSPS)	ADC Channels	ADC S&H	DAC Outputs	DAC Resolution	PGA or OpAmps	Analog Comparators	U A R T	S P I	I 2 C	E C A N	D M A	16-Bit Timers	External Interrupts	Other	Status
dsPIC33FJ64GS610	100	64K	9K	50/40	9x2	1ns	4	4	10	4	24	6	1	10	0	4	2	2	2	1	4	5	5	1% FRC	Production Today
dsPIC33FJ64GS608	80	64K	9K	50/40	8x2	1ns	4	4	10	4	16	6	1	10	0	4	2	2	2	1	4	5	5		
dsPIC33FJ64GS606	64	64K	9K	50/40	6x2	1ns	4	4	10	4	16	6	1	10	0	4	2	2	2	1	4	5	5		
dsPIC33FJ64GS406	64	64K	8K	50/40	6x2	1ns	4	4	10	4	16	5	0	-	0	0	2	2	2	0	0	5	5		
dsPIC33FJ32GS610	100	32K	4K	50/40	9x2	1ns	4	4	10	4	24	6	1	10	0	4	2	2	2	0	0	5	5		
dsPIC33FJ32GS608	80	32K	4K	50/40	8x2	1ns	4	4	10	4	16	6	1	10	0	4	2	2	2	0	0	5	5		
dsPIC33FJ32GS606	64	32K	4K	50/40	6x2	1ns	4	4	10	4	16	6	1	10	0	4	2	2	2	0	0	5	5		
dsPIC33FJ32GS406	64	32K	4K	50/40	6x2	1ns	4	4	10	4	16	5	0	-	0	0	2	2	2	0	0	5	5		
dsPIC33FJ16GS504	44	16K	2K	50/40	4x2	1ns	2	2	10	4	12	6	1	10	0	4	1	1	1	0	0	3	3	2% FRC PPS	Production Today
dsPIC33FJ16GS502	28	16K	2K	50/40	4x2	1ns	2	2	10	4	8	6	1	10	0	4	1	1	1	0	0	3	3		
dsPIC33FJ16GS404	44	16K	2K	50/40	3x2	1ns	2	2	10	2	8	4	0	-	0	0	1	1	1	0	0	3	3		
dsPIC33FJ16GS402	28	16K	2K	50/40	3x2	1ns	2	2	10	2	8	4	0	-	0	0	1	1	1	0	0	3	3		
dsPIC33FJ06GS202	28	6K	1K	50/40	2x2	1ns	1	1	10	2	6	3	1	10	0	2	1	1	1	0	0	2	3		
dsPIC33FJ06GS102	28	6K	256	50/40	2x2	1ns	0	1	10	2	6	3	0	-	0	0	1	1	1	0	0	2	3		
dsPIC33FJ06GS101	18	6K	256	50/40	2x2	1ns	0	1	10	2	6	3	0	-	0	0	1	1	1	0	0	2	3		
dsPIC33FJ09GS302	28/36	9K	1K	40	3x2	1ns	1	1	10	2	8	3	1	10	0	2	1	1	1	0	0	2	3	2% FRC, PPS, PMBA Current Src Rail-to-Rail CMP	Production Today
dsPIC33FJ06GS202A	28/36	6K	1K	40	2x2	1ns	1	1	10	2	6	3	1	10	0	2	1	1	1	0	0	2	3		
dsPIC33FJ06GS102A	28/36	6K	256	40	2x2	1ns	0	1	10	2	6	3	0	-	0	0	1	1	1	0	0	2	3		
dsPIC33FJ06GS101A	18/20	6K	256	40	2x2	1ns	0	1	10	2	6	3	0	-	0	0	1	1	1	0	0	2	3		
dsPIC33FJ06GS001	18/20	6K	256	40	2x2	1ns	0	0	10	2	6	2	0	-	0	2	0	0	1	0	0	2	3		



MICROCHIP

mTouch™ Sensing Solutions

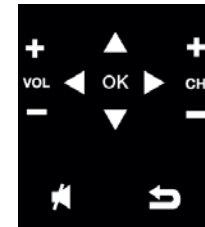




Typical Human Interface System Features

- **Input features**

- Keypad, Switches, Buttons
- Touch sensitive keys
- Touch-screen



- **Output features**

- Segmented or Graphical LCD
- LEDs
- Buzzers, Speakers



- **Communication Protocols**

- USB, RF Wireless, IrDA, CAN, RS-232





mTouch™ Solutions

Keys, Sliders & Proximity Sensing



Touch Screen Controllers



Integrated *USB, LCD & Graphical Display* options





MICROCHIP

mTouch™ Keys & Sliders





One-Stop Shop for Touch Sensing

- **Industry's broadest portfolio**
- **Industry's lowest power touch solution**
- **High robustness to noise & low emissions**
- **Works through most surfaces – glass, plastic, metal (stainless steel, aluminum)**



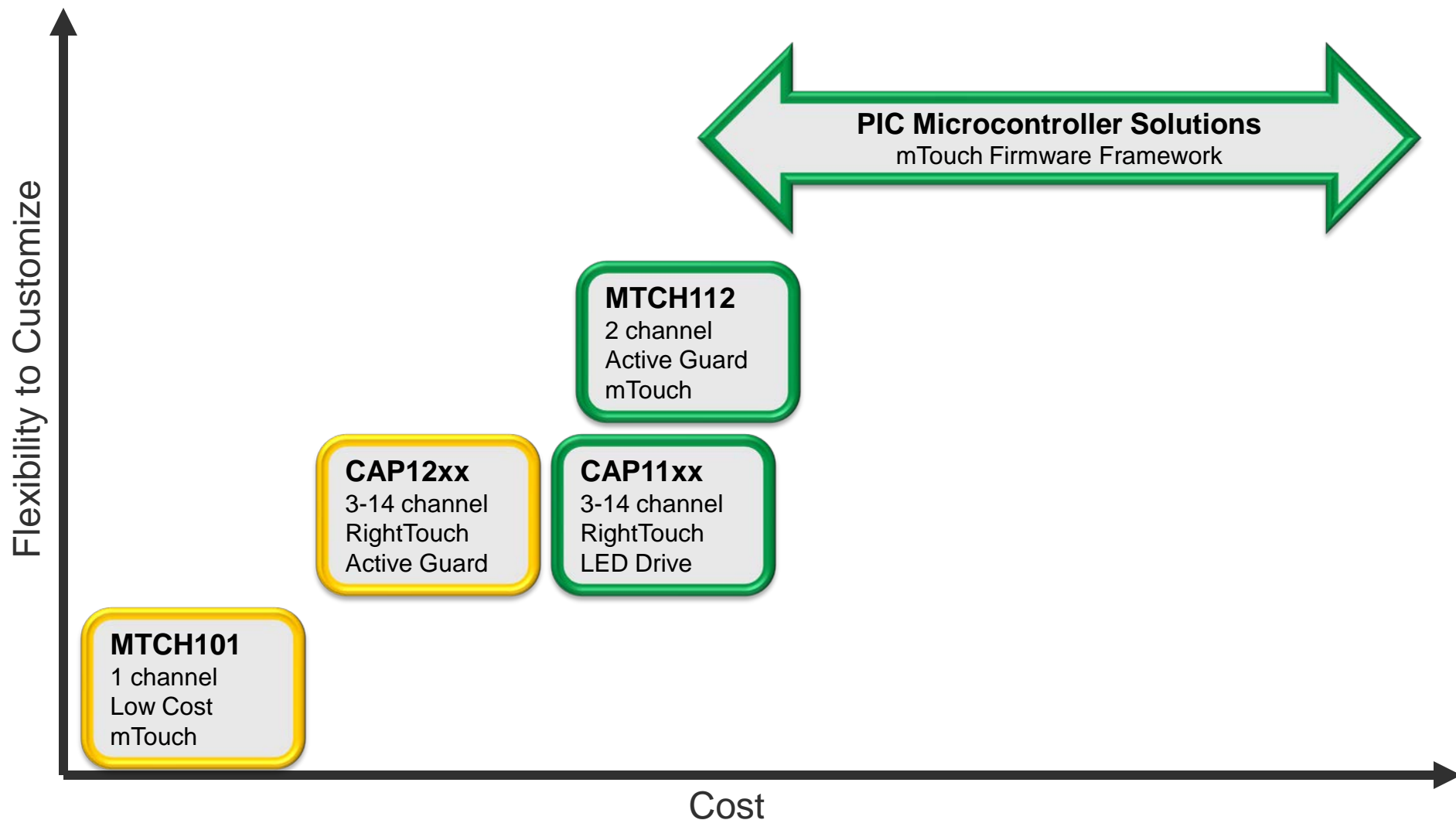
Low Power Touch Sensing

- Increase your Battery Life
- Lower current in standby mode
- $<5\mu\text{A}$ touch-sensing with PIC[®] MCUs
- eXtreme Low Power (XLP) technology on many MCUs
 - Sleep current down to 9nA
 - Active current down to 30 $\mu\text{A}/\text{MHz}$
 - Real-Time Clock current down to 400 nA



