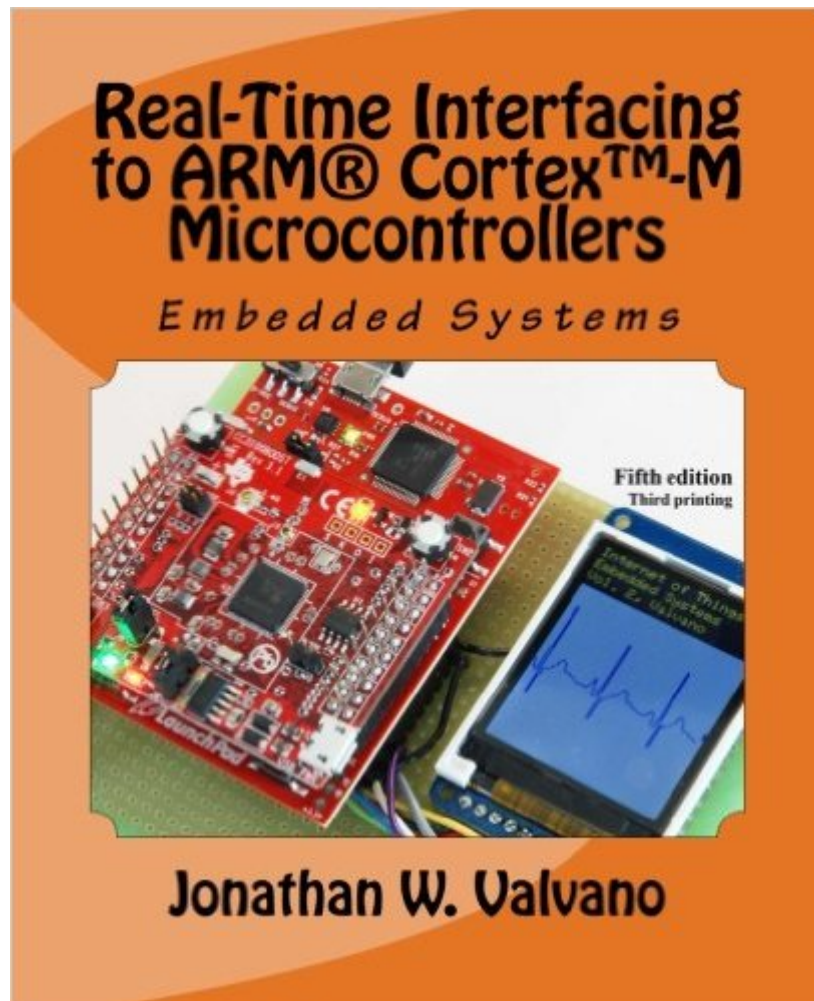


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# Embedded Systems: Real-Time Interfacing To Arm® Cortex™-M Microcontrollers



## Synopsis

This book, published August 2016 as a fifth edition 3rd printing, is the second in a series of three books that teach the fundamentals of embedded systems as applied to ARM Cortex-M microcontrollers. The three books are primarily written for undergraduate electrical and computer engineering students. They could also be used for professionals learning the ARM platform. The first book *Embedded Systems: Introduction to ARM Cortex-M Microcontrollers* is an introduction to computers and interfacing focusing on assembly language and C programming. This second book focuses on interfacing and system-level design. The third book *Embedded Systems: Real-Time Operating Systems for ARM Cortex-M Microcontrollers* is an advanced book focusing on operating systems, high-speed interfacing, control systems, and robotics. An embedded system is a system that performs a specific task and has a computer embedded inside. Topics include design, verification, hardware/software synchronization, interfacing devices to the computer, timing diagrams, real-time systems, data collection and processing, motor control, analog and digital filters, real-time signal processing, low-power design, and the internet of things. In general, the area of embedded systems is an important and growing discipline within electrical and computer engineering. The educational market of embedded system is dominated by simple microcontrollers like the PIC, 9S12, and 8051. This is because of their market share, low cost, and historical dominance. However, as problems become more complex, so must the systems that solve them. A number of embedded system paradigms must shift in order to accommodate this growth in complexity. First, the number of calculations per second will increase from about 1 million/sec to 1 billion/sec. Similarly, the number of lines of software code will also increase from thousands to millions. Thirdly, systems will involve multiple microcontrollers supporting many simultaneous operations. Lastly, the need for system verification will continue to grow as these systems are deployed into safety critical applications. These changes are more than a simple growth in size and bandwidth. These systems must employ parallel programming, DMA synchronization, real-time operating systems, fault tolerant design, priority interrupt handling, and networking. Consequently, it will be important to provide our students with these types of design experiences. The ARM platform is both low cost and provides the high performance features required in future embedded systems. The ARM market share is currently large and growing. Furthermore, students trained on the ARM will be equipped to design systems across the complete spectrum from simple to complex. The purpose of writing this book at this time is to bring engineering education into the 21st century. This book employs many approaches to learning. It will not include an exhaustive recapitulation of the information in data sheets. First, it begins with basic fundamentals, which allows the reader to solve

new problems with new technology. Second, the book presents many detailed design examples. These examples illustrate the process of design. There are multiple structural components that assist learning. Checkpoints, with answers in the back, are short easy to answer questions providing immediate feedback while reading. Simple homework provide more detailed learning opportunities. The book includes an index and a glossary so that information can be searched. The most important learning experience in a class like this are of course the laboratories. Each chapter has suggested lab assignments. More detailed lab descriptions are available on the web. The book will cover embedded systems for the ARM Cortex-M with specific details on the TM4C123, and TM4C1294. Although the solutions are specific for the Tiva TM4C, it will be possible to use this book for other ARM derivatives.

## **Book Information**

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## **Customer Reviews**

I took the class that Dr. Valvano designed at the University of Texas at Austin last year and this was our textbook (took it the semester that he didn't teach, but it was still great). This was the best and most useful class that I took in college and the textbook was great for use in the class and all of the content is wonderful for reference for any microcontroller project after (also it's really cheap for a textbook and for all of the information it contains is really worth it).As a textbook:1. This book has the clearest explanation of embedded systems I've ever read2. Every concept you would ever want (minus a couple exotic concepts) is explained plainly and clearly (with handy circuit diagrams and example code!)3. Lots of programming problems and labs that you can try (especially useful if you

are self-pacing this one and need some practice on the concepts)As a reference:1. Clearly and cleanly organized by topics for quick reference2. Although much of the code is specific to certain microcontrollers, the steps and methods are clearly presented and can be easily generalized to any processor (I used this heavily in my senior design project with the MSP430)3. This (and the previous volume) have such a clear introduction to all topics that you could teach yourself embedded programming from the ground up using this book (and one of the Launchpads that this version is targeted for