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Innovative 16-bit Input/Output Expanders from Microchip Provide Cost-Effective Increase of Digital I/O Capabilities



Microchip has introduced two 16-bit input/output (I/O) expanders. The **MCP23017** is the only 16-bit I/O expander that supports standard (100 kHz), fast (400 kHz) and high-speed (up to 1.7 MHz) I²C™ communications. The **MCP23S17** features SPI™ clock speeds of up to 10 MHz for higher throughput applications. The two devices differ only in the serial interface.

These unique solutions make it easy and cost-effective for designers to upgrade or enhance their current microcontroller-based systems that require additional I/O. The MCP23017 and MCP23S17 provide system I/O expansion via existing microcontroller serial ports, saving development time and cost by eliminating the need to redesign the complete system with a higher I/O microcontroller. These products can support a broad range of applications with low- and high-bandwidth requirements. Hardware-address pins allow cascading of multiple devices in one system—up to 128 bits of I/O can be added to existing systems, providing ample design flexibility.

The MCP23017 and MCP23S17 operate down to 1.8 volts and have a standby mode where current consumption is less than 2 microamps. Separate interrupt outputs for each bank of 8 I/O ports can be utilized for system partitioning. Pins can drive standard LEDs directly (25 milliamps sink/source capability per I/O). These devices complement the Company's existing 8-bit MCP23008 and MCP23S08 I/O expanders.

Additional Features

- 16-bit remote bidirectional I/O port:
 - I/O pins default to input
- High-speed I²C™ interface (MCP23017):
 - 100 kHz
 - 400 kHz
 - 1.7 MHz
- High-speed SPI™ interface (MCP23S17):
 - 10 MHz (max)
- Configurable interrupt output pins:
 - Configurable as active-high, active-low or open-drain
- INTA and INTB can be configured to operate independently or together
- Configurable interrupt source:
 - Interrupt-on-change from configured register defaults or pin changes
- Polarity inversion register to configure the polarity of the input port data
- External reset input
- Three hardware address pins to allow up to eight devices on the bus
- Low standby current:
 - 1 µA (max.)
- Operating voltage:
 - 1.8V to 5.5V @ -40°C to +85°C
 - 2.7V to 5.5V @ -40°C to +85°C
 - 4.5V to 5.5V @ -40°C to +125°C

Availability

Samples and volume production are available today. Packaging is lead (Pb)-free, including 28-pin PDIP, SOIC, SSOP and 6x6 millimeter QFN options. See Microchip's Web site for complete details or contact any Microchip sales representative or authorized Microchip distributor around the world.

For more information visit: www.microchip.com/mcp23X17

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literature HIGHLIGHTS

Application Notes:

AN981: [Interfacing a MCP9700 Analog Output Temperature Sensor to a PICmicro® Microcontroller](#)

Analog output silicon temperature sensors offer an easy-to-use alternative to traditional temperature sensors, such as thermistors. The **MCP9700** offers many system-level advantages, including the integration of the temperature sensor and signal-conditioning circuitry on a single chip. Analog output sensors are especially suited for embedded systems due to their linear output. This application note discusses system integration, firmware implementation and PCB layout techniques for using the MCP9700 in an embedded system.

The firmware required to interface the MCP9700 to a microcontroller is demonstrated using the PICkit™ 1 Flash Starter Kit. The PICkit 1 Flash Starter Kit is a low-cost development kit with an easy-to-use interface for programming Microchip's 8-pin and 14-pin Flash family of microcontrollers.

AN982: [Interfacing I²C™ Serial EEPROMs to PIC10 and PIC12 Devices](#)

The **24LCXXB** Serial EEPROMs from Microchip are I²C™ compatible and support both the standard 100 kHz and the 400 kHz Fast mode. Many times when designing an application which utilizes a serial EEPROM device, it may be beneficial to use a microcontroller which does not feature a dedicated protocol-specific serial port. This is due to several possible reasons, including size restrictions or costs. In these instances, the designer is required to write software routines capable of generating the proper signals for communicating with the EEPROM device. This application note is intended to serve as a reference for manually communicating with Microchip's 24LCXXB serial EEPROM devices; that is, without relying on a hardware serial port to handle the I²C operations. Also, the advantages of each I²C operation are discussed and compared. Source code for common data transfer modes is also provided.