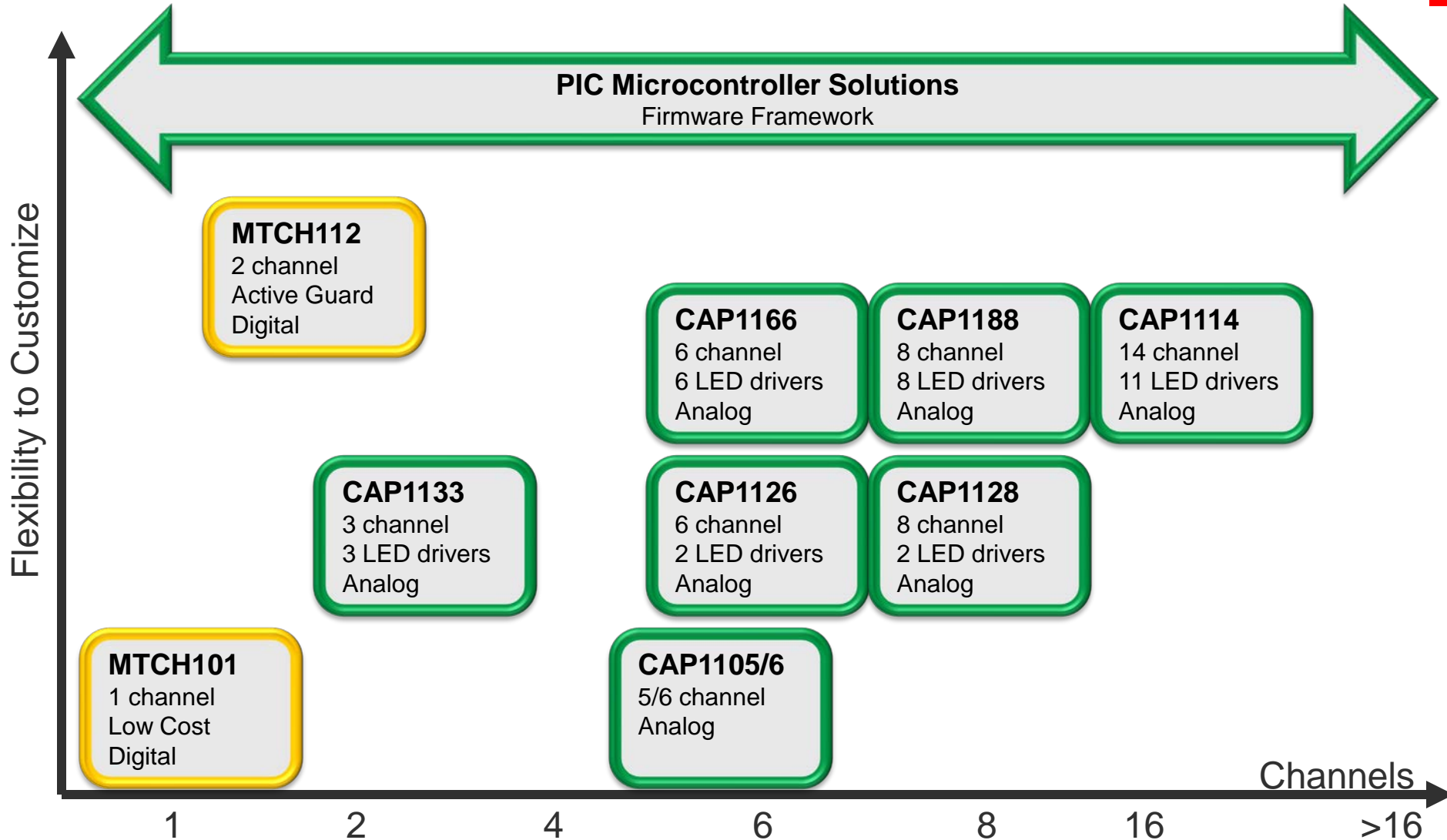


Proximity, Keys, and Sliders mTouch and RightTouch



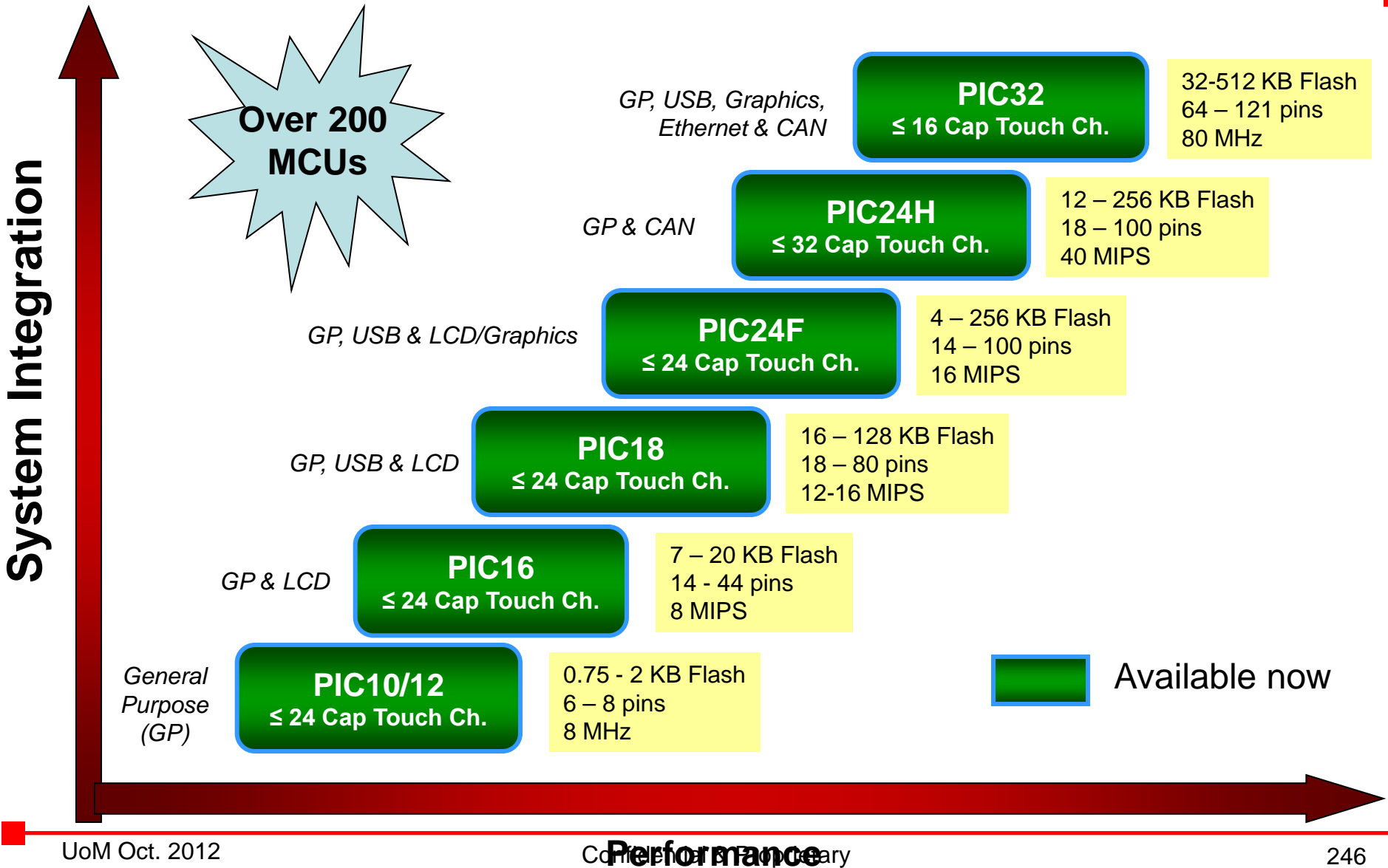


Proximity, Keys, and Sliders mTouch and RightTouch





Capacitive Touch MCU mTouch Portfolio Overview





General Guidelines

RightTouch

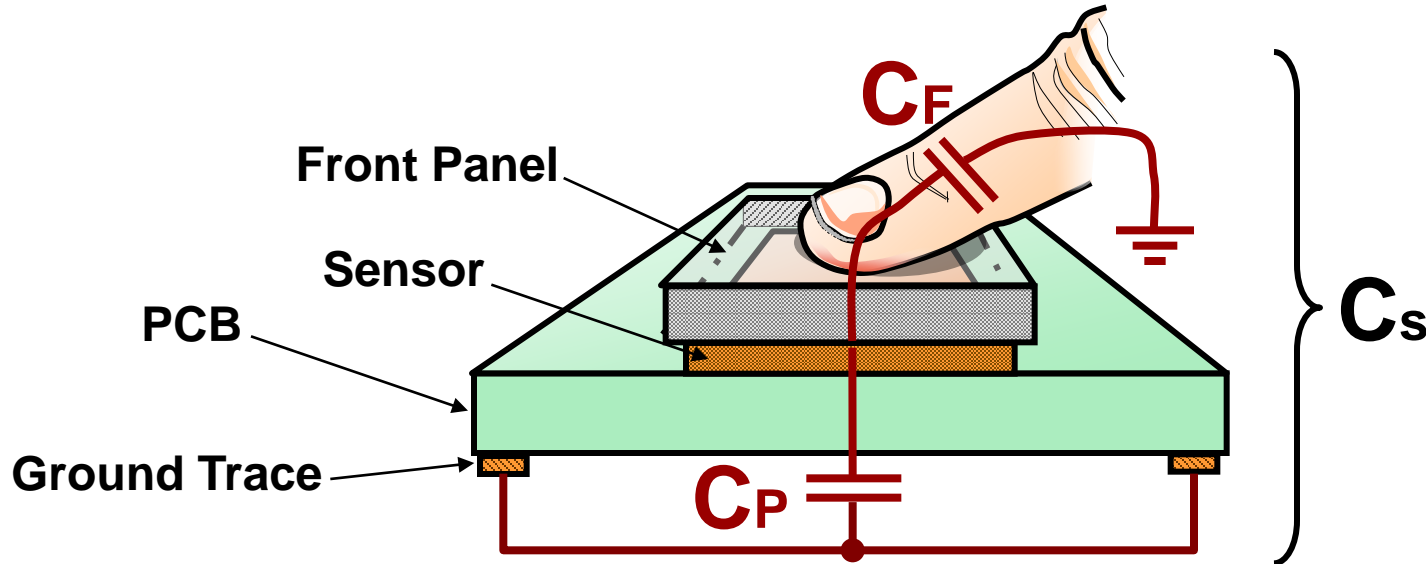
- No firmware experience
- Analog design engineer
- No system integration value
- Lowest device cost
- Not low power focused
- Just want touch function
- 3 to 14 Channels
- Simple/Basic implementation

mTouch

- Firmware experience
- Digital design engineer
- Wants to integrate other functions
- Lowest system cost
- Low power is important
- Want to customize
- Larger key count
- Complex interactions between prox, sliders and keys

Capacitive Touch Principle

Introduction of a finger produces a parallel capacitance (C_F)



C_P is the Parasitic capacitance
 C_F is the Finger capacitance
 C_S is the total Sensor capacitance

$$\text{Sensor Capacitance } (C_S) = C_P + C_F$$

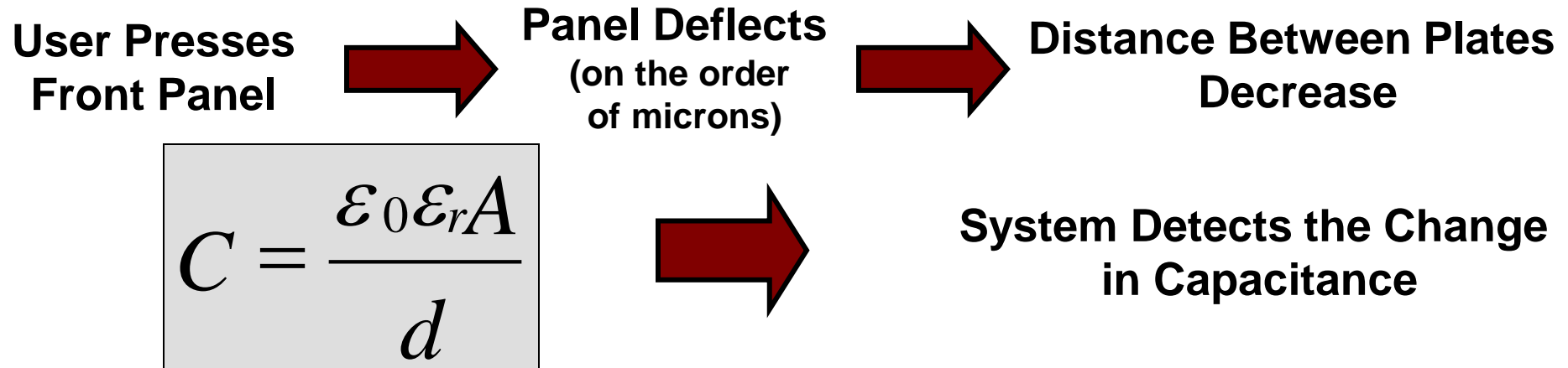
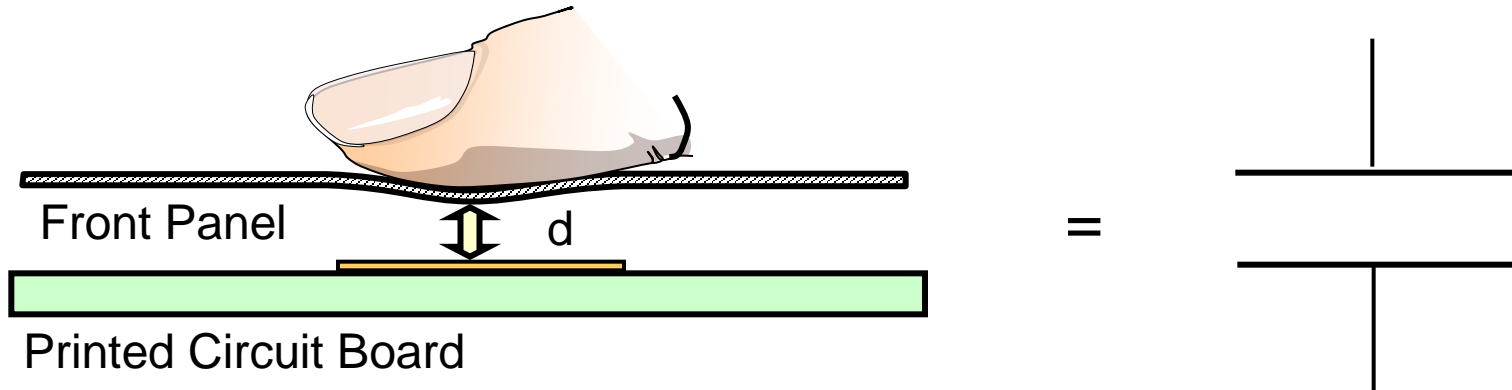


