



## EMBEDDED COMPUTING AND MECHATRONICS WITH THE PIC32 MICROCONTROLLER

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### AUDIENCE:

University courses, students, professionals and hobbyists

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# Embedded Computing and Mechatronics with the PIC32 Microcontroller

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**An introduction to Microchip's PIC32 microcontroller and its use in embedded computing and mechatronics**

### KEY FEATURES

- Extensive, freely downloadable sample code for the NU32 development board incorporating the PIC32MX795F512H microcontroller
- Free online instructional videos to support many of the chapters

### DESCRIPTION

For the first time in a single reference, this book provides the beginner with a coherent and logical introduction to the hardware and software of the PIC32, bringing together key material from the PIC32 Reference Manual, Data Sheets, XC32 C Compiler User's Guide, Assembler and Linker Guide, MIPS32 CPU manuals, and Harmony documentation. This book also trains you to use the Microchip documentation, allowing better life-long learning of the PIC32. The philosophy is to get you started quickly, but to emphasize fundamentals and to eliminate "magic steps" that prevent a deep understanding of how the software you write connects to the hardware.

Applications focus on mechatronics: microcontroller-controlled electromechanical systems incorporating sensors and actuators. To support a learn-by-doing approach, you can follow the examples throughout the book using the sample code and your PIC32 development board. The exercises at the end of each chapter help you put your new skills to practice.

The material in this book has been tested and refined over several years of use as the primary reference for the mechatronics sequence at Northwestern University.

### Coverage includes:

- A practical introduction to the C programming language
- Getting up and running quickly with the PIC32
- An exploration of the hardware architecture of the PIC32 and differences between PIC32 families
- Fundamentals of embedded computing with the PIC32, including the build process, time- and memory-efficient programming, and interrupts
- A peripheral reference, with extensive sample code covering digital input and output, counter/timers, PWM, analog input, input capture, watchdog timer, and communication by the parallel master port, SPI, I2C, CAN, USB, and UART
- An introduction to the Microchip Harmony programming framework
- Essential topics in mechatronics, including interfacing sensors to the PIC32, digital signal processing, theory of operation and control of brushed DC motors, motor sizing and gearing, and other actuators such as stepper motors, RC servos, and brushless DC motors

Visit <http://nu32.org> for sample code, accompanying online videos, and ordering information

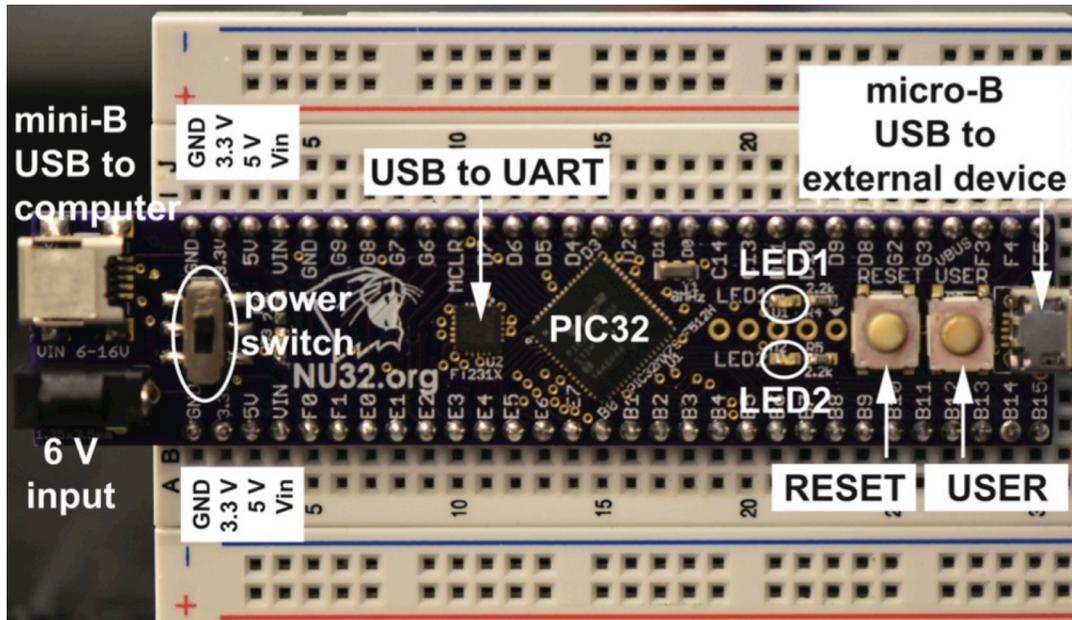
# The NU32 PIC32MX795F512H Development Board

The companion board for the book

*Embedded Computing and Mechatronics with the PIC32 Microcontroller*

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## The NU32

The NU32 is an inexpensive 60-pin DIP-compatible development board for the 64-pin surface mount PIC32MX795F512H. Its primary purpose is to break out the pins of the PIC32. It also includes an FTDI FT231XL USB-to-UART chip that allows simple serial port communication over a USB cable with a program running on the host computer (e.g., a terminal emulator, MATLAB, Python, etc.). The board can be powered standalone by the included 6 V wall adapter or by the host's USB port. An onboard bootloader allows programming the PIC32 using only a USB cable, without an external programmer device. An onboard clock clocks the CPU at 80 MHz.

## Features

- 80 MHz MIPS32 M4K 32-bit CPU
- 512 KB flash and 128 KB RAM
- Many digital I/O and change notification pins
- Five 16-bit counter/timers
- Five PWM and 5 input capture channels
- 1 MHz 10-bit analog input (multiplexed to 16 inputs)
- Six UART, 2 CAN, 3 SPI, 4 I2C, 1 PMP, 1 USB, and 1 Ethernet modules
- Two LEDs and one pushbutton available for user programs
- 3.3 V and 5 V regulated voltage outputs
- Mini-B USB jack to connect to the host
- Micro-B USB jack for USB with another device

## What's in the Box

- The NU32 development board, with soldered header pins
- A solderless prototyping breadboard into which the NU32 can be inserted
- A USB cable for programming and communication with the host
- A 6 V wall power supply

## Sample Code

Extensive freely downloadable and easily modified C sample code demonstrates most of the major functions of the PIC32, including use of the peripherals and special features of the CPU and the XC32 C compiler, such as interrupts and code time and space efficiency.

## Sample Book Chapters

Freely downloadable book chapters allow the NU32 user to get started quickly with the NU32, without purchasing the book. The free book chapters also include an extensive introduction to programming in the C language, a circuits review (useful for interfacing the PIC32 with sensors and actuators), and a description of the theory of DC motors.

## Online Videos

The online videos demonstrate many of the features of the NU32 (and the PIC32 generally), as well as its application in mechatronics projects involving sensors and actuators. The videos also facilitate flipping a traditional classroom.

Visit <http://nu32.org> for sample code, accompanying online videos, and ordering information