The included firmware supports both the PIC10F202 and the PIC12F675 PICmicro® microcontrollers. Conditional assembly is implemented to account for the small differences between the two processors.

AN984: [An Introduction to AC Induction Motor Control Using the dsPIC30F DSC](#)

This application note demonstrates how you use the **dsPIC30F** digital signal controller to control an AC Induction Motor (ACIM). The discussion is based on the dsPICDEM™ MC Motor Control Development System, but you can use your own hardware if you choose. The dsPICDEM MC Motor Control Development System has electrical isolation and is fully self-protected against Faults. With these features, you can safely develop a motor control application and also avoid damage to hardware by software errors. The code provided in this application note is a simple example that provides basic variable speed control of an ACIM. It will help you learn about the dsPIC30F architecture and the basics of ACIM control.

Product Guide:

[Low-Cost Development Tools Guide - \(DS51560\)](#)

Microchip offers a broad selection of Development Tools comprised of software and hardware components to help you design applications using Microchip devices. This Development Tools Guide provides a brief summary of all our low-cost demonstration boards and development kits. Development tools featured in this guide cover the following product lines: Linear, Interface, Mixed-Signal, Power Management and Thermal Management. Additionally, this guide offers information on various Analog Software Tools, Microcontroller Software Tools and Evaluation Software Tools.

All of the products listed in the Development Tools Guide sell for \$150 or less (Retail USD). For a complete listing of Microchip products and their corresponding literature and technical information, visit our web site at www.microchip.com.

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Unmanned Aerial Vehicle Uses Microchip Technology's PIC18 Microcontrollers for Record-Breaking 48-Hour Flight

AC Propulsion's SoLong UAV Flies for Two Days Straight Using Solar Energy to Power Onboard 8-bit PIC[®] Microcontrollers

Microchip announced that AC Propulsion utilized the high-density memory, high pin count PIC18 microcontrollers to control its SoLong Solar Electric-Powered Unmanned Aerial Vehicle (UAV) during its record-breaking 48-hour flight earlier this month. The SoLong's creator and chief pilot, a self-proclaimed analog guy, selected Microchip because of its development tools.

"I consider myself a newcomer to microcontrollers — I was strictly an analog guy until four years ago," said Alan Cocconi, founder, chairman and chief engineer of AC Propulsion Inc. "With Microchip's MPLAB[®] Integrated Development Environment (IDE), I only had to learn one set of development tools to use a wide variety of products, which gave me more time to concentrate on completing the SoLong."



The SoLong UAV

The SoLong UAV's systems that are controlled by the 12 onboard PIC18 microcontrollers include:

Autopilot

A PIC18LF452 operating at 20 MHz clock speed decodes 13 Pulse Width Modulator (PWM) control inputs from the uplink receiver, serial data from the Ublox GPS module, and takes in analog sensor data from 23 channels. The assembly-language code calculates four PID loops for stability augmentation, as well as managing the GPS navigation and waypoints. The same PIC18LF452 microcontroller also generates the telemetry data stream and eight channels of command pulses for the flight controls.



**Alan Cocconi,
President and Founder
AC Propulsion**

Motor Drive

A PIC18F452 operating at 24 MHz clock speed is used in conjunction with a Flash memory lookup table to generate nine sine-modulated 38 kHz PWM outputs for the 800W sensorless Brushless DC (BLDC) motor drive.

Peak Power Tracker

A PIC18F452 operating at 40 MHz clock speed controls the 4 phase 38 kHz PWM of the 300W DC-DC converter, with a dynamic peak power tracking algorithm to match the solar array output to the Lithium-Ion (Li-Ion) battery.

Servos

Each of the six servo motors use a PIC18LF1320 operating at 20 MHz clock speed to calculate a 600 Hz PID loop, and output 78 kHz PWM to run the small DC motor. The PIC18LF1320 stores in-flight load and wear data to help ensure system reliability for the long flights.

Battery Monitor

Two PIC18F1220s using the internal clock, operating at 250 kHz, monitor the individual cell voltages with 20 mV resolution and protect the Li-Ion battery pack. A serial data-stream is available for diagnostics.