Metal-over-Cap Technology

- In addition to plastic and glass, sense through *stainless steel, aluminum*, and more
- *Completely waterproof*
- Through thick *gloves*
- With the advantages of our Capacitive mTouch technologies, such as *low power* and *low cost*

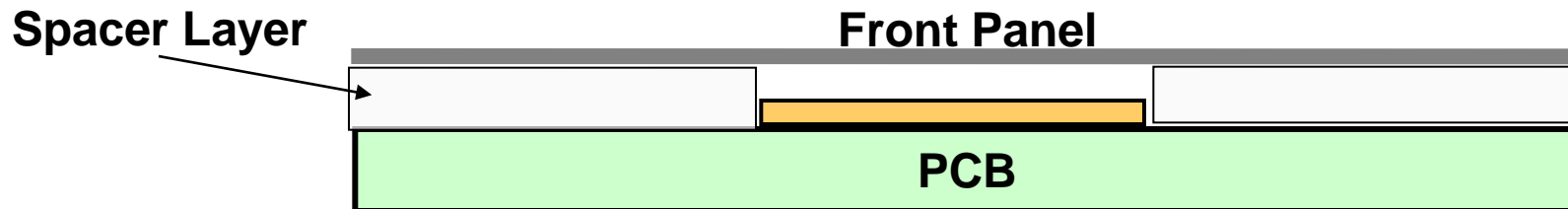


How does it work?



Simple Mechanical Construction

- **The only difference is the introduction of a spacer layer to allow the deflection of the front panel**
 - It needs to be non deformable
 - Thickness must be between 50um and 150um
 - The most common materials are Glue, FR4 or Mylar
- **The Front panel can be metal, plastic with metal flash/coating...**





Metal-over-Cap Applications



- **Appliance**

- Aesthetics of Stainless Steel Finish
- Sealed and waterproof

- **Automotive**

- Aluminum Finish
- Tactile Feedback

- **Medical**

- Cleanliness

- **Industrial**

- Vandal proof
- Robust for outdoor environments
- Works with Gloves

- **Consumer**

- Aesthetics
- Braille
- Low Cost
- Low Power

Getting Started

- **mTouch™ Capacitive Touch Evaluation Kit**
- **4 PIC® MCU-specific Motherboards**
 - One each PIC16, PIC18, PIC24F and PIC32
- **4 Sensor Daughter Boards**
 - 2-Channel Slider
 - 4-Channel Slider
 - 8 Keys Direct Sense
 - 12-Key Matrix
- **PICkit™ Serial Analyzer**
 - Program & Debug
- **mTouch Diagnostic Utility**



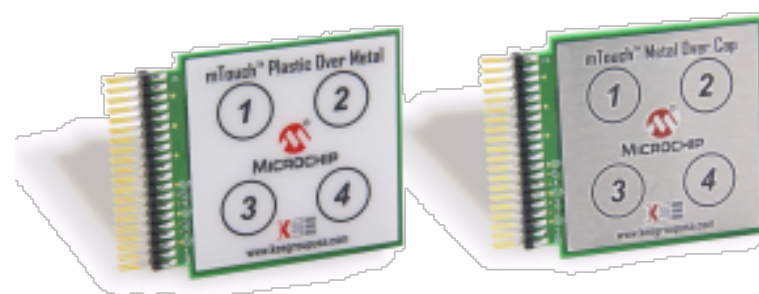
Orderable PN: **DM183026-2**



Metal Over Cap Accessory Kit



- **Contains 2 Daughter boards**
 - Plastic Cover
 - 0.25 mm Polycarbonate with silver printing on the back
 - Metal Cover
 - 0.5 mm Stainless Steel etched on the back
- **Demo SW for mTouch Eval Kit**
 - Included in [Microchip Applications Library](#)
- **P/N: [AC183026](#)**
- **Available now!**



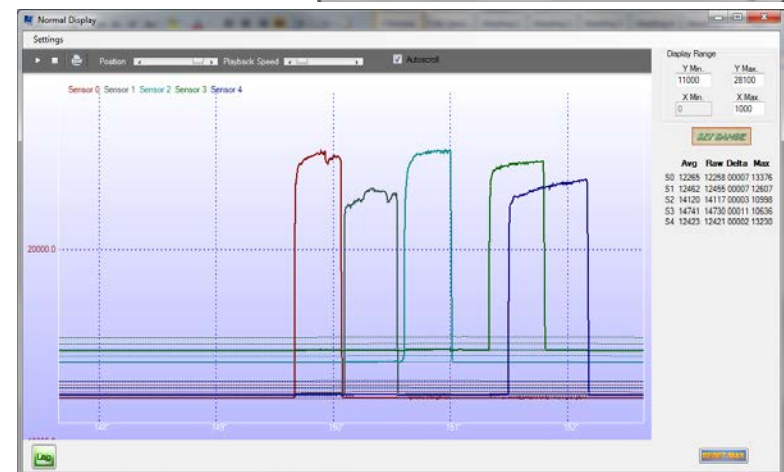
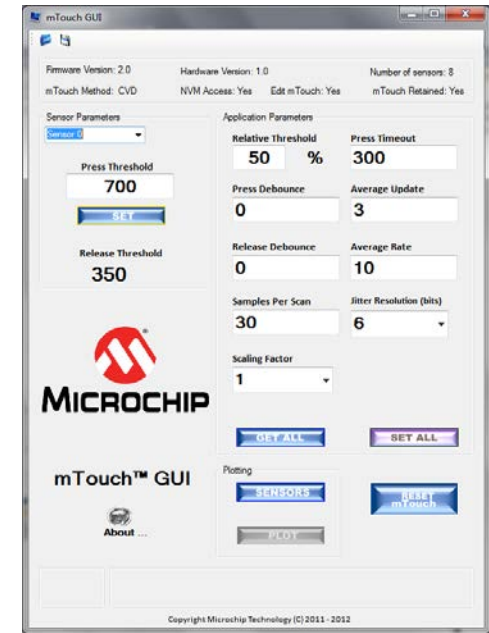
**Metal Over Cap Accessory Kit
(Part # AC183026)**



Keys/Slider Graphical User Interface (GUI)

Package, allows engineer to:

- **Use Evaluation Kit or Custom Boards**
 - UART or USB interface Supported
- **Monitor Sensor's data**
 - Real Time Data
 - Max/Min
 - Calculate Signal To Noise Ratio
- **Easily set up Thresholds**
- **Record and Export data to CSV format for further analysis**



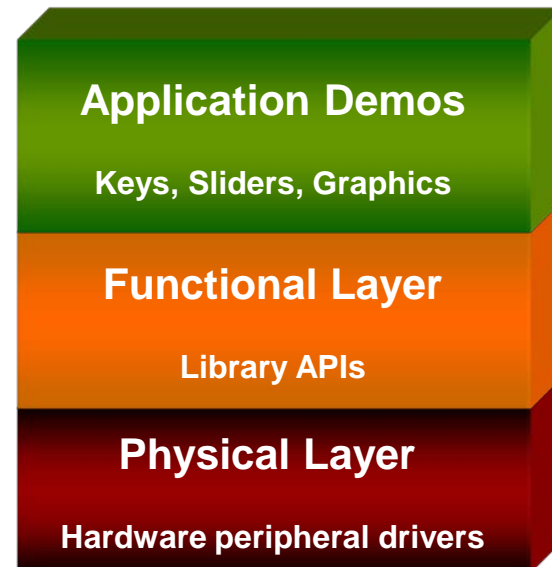
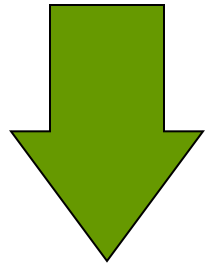


mTouch™ Cap Software Library

(source code included)

- **Easily integrate Touch interface into your application**
- **Interoperable with other libraries (Graphics, USB)**
- **Speed up time to market**
 - Hardware drivers & sensing algorithm implemented
 - Common interfaces implemented
 - Easy migration from one PIC® MCU to another
- **Demonstration projects in v1.2 include:**
 - 2-channel & 4-channel slider, Matrix key pad
 - Swiping gesture of 2 or more keys
 - Proximity detection using key matrix
 - Graphics Display + 5 touch keys on DM240312
 - Demos run on mTouch Capacitive Evaluation Kit
- **Version 1.2 supports PIC18 & PIC24F MCU**
 - Support for PIC24H & PIC32 in future

Download
Now!





Microchip Capacitive Technology Overview

- **Solutions for a wide range of applications**
- **Access to algorithms for ease of design and more advanced options**
- **Easy integration and migration path via broad PIC[®] MCU portfolio**
- **Robust noise performance**
- **Low Power Performance**
- **Smallest Package Options**



MICROCHIP

Touch Screen Controllers



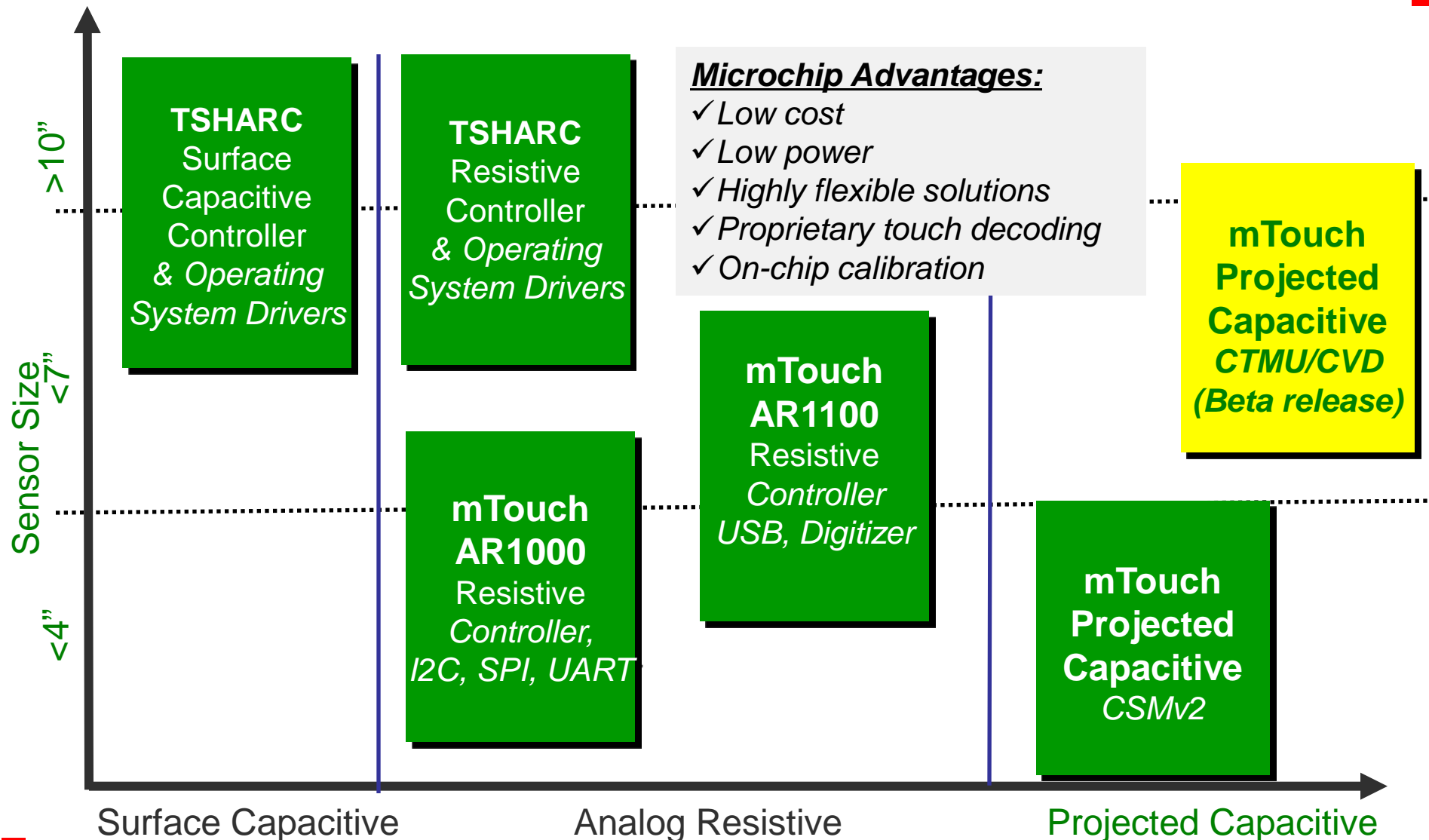
Fixed Location Buttons

- **Low Cost Single Layer ITO**
- **Same SW as Buttons**
 - Easy implementation
- **Single Micro**
 - PIC16F19XX for LCD
 - PIC24FJXXXDA2XX





Touch Screen Controller Portfolio





Touch Screen Technology Comparison

NEW

	Analog Resistive	Projected Capacitive
Cost for screen < 6"	Lowest	Low
Cost for screen > 10"	Lowest	High
Optics	75%	90%
Screen Life	Good	Better
Ease of Integration	Easy	Moderate
Multi-Touch	Limited	Yes
Touch Object	Finger Stylus/Glove	Finger
Availability	Now	Now



MICROCHIP

mTouch™ Projected Capacitive Solutions



Projected Capacitive User Interface Example Applications

- Appliances
Automotive
- GPS & Navigation Devices Mobile Phones
PDAs & MP3 Players
Security Control Panels
- Printers
- Remote controls
- Thermostats
Gaming



Any application with < 4" finger input device



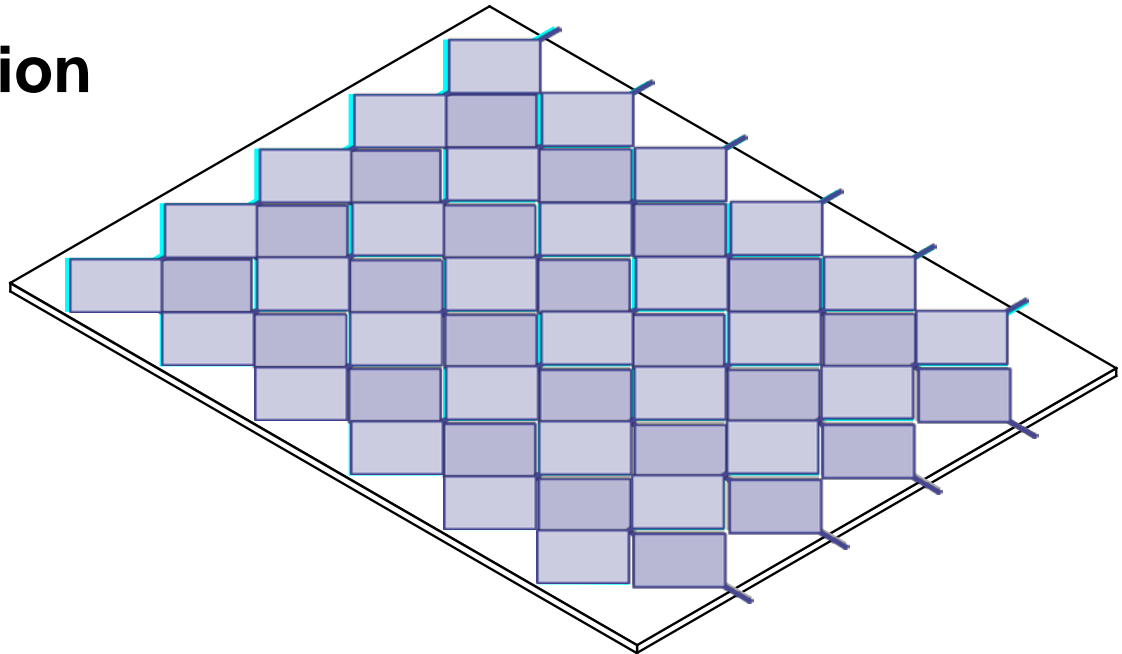
Microchip's mTouch™ Projected Capacitive Solution

- **Royalty-free source code license**
- **High Flexibility**
 - Support for variety of screen sizes
- **Low Power**
 - *Voltage Range: 1.8 – 5.5V*
 - *I_{DD} 1.5 mA at 5V typical*
- **Low Cost Implementation**



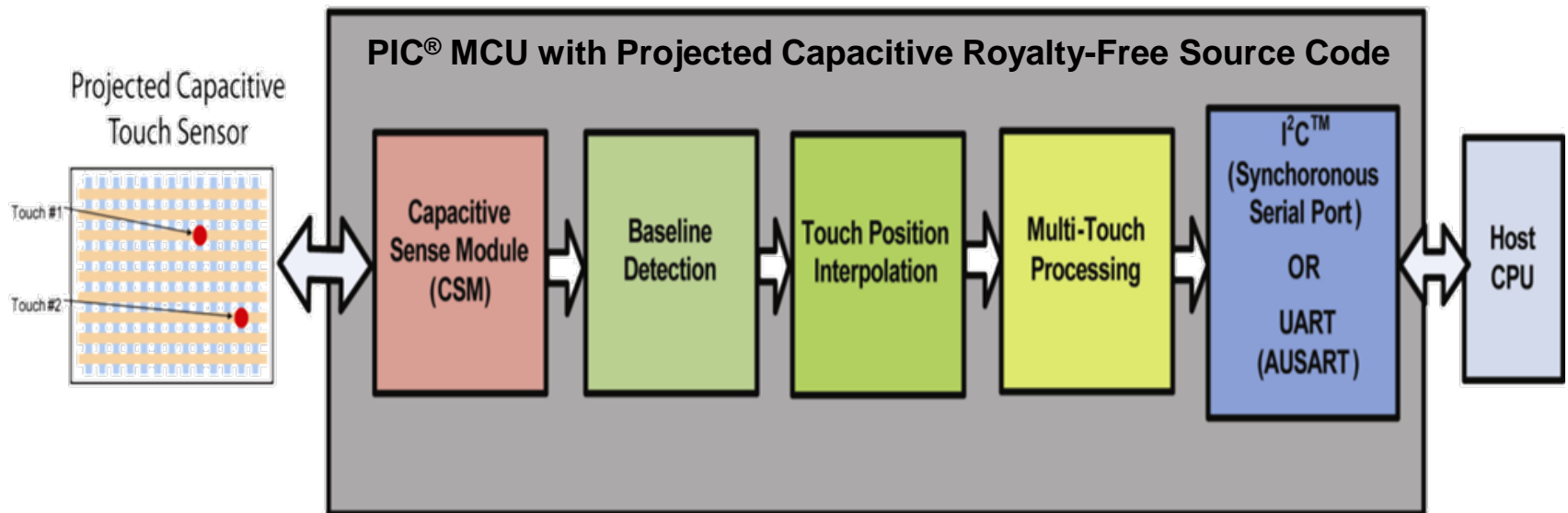
Projected Capacitive

- Point of contact identified by change in capacitance of row and column cells
- Scan along each axis (Self)
- Determine intersection of high capacitance lines (Mutual)
- Inter-bar interpolation



Projected Capacitive Solution

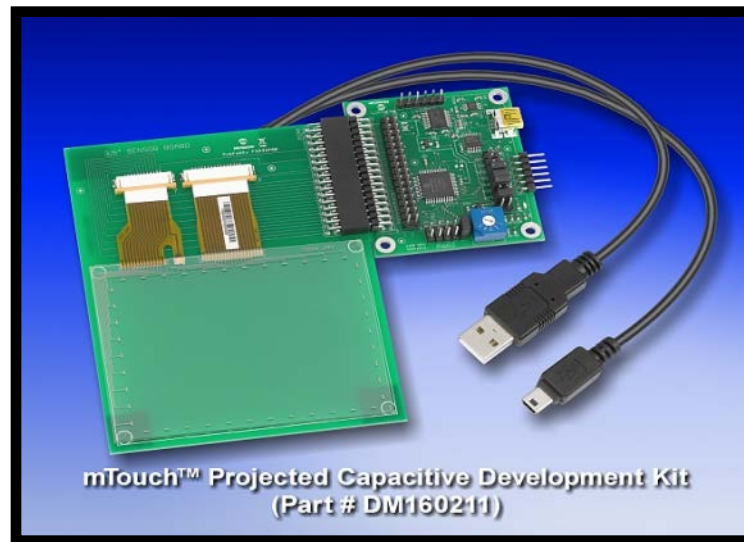
- No external components required
- Valid, filtered touch locations transmitted to host
- No additional data processing needed by host





mTouch™ Projected Capacitive Development Kit

- PN: DM160211
- Processor Board with fully functional firmware on PIC16F707
- Sensor Board with 3.5" PCap 12 x 9 Touch Screen
- Software GUI Development Tool



Specification	Description
Touch-Screen Support	3.5", independent, real time XY tracking for up to 2 touches
Channels	12 x 9, 108 nodes software expandable to 24 channels, 144 nodes
Response Time	Typical <15 ms
Report Rate	Single Point 65 pps, Two Points 55 pps
Power Consumption	Operating 1.5 mA at 5V, sleep 20 μ A typical
Resolution	128 bar-to-bar, scaled to 1024 x 1024



MICROCHIP

Analog Resistive Controllers



Analog Resistive Applications

Universal Touch-Screen Controllers Provide Fully Processed, Reliable Touch Coordinates for a Variety of Consumer, Industrial and Medical Applications