Tracking Downlink Antenna and Anemometer

A PIC18C452 operating at 20 MHz clock speed communicates with the telemetry decoding PC (which runs Labview) using the serial port, and controls two servos that aim the antenna at the airplane using the GPS data. Analog wind speed and direction data is acquired and sent to the PC through the same port for display.

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Tips 'n Tricks - PICmicro® Microcontroller DC Motor Control

Every motor control circuit can be divided into the drive electronics and the controlling software. These two pieces can be fairly simple or extremely complicated depending upon the motor type, the system requirements and the hardware/software complexity trade-off. Generally, higher performance systems require more complicated hardware. The tips below describe some basic circuits and software building blocks commonly used to control motors. Additional tips and tricks can be found at: www.microchip.com.

TIP 1. Brushed DC Motor Drive Circuits

All motors require drive circuitry which controls the current flow through the motor windings. This includes the direction and magnitude of the current flow. The simplest type of motor to drive is the Brushed DC motor. Drive circuits for this type of motor are shown below.

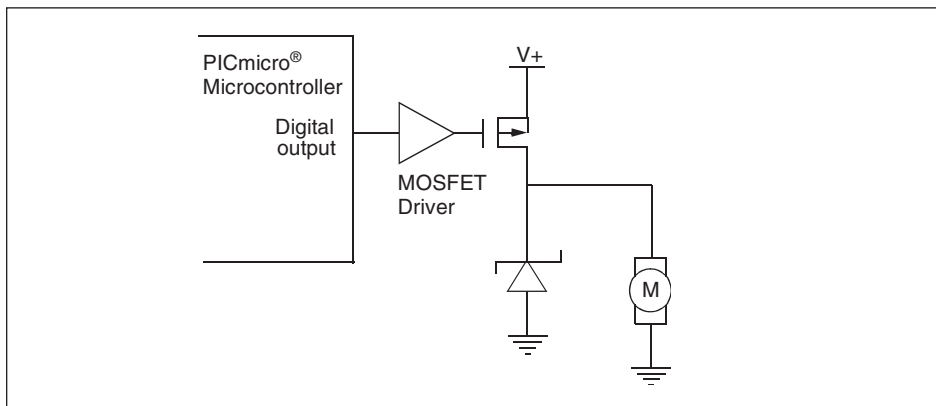


Figure 1-1 High Side Drive

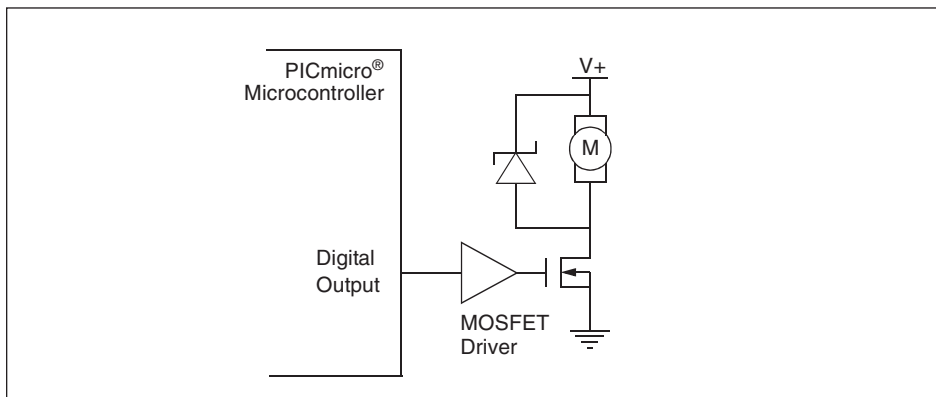


Figure 1-2 Low Side Drive

This is the lowest cost drive technique because of the MOSFET drive simplicity. Most applications can simply use an output pin from the PICmicro® microcontroller to turn the MOSFET on.

The H-bridge derived its name from the common way the circuit is drawn. This is the only solid state way to operate a motor in both directions.