- **Appliance/Home**

- Kitchen Recipe Reader
- HVAC controls
- Security systems



- **Consumer & Automotive**

- Fitness Equipment
- Remote controls
- Mobile communication
- GPS & Navigation Systems



- **Medical**

- Glucose monitors
- Patient monitoring equipment



- **Industrial Automation & Office**

- Industrial controls
- Printers



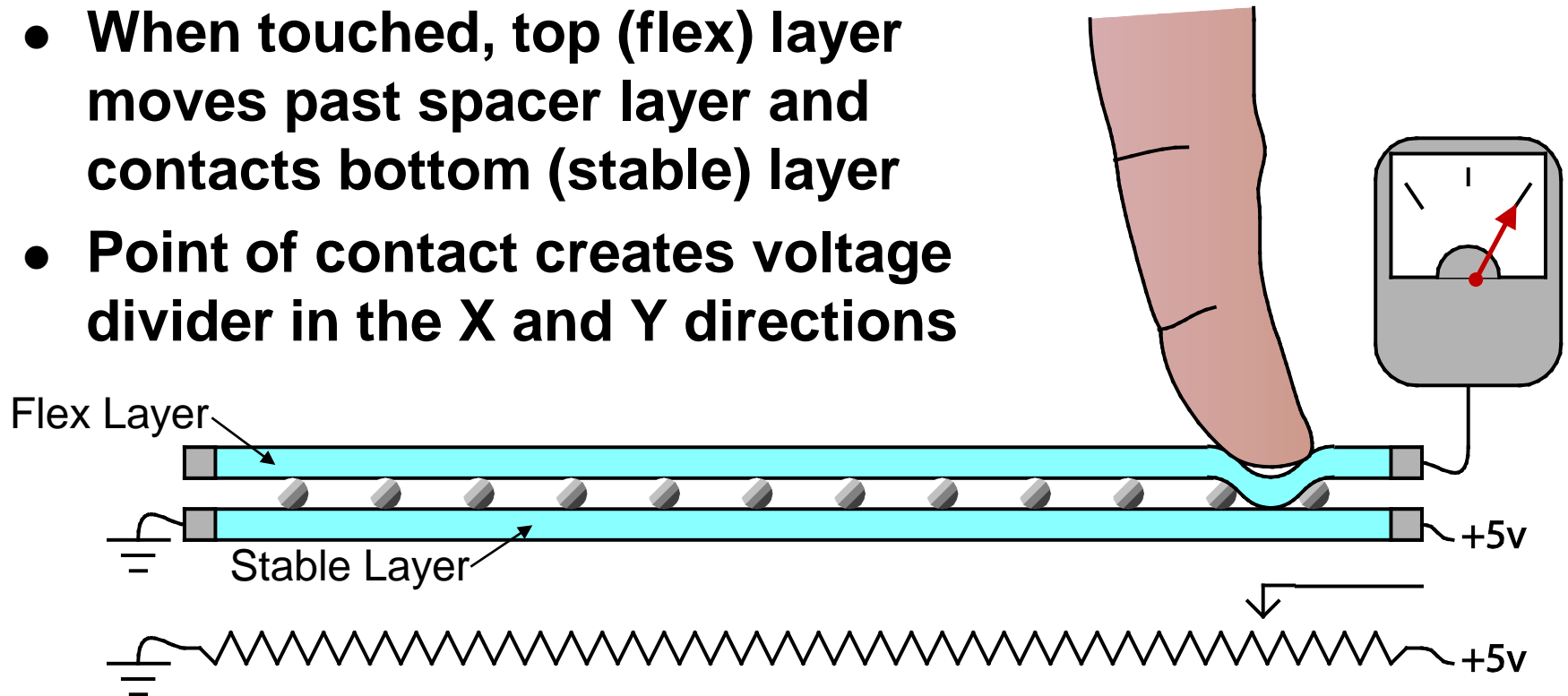
- **Retail Point-of-Sale**

- Cash registers
- ATM
- Kiosks
- Commercial Scales



How Analog Resistive Works

- Two layers of Indium Tin Oxide (ITO) on polyester separated by a spacer layer
- When touched, top (flex) layer moves past spacer layer and contacts bottom (stable) layer
- Point of contact creates voltage divider in the X and Y directions





Analog Resistive Overview

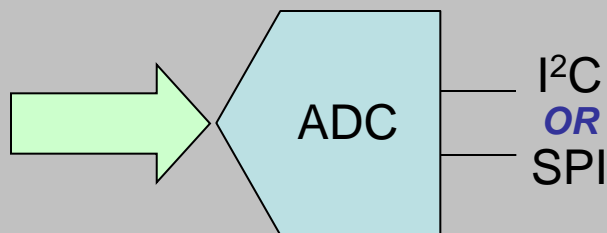
	4 Wire	5 Wire	8 Wire
Linearity	Very Good	Least Linear	Very Good
Power	Low	Medium	Low
Bus Bar Size	Thin	Medium	Wide
Drift Susceptibility	Susceptible	Susceptible	Senses & Compensates ♦
Durability	Medium	High ♦	Medium
Cost	Low ♦	Medium	Medium
Suppliers	Many	Many	Fewest

- 4 wire is the low cost/ high volume solution
- 5 wire improves durability
- 8 wire helps adjust for environmental drift conditions

Analog Resistive Touch Screen Controllers

Interface
Typical 4-wire only

Competition

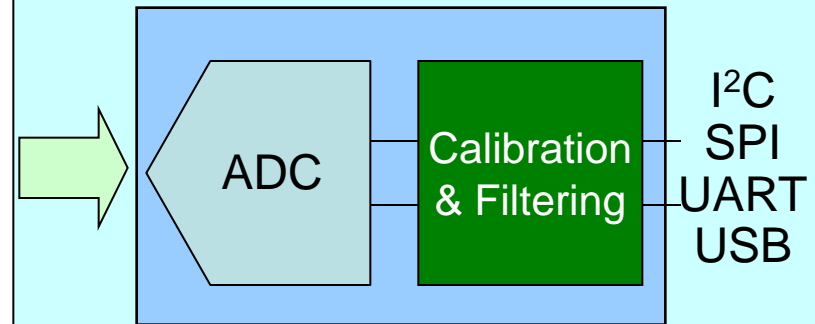


Basically an ADC...

- **No** Calibration
- **No** Filtering
- **Not** Universal, requires code rewrite
- **Risk** associated with development
- **Higher** system power, host dependent

Interface
4,5 and 8 wire

Microchip AR1000 Family

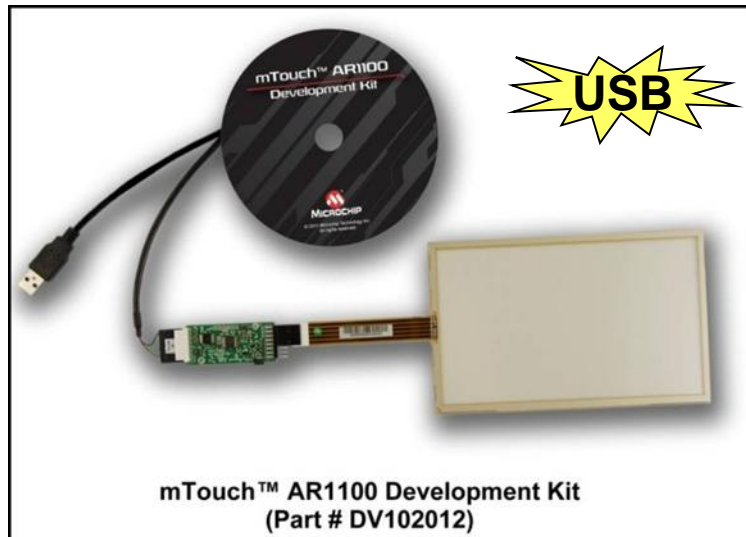


Turnkey Solution...

- ✓ **Calibration**
- ✓ **Filtered, valid** touch coordinates
- ✓ **Universal**, supports all 4/5/8 wire sensors
- ✓ **Proven plug and play** design
- ✓ **Low system power** - touch to wake up

Getting Started

- Everything needed to easily evaluate resistive touch screen controllers
- 7" touch screen sensor & all necessary cables
- Easy-to-use configuration utility with GUI





Why AR1X00?

- **Controller-driven calibration**
 - *No need for calibration calculations*
- **Eliminates need to write touch code**
- **Supports all 4/5 and 8 wire sensors**
- **Low power**
- **Works right out the box**

Faster Development, Lower Risk and Lower Power



Summary

- **Broad portfolio includes solutions for**
 - Keys, Sliders & Proximity Sensing
 - Works through Metal
 - Touch Screen Controllers
 - Analog Resistive & Projected Capacitive
- **Lowest Power**
 - Award-winning XLP technology
- **High System Integration**
 - Touch integrated with Display, USB, CAN
- **High Flexibility**

www.microchip.com/mtouch

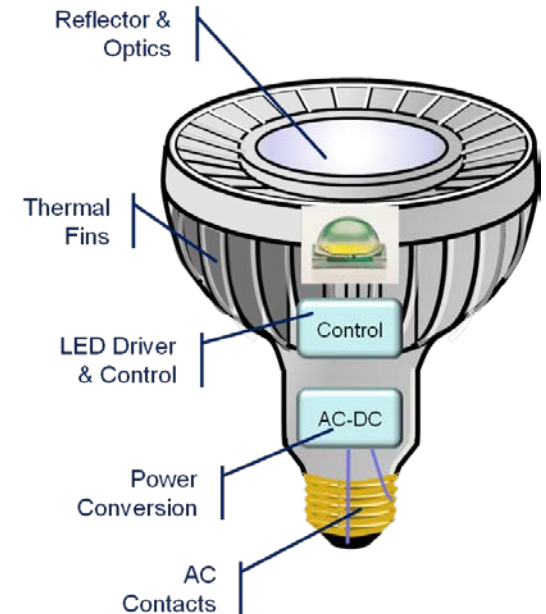


LED Lighting

Control Solutions

LED Lighting Advantages

- **Best Overall Efficiency**
 - ~75% less energy than incandescent
 - ~25% input energy = light
 - 60 → 100++ lumens/watt (efficacy)
- **Long Life: >50,000 hours**
- **No “warm-up” required**
- **Minimal Radiated Heat**
- **Both indoor and outdoor applications**
- **Opportunity to provide additional intelligence**





LED Lighting Issues

- **Still relatively expensive**
- **Color shades vary from LED to LED**
 - Requires electronic drive to initiate & maintain constant voltage/current across LED
 - Dimming an LED with less current affects color
- **LEDs are low voltage devices that require constant current rather than voltage**
 - PWMs can provide the constant current required to control light output w/o effecting the color shade
- **May require thermal solution to remove conducted heat**



Market Challenges

- **Transitioning from incandescent designs**
 - Industry dominated by system integrators
 - Lack of technical expertise in MCU based designs
- **Educating market of MCU capabilities**
- **Increasing competitive landscape**
- **Evolving standards & regulations**
- **Perceived cost barriers of ASIC versus MCU**