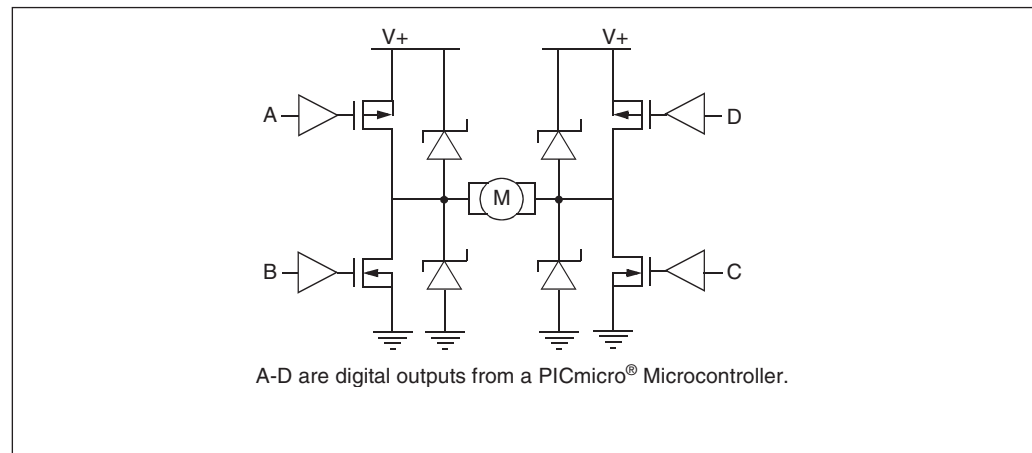


Figure 1-3 H-Bridge Drive

TIP 2. Brushed DC Motor Control Circuits

A Brushless DC motor is a good example of simplified hardware increasing the control complexity. The motor cannot commutate the windings (switch the current flow), so the control circuit and software must control the current flow correctly to keep the motor turning smoothly. The circuit is a simple half-bridge on each of the three motor windings. There are two basic types of Brushless DC motors; sensor and sensorless. Because it is critical to know the position of the motor so the correct winding can be energized, some method of detecting the motor position is required. A sensor motor will directly report to the controller, the current position of the motor. Driving a sensor motor requires a look-up table. The current sensor position directly correlates to a commutation pattern for the bridge circuits. A sensorless motor requires that the induced voltage in the un-driven winding be sensed and used to determine the current speed of the motor. Then, the next commutation pattern can be determined by a time delay from the previous pattern.

Sensorless motors are simpler to build due to the lack of sensors, but they are more complicated to drive. A sensorless motor performs very well in applications that don't require the motor to start and stop. A sensor motor would be a better choice in applications that must periodically stop the motor.

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Tips 'n Tricks - PICmicro® Microcontroller DC Motor Control

TIP 2. Brushed DC Motor Control Circuits (Continued)

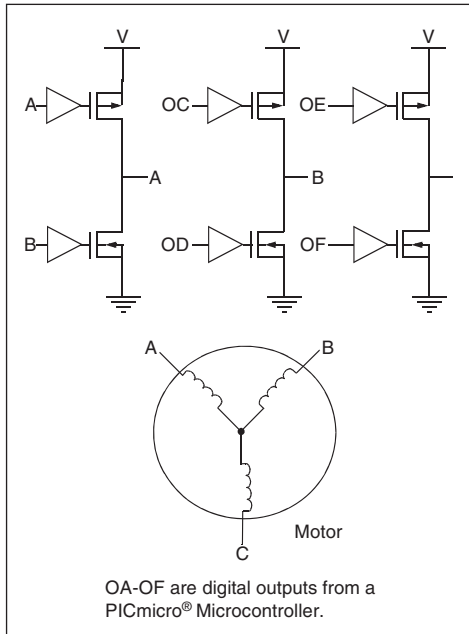


Figure 2-1 3-Phase Brushless DC Motor Control

OA-OF are digital outputs from a PICmicro® Microcontroller.

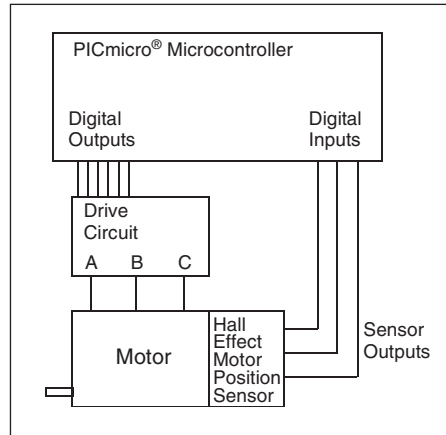


Figure 2-2 Quadrature Decoder (Sensor Motor)