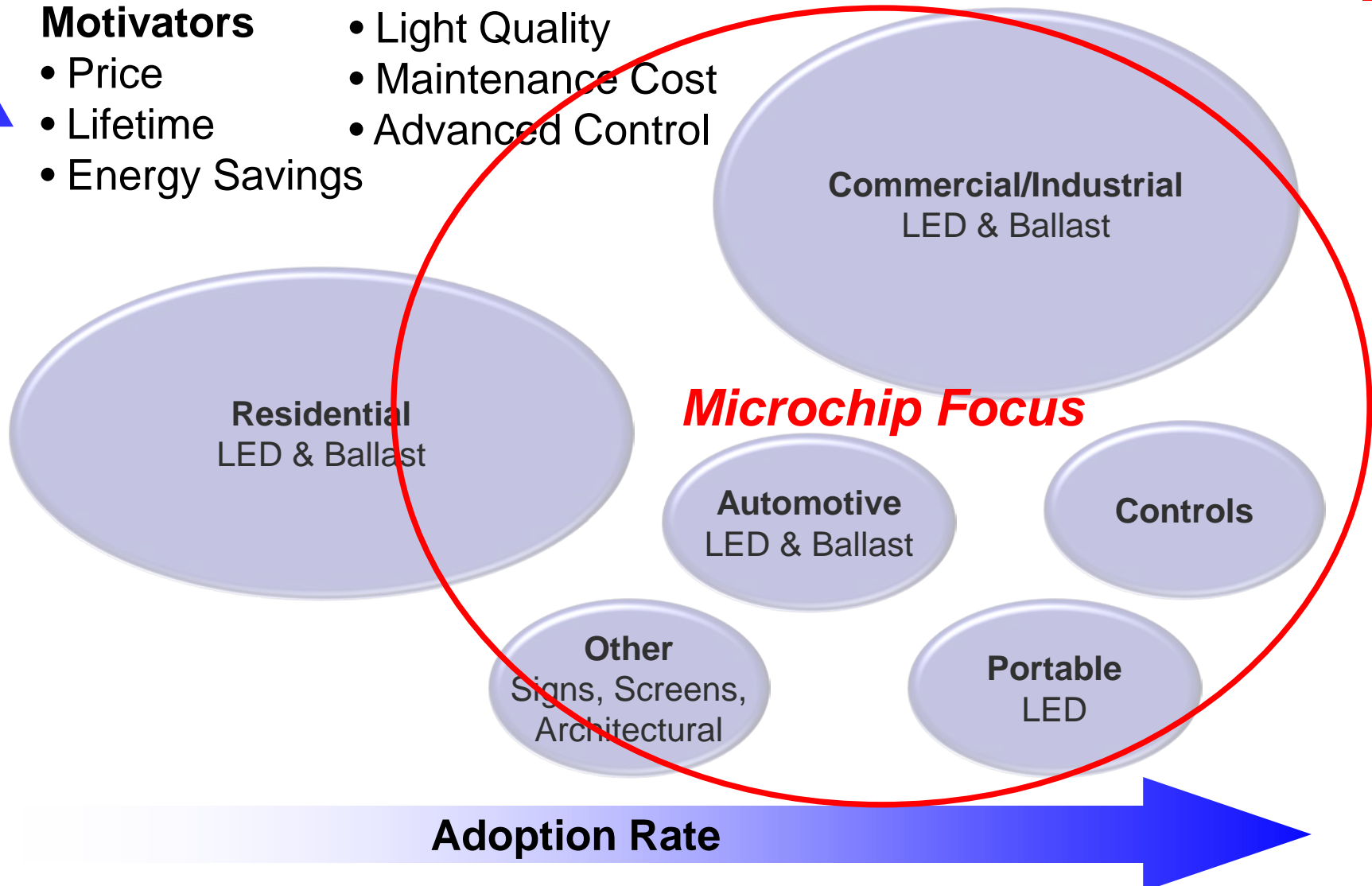
The opportunity for “LED Lighting” extends beyond simply turning the light on and off

Target Markets

Motivators

- Price
- Lifetime
- Energy Savings
- Light Quality
- Maintenance Cost
- Advanced Control

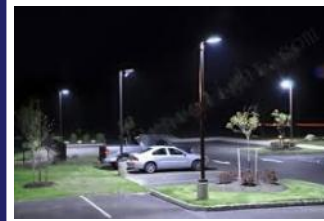
Relative Market Size



Adoption Rate

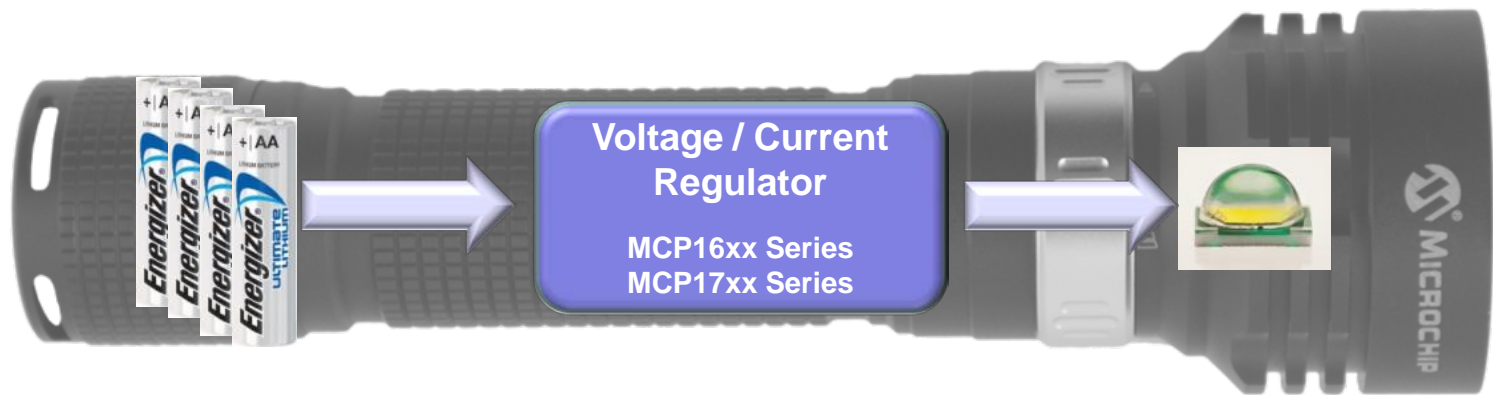
Target Markets & Applications

- **Indoor Lighting**
 - Commercial / Industrial
 - Residential
- **Outdoor Lighting**
 - Streetlamps / Parking
 - Pedestrian / Traffic
 - Landscape
- **Automotive Lighting**
 - Interior Ambient
 - Head & Tail Lamps
- **Portable Lighting**
 - Flashlights / Headlamps
- **Specialty Lighting**
 - Video Screen / Signage
 - Architectural / Emergency
- **Lighting Controls**
 - Wall mount
 - Remote (PC, phone, etc.)



Simple LED Lighting

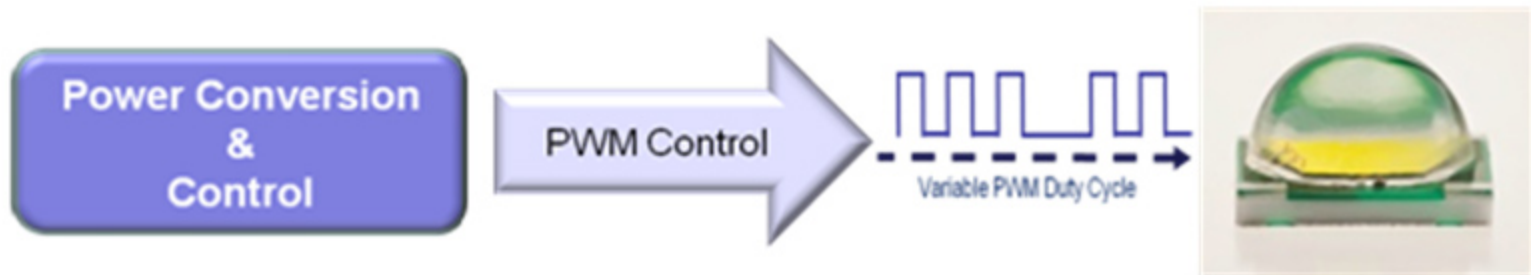
- Simplest solution requires only a standalone voltage regulator
 - Low-voltage: MCP16XX
 - Higher voltage: MCP17XX



- Beyond simple on/off control requires the addition of intelligence (ie. An MCU)

PWM Control

- Fixed current drive chopped by PWM
- Dimming control via varying PWM duty cycle



- **PWM controlled LED drivers can provide dimming and color mixing by:**
 - Providing a high resolution PWM (or variants such as VFM – Variable Frequency Modulation) signal
 - Varying the constant current

High Resolution PWM

Microchip Patent

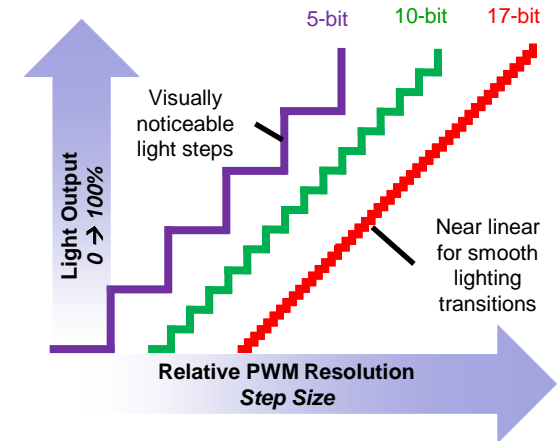
- **HRPWM → High Resolution PWM**

- Increases number of steps between power levels
- More accurate color mixing & color temp control
- Provides “smoother” dimming & brightness control

- **High Switching Frequency**

- Higher frequencies permits use of smaller inductors and capacitors
 - *Reduced BOM cost*
 - *Improved EMI*

Implemented via the NCO + CLC peripherals available on PIC10F32X, PIC16F150X

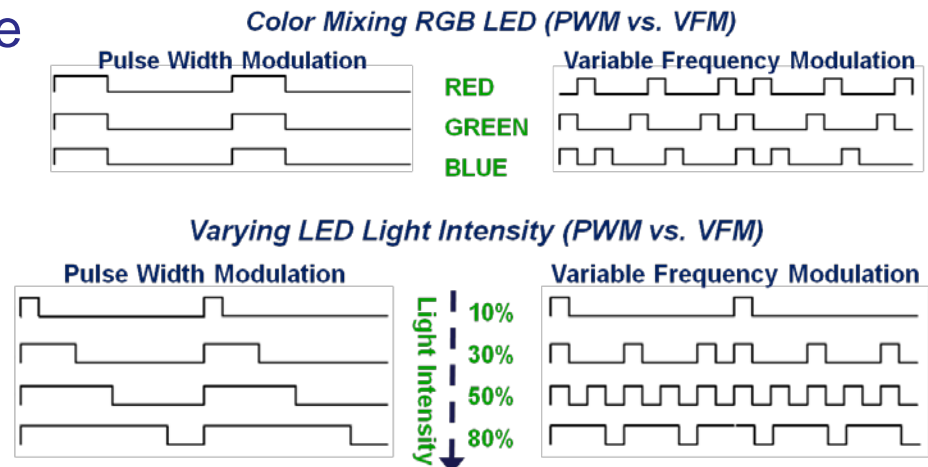




Variable Freq Modulation

Microchip Patent

- **VRM → Variable Frequency Modulation**
 - Variable frequency at fixed duty cycle
 - Alternative to traditional PWM
 - May be implemented in software on *any* PIC® MCU
 - Hardware solution on any PIC MCU w/ **PSMC peripheral**
- **Advantage of VRM**
 - Lower power
 - Improved EMC performance



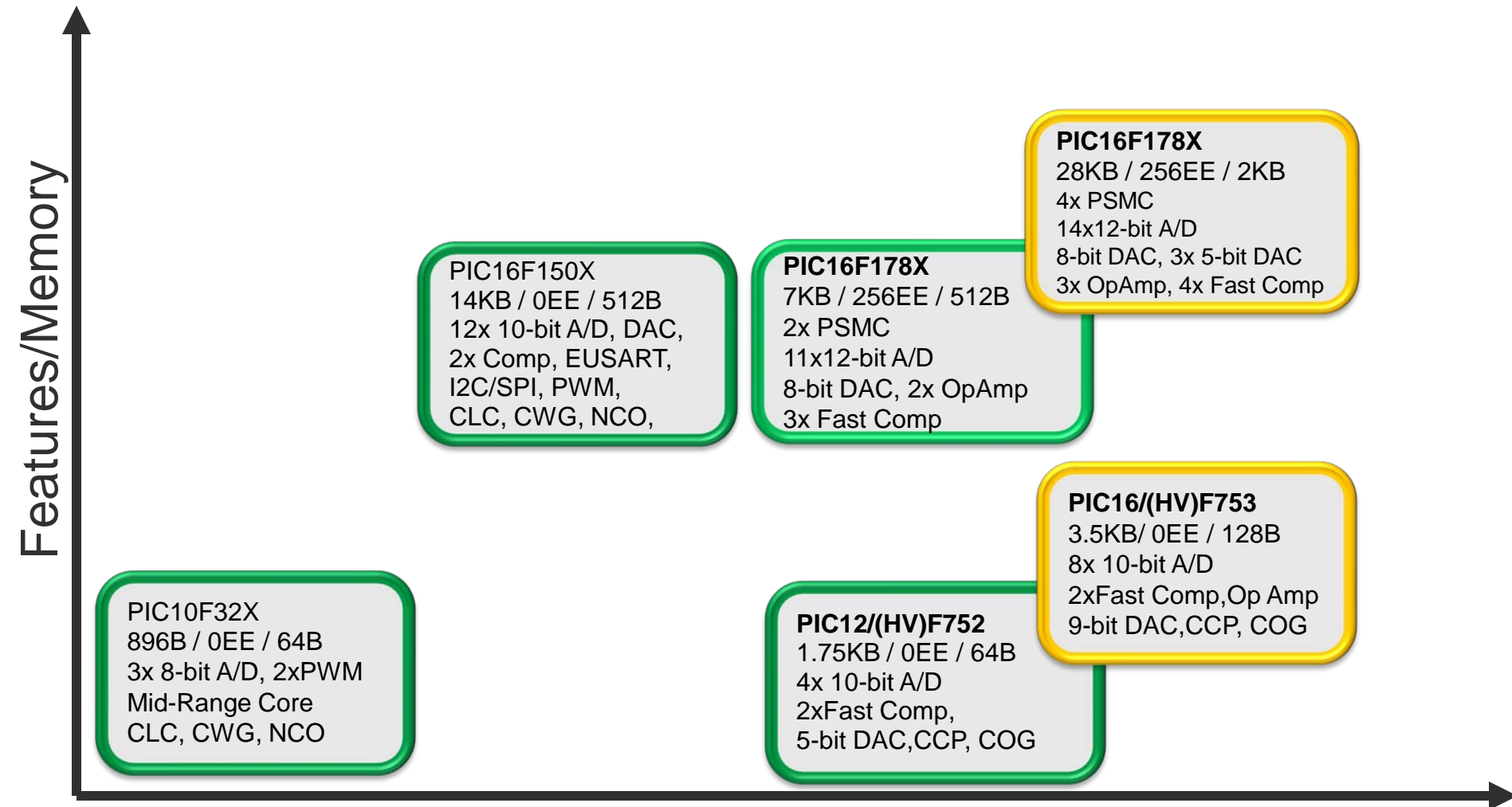


New Peripherals Enhances LED Lighting Control

- **CLC – Configurable Logic Cell**
 - Integrated combinational & sequential logic
- **NCO – Numerically Controlled Oscillator**
 - Industry's most precise, linear, low-cost 20-bit PWM
- **CWG – Complementary Waveform Generation**
 - Non-overlapping waveform generator
- **COG – Complementary Output Generation**
 - Enhanced non-overlapping waveform generator
- **PSMC – Programmable Switch Mode Controller**
 - Advanced, customizable high speed 16-bit PWM module



PIC[®] MCUs w/ New Peripherals





Temperature Monitoring?

- Heat affects efficiency, light intensity, color and lifetime of an LED
- Temp sensors placed near to power LEDs provide accurate temperature monitoring
- Logic output sensors can trigger an interrupt to the to shutdown if over temp
 - The low-cost **TC65XX** temp sensors have a factory pre-programmed temp threshold
 - The **MCP9509/10** are programmable via an external resistor
- Voltage output temp sensors (**MCP9700/1**) provide feedback to vary the drive current when an over temp situation is looming



MICROCHIP

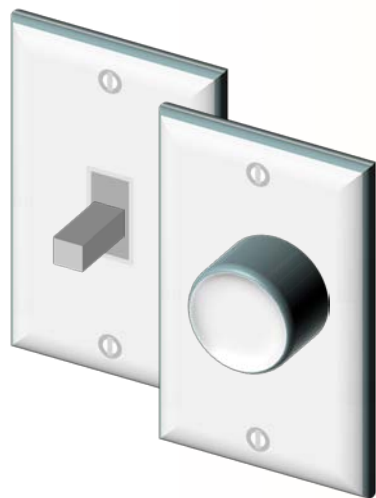
Intelligent Lighting Controls

User Interface & Control



Wall Controllers & Remotes

Legacy Control



Non-Intelligent Lighting Control

- Mechanical Interface
- Limited Luminaire Control
- Lacks User Feedback
- Lacks Communication
- Lacks Product Differentiation

Microchip Human Interface Options

mTouch™ – all PIC MCU families

- Capacitive buttons and sliders
- Metal over Cap capability
- Projected Capacitive capability

Segmented LCD – PIC16, PIC18, PIC24

- Up to 480 segments
- Low power display modes
- Contrast control

Graphics – PIC24, PIC32, dsPIC® DSC

- Integrated graphics controllers
- Direct drive for QVGA and W-QVGA
- FREE graphics library and designer tool

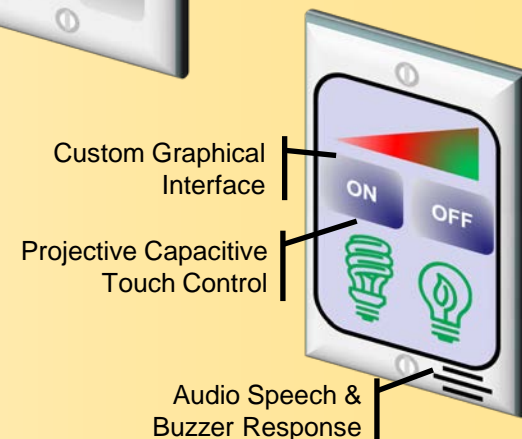
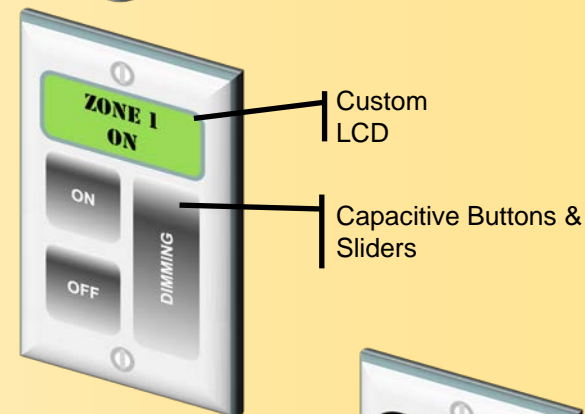
Audio – PIC18, PIC24, PIC32, dsPIC DSC

- Speech coding libraries
- MP3 & echo cancellation libraries
- Made for iPod and Android accessories

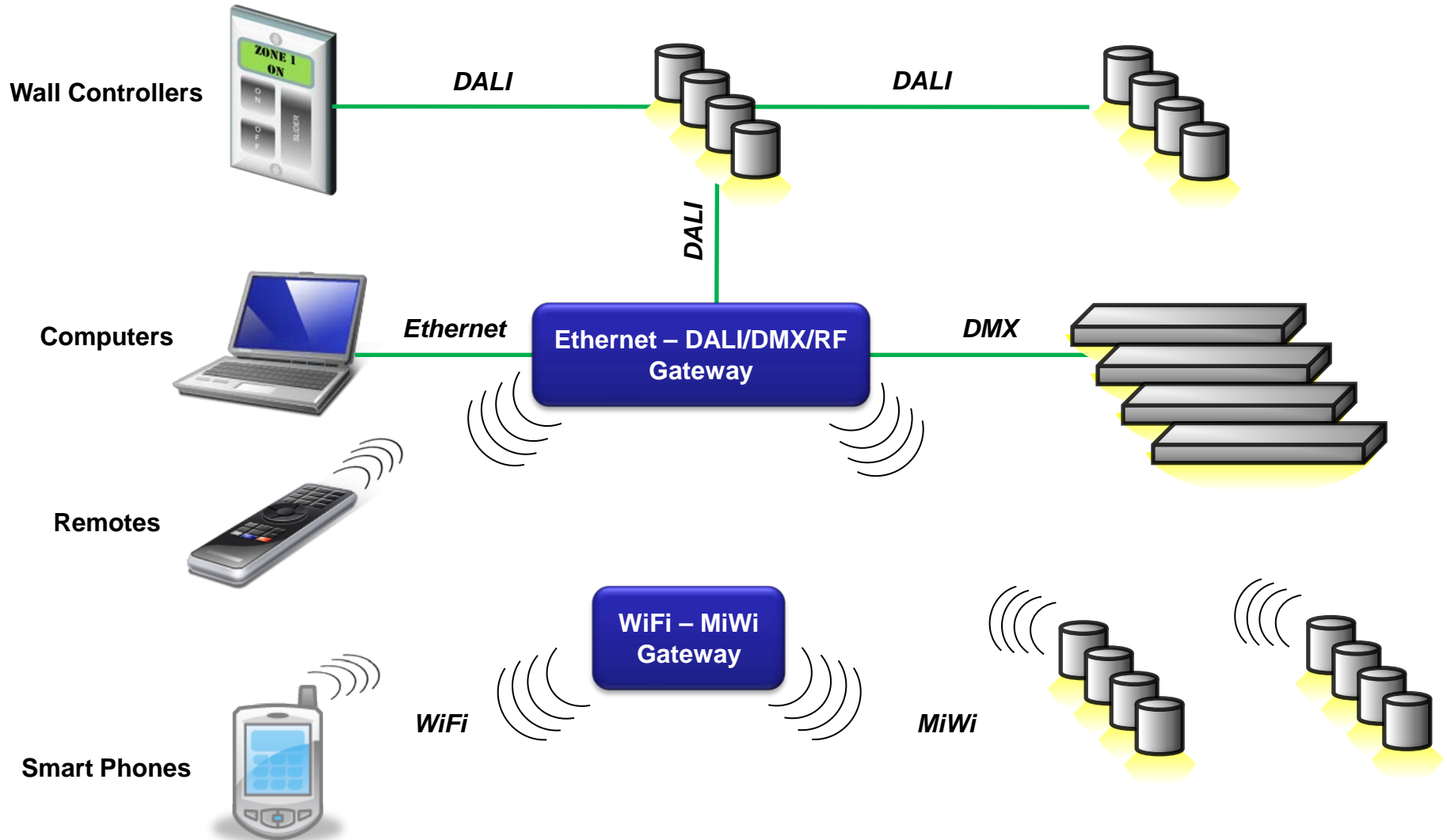
Communication – all PIC MCU families

- Intelligent luminaire control
- DALI, DMX512, LIN/CAN, Wireless, others...
- FREE code libraries

Intelligent Control



Lighting Control Networking & Communication





DALI

DALI – “Digital Addressable Lighting Interface”

- Designed primarily for Commercial & Industrial lighting
- 2-wire connection and offers individual lamp or group addressability in a bus configuration

FREE DALI Firmware Stack

- ‘C’ based firmware stack
- Control Gear & Control Device libraries (master/slave)
- Firmware implementation on any PIC® MCU
- Automated Commissioning
- Simple API to make it easy to use



DMX512

DMX512 – “Digital Multiplex with 512 pieces of information”

- Designed primarily for Theatrical & Architectural lighting
- Increased reliability over that of 0-10V

FREE DMX512 Firmware Stack

- ‘C’ based firmware stack
- Master & Slave in a single library
- Firmware implementation on any PIC[®] MCU with:
 - (1) EUSART & (1) Timer
- Simple API to make it easy to use



Wireless Communications

- For remote control and diagnostics
- ZigBee®, MiWi™ or Wi-Fi™ will all work depending on the application
- **Fully certified add-on wireless modules**
 - MRF24J40Mx 2.4GHz ZigBee/MiWi
 - Well suited for simple short distance wireless control
 - MRF24WB0Mx 2.4GHz WiFi
 - Remote control and/or diagnostics via the internet





Reference Designs, Demos, & Development Platforms

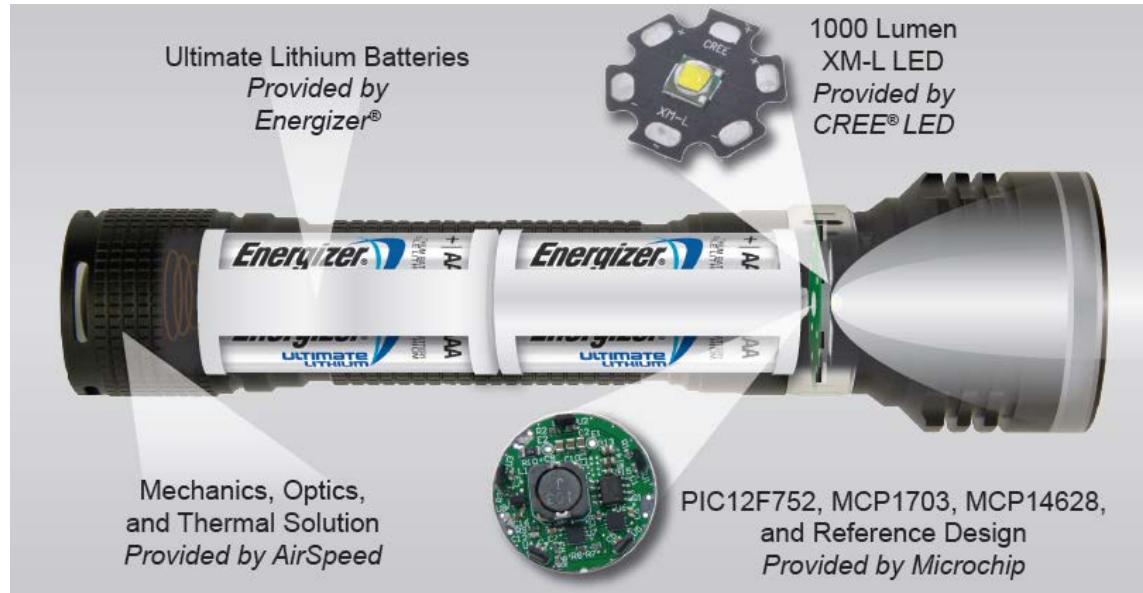


High Power LED Flashlight Demonstration

Advanced Control and Increased Efficacy

Available as FREE download

Collaborative Lighting Development Platform



Demonstration Highlights

- > 90% efficient buck power supply
- ~1000 lumen output at 10W
- Anodized aluminum enclosure
- Magnetic rotational mode selector
- Multiple operating modes
 - Low power (60 lumens @ 0.6W)
 - Medium power (200 lumens @ 2W)
 - High power (1000 lumens @ 10W)
 - SOS (customized lighting sequence)
- Long life operation
 - Low power = >18 hours @ 0.6W
 - Medium power = >6 hours @ 2W
 - High power = 1.5 hours @ 10W

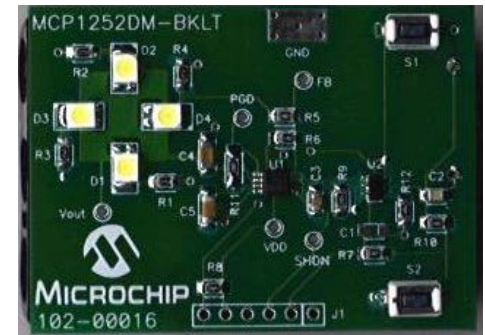
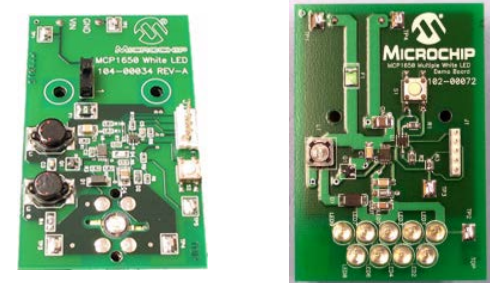
Development Made Easy

- Low-cost development experience
- Start with the FREE download
 - Schematics & 'C' source code
- Easily modified to your specific application needs

Download at www.microchip.com/HPLEDFlashlight

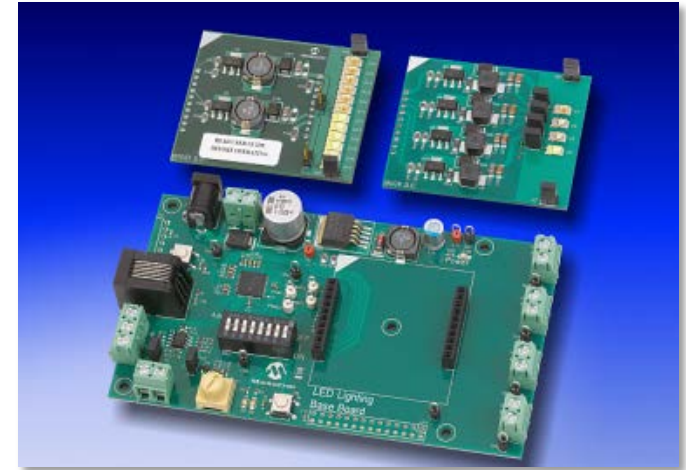
LED Demo Boards

- **MCP1650 White LED Demo Boards**
 - For Battery-powered white LED applications
 - MCP1650DM-LED1 3W white LEDs
 - MCP1650DM-LED2 drives multiple white LEDs
 - Both boards include a PIC10F MCU for dimming/brightness control
- **MCP1252 Charge Pump Backlight Demo Board**
 - MCP1252 charge pump and a PIC10F206 to drive 5 white LEDs at varying intensity for LCD backlighting applications
- **MCP1630 Boost Mode LED Driver Demo Board**
 - Uses MCP1630V high-speed PWM to provide 350mA or 700mA of constant current



LED Lighting Dev Kit

- **Four channel LED Output**
 - Red, Green, Blue and White
- **Digital Dimming for brightness control**
- **On-board 1W LEDs**
 - Pins for connecting external LEDs
- **Applications:**
 - Dimmable LCD Backlighting
 - Digital signage
 - LED replacement for fluorescent or incandescent
 - Architectural lighting
 - Automotive lighting

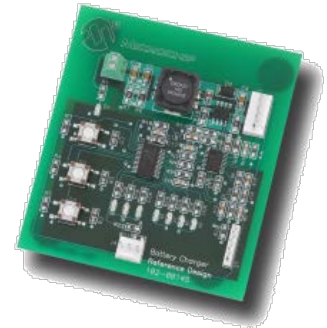


**Digital LED Lighting
Development Kit**
Part Number: DM330014

Reference Designs

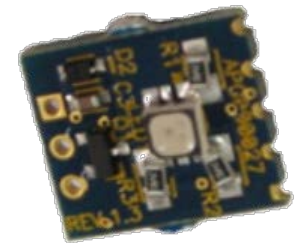
- **MCP1631RD-DCPC1 - MCP1631HV**
Digitally Controlled Current Source

- Drive and dim one or more power LEDs
- Includes PIC16F616 MCU for dimming/brightness control



- **APGRD004 - Automotive Ambient Lighting**

- Provides control of RGB LEDs over a LIN network





Microchip Value Add

- **New peripherals provide high resolution dimming/current control of HBLED**
- **Advanced Human Interface control options**
 - mTouch™
 - Segmented/Graphical LCD
- **Several communication options**
 - Pre-certified wireless modules support ZigBee®, MiWi™ and WiFi™
 - Free Dali/DMX512 stacks
 - Free code libraries
- **Wide selection of development tools, demos and reference designs**

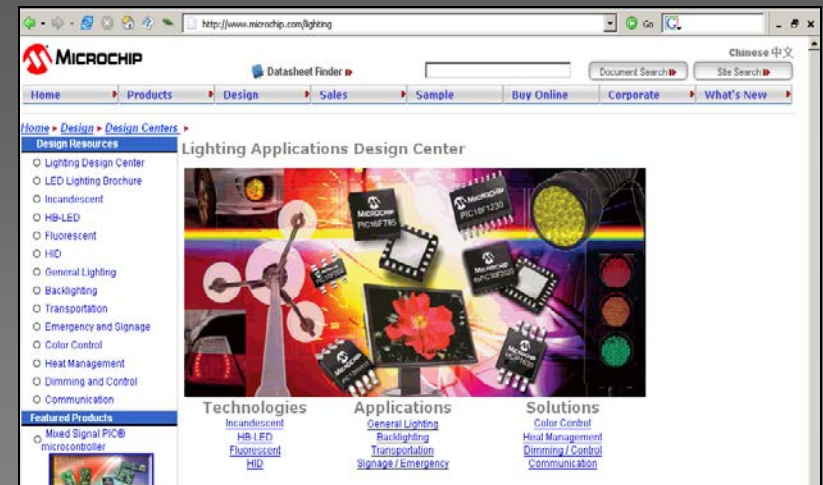


Summary

- **Microchip offers various solutions for LED Lighting**
 - **Controllers** – 8/16/32 - bit PIC MCUs
 - **Drivers** – Analog & Mixed Signal
 - **Communications** – Interface Products & Integrated MCU solutions
 - **Thermal Management** – Temp Sensors with Voltage, Logic or Digital Outputs
- **Web-seminars, application notes and reference designs are available to get customers started**

Lighting Design Center

www.microchip.com/lighting





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Thank You!