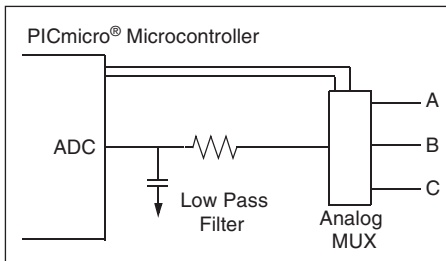


Figure 2-2 Back EMF Sensing (Sensorless Motor)

TIP 3. Stepper Motor Drive Circuits

Stepper motors are similar to Brushless DC motors in that the control system must commutate the motor through the entire rotation cycle. Unlike the brushless motor, the position and speed of a stepping motor is predictable and does not require the use of sensors. There are two basic types of stepper motors, although some motors are built to be used in either mode. The simplest stepper motor is the unipolar motor. This motor has four drive connections and one or two center tap wires that are tied to ground or V_{SUPPLY} , depending on the implementation. Other motor types are the bipolar stepper and various combinations of unipolar and bipolar, as shown in Figure 3-1 and Figure 3-2. When each drive connection is energized, one coil is driven and the motor rotates one step. The process is repeated until all the windings have been energized. To increase the step rate, often the voltage is increased beyond the motor's rated voltage. If the voltage is increased, some method of preventing an overcurrent situation is required.

There are many ways to control the winding current, but the most popular is a chopper system that turns off current when it reaches an upper limit and enables the current flow a short time later. Some systems are built with a current chopper, but they do not detect the current, rather, the system is designed to begin a fixed period chopping cycle after the motor has stepped to the next position. These are simpler systems to build, as they only require a change in the software.

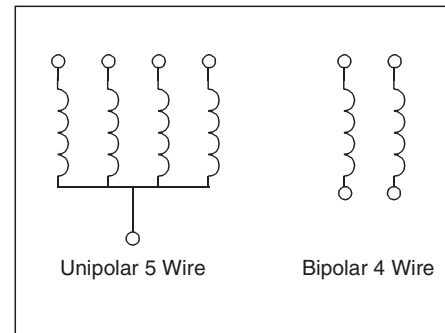


Figure 3-1 4- and 5-Wire Stepper Motors

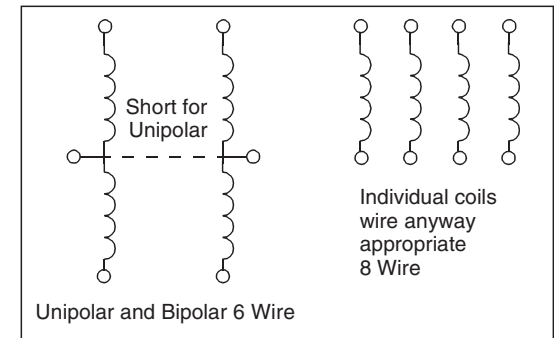
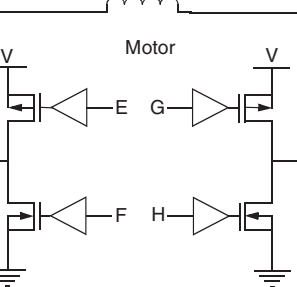
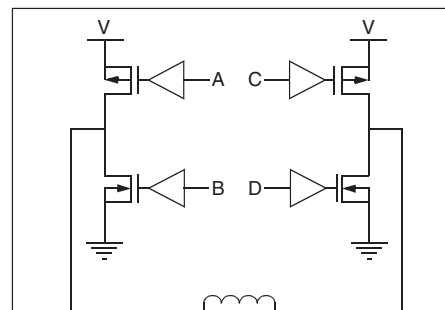
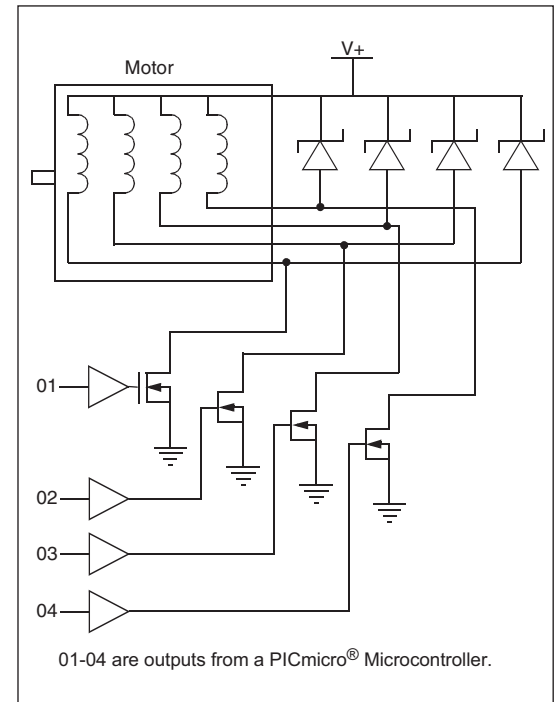


Figure 3-2 6- and 8-Wire Stepper



A-H are digital outputs from a PICmicro® Microcontroller.

Figure 3-3 Unipolar Motor (4 Low-Side Switches)



01-04 are outputs from a PICmicro® Microcontroller.

Figure 3-4 Bipolar Motor (4 Half-Bridges)

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Archived WebSeminars

For more information visit: www.microchip.com/webseminars

Seminar Title	Category	Date	Duration
dsPIC30F General Purpose Timers	Products	April 2005	30 min.
Serial Communications using the dsPIC30F I ² C™ Module	Connectivity	April 2005	30 min.
Serial Communications using the dsPIC30F CAN Module	Connectivity	April 2005	30 min.
dsPIC® DSC SPI™ Communication Module	Products	March 2005	20 min.
dsPIC UART Module	Products	March 2005	20 min.
dsPIC30F Quadrature Encoder Interface Module	Motor Control	March 2005	20 min.
dsPIC30F Motor Control PWM Module	Motor Control	March 2005	20 min.
Introduction to Mechatronics and the Mechatronic Design Center	Applications	Feb 2005	20 min.
Do I Filter Before, After, or Never?	Analog	Jan 2005	20 min.
Designing Intelligent Power Supplies	Applications	Dec 2004	30 min.
Introduction to dsPIC30F Architecture (Part 1)	Products	Dec 2004	20 min.
Introduction to dsPIC30F Architecture (Part 2)	Products	Dec 2004	20 min.
The LCD PIC® Microcontrollers, PIC18F8490/6490, with 16 Kbytes of Flash in 64- and 80-pin packages	Products	Nov 2004	20 min.
Thermistor Application for the New MCP6S9X PGA	Applications	Nov 2004	20 min.
Introduction to the dsPIC® DSC	Products	Nov 2004	20 min.
64 Kbyte Flash Microcontrollers in 28- and 40-pin packages: PIC18F4620 and PIC18F2620	Products	Oct 2004	20 min.
Introduction to the Signal Analysis PICtail™ Daughter Board	Development Tools	Oct 2004	30 min.
Basic dsPIC® DSC Development Tools	Development Tools	Oct 2004	25 min.
Introduction to MPLAB® SIM Software Simulator	Development Tools	Sep 2004	25 min.
Get Started with the 64/80-pin TQFP Demo Board	Development Tools	Sep 2004	20 min.
Tips and Tricks Using MPLAB® IDE v6.61	Development Tools	Sep 2004	30 min.
Introduction to the PIC18F High Pin Count and High Density Family of Devices	Development Tools	Sep 2004	20 min.
Introduction to the MPLAB® Visual Device Initializer (VDI)	Development Tools	Aug 2004	30 min.
Selecting the Ideal Temperature Sensor	Analog	Aug 2004	30 min.
PIC10F Development Tools: Small Tools for Small Parts	Development Tools	Aug 2004	30 min.
An Introduction to the Controller Area Network (CAN)	Interface	Jun 2004	30 min.
Control the World with the World's Smallest Microcontroller (PIC10F)	Products	Jun 2004	30 min.
Predict the Repeatability of Your ADC to the Bit	Analog	May 2004	20 min.
What Does "Rail-to-Rail" Operation Really Mean?	Analog	Apr 2004	20 min.
Introduction to MPLAB® IDE	Development Tools	Mar 2004	25 min.
Lithium-Ion Battery Charging: Techniques and Trade-offs	Analog	Mar 2004	20 min.
Techniques that Reduce System Noise in ADC Circuits	Analog	Feb 2004	20 min.
Introduction to Microchip's Development Tools	Development Tools	Feb 2004	25 min.
Wireless Communication Using the IrDA® Standard Protocol	Applications	Jan 2004	20 min.
Driving Lumileds LEDs with Microchip Microcontrollers	Applications	Jan 2004	60 min.
AC Induction Motor (ACIM) Control Using the PIC18FXX31	Motor Control	Jan 2004	20 min.
Peripheral-Rich, Low Pin Count, PIC® Microcontrollers with nanoWatt Technology	Products	Jan 2004	30 min.

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What's New in Microchip Literature?

Click on a **Document Title** to view the document.

Type of Document	Title of Document	DS#	Print/Web
Application Notes	AN557, Four-Channel Digital Voltmeter with Display and Keyboard	00557D	Web
	AN993, Interfacing Microwire Serial EEPROMs to PIC16 Devices	00993A	Web
Data Sheets	TC1232, Microprocessor Monitor	21370C	Web
	MCP111/112, Micropower Voltage Detector	21889D	Web
Erratas	PIC18F2331/2431/4331/4431 Rev. A2 Silicon Errata	80180C	Web
	PIC18F2331/2431/4331/4431 Rev. A3 Silicon Errata	80192C	Web
	PIC16F91X Data Sheet Errata	80238A	Web
Product Brief	TC2285, 300 mA CMOS LDO with Shutdown and Reference Bypass	21951A	Web
Product Brochure	dsPIC30F Product Map	70160A	Web
Technical Briefs	TB089, CAN Glitch Filtering of the PIC18FXX8	91089A	Web
User Guides	MCP1630 Low-Cost Li-Ion Battery Charger User's Guide	51555A	Web
	dsPICDEM™ 2 Development Board User's Guide	51558A	Web
	dsPIC30F Family Reference Manual - High Performance Digital Signal Controllers	70046C	Web

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web site HIGHLIGHTS

Did you know...

There's an easy way to [Start Now with dsPIC® Digital Signal Controllers](#). It's easy to learn about these devices for your next application. This section gives an overview of the architecture and identifies some of the characteristics that will help you decide which dsPIC Digital Signal Controller is right for you.

The screenshot shows a Microsoft Internet Explorer browser window displaying the Microchip website. The address bar shows the URL: http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=2126. The page content includes a navigation menu with options like Home, Products, Design, Sales, Sample, Buy, Corporate, and What's New. A search bar is visible with a search icon and a dropdown menu for 'Quick Links'. The main content area is titled 'Start Now dsPIC' and 'dsPIC30F Digital Signal Controller Overview'. It features a section for 'Architecture' and 'Advantages'.

Architecture:

The dsPIC® Digital Signal Controller (DSC) from Microchip is a powerful 16-bit (data) modified Harvard RISC machine that combines advantages of a high-performance 16-bit microcontroller (MCU) with the high computation speed of a fully implemented digital signal processor (DSP), to produce a tightly coupled single-chip single-instruction stream solution for embedded systems design.

These dsPIC devices reach speeds of up to 30 MIPS, are very efficient for C programming and have Flash program memory, data EEPROM, data SRAM, powerful peripherals and a variety of software libraries that allow high performance embedded solutions to be designed effortlessly and in a short amount of time. The Flash program memory varies in size from 12 Kbytes to 144 Kbytes. There are 18 members of the dsPIC30F family and growing.

Advantages:

- Powerful and fast 16 bit (data) MCU
- High-performance DSP capability
- RISC-based instruction architecture
- Reliable Flash memory
- Separate program and data busses
- Powerful peripherals on chip
- Silicon supported through MPLAB® development tools (H/W & S/W) & libraries
- Silicon supported by application firmware and development boards and reference designs

Features:

- Operation voltage range of 2.5 to 5.5 V
- Operating temperature range of -40° to +125°C
- Operating speed range of DC to 30 MIPS
- Package size ranges from 18-pin PDIPs to 80-pin TQFPs
- Highly capable and flexible power management system:
 - Programmable Power-on Reset
 - Programmable Brown-out Reset
 - Programmable low-voltage detect
- Idle & Sleep modes
 - Switch between clock sources in real-time
- Programmable Flash memory – in circuit
- Data EEPROM memory
- Data SRAM memory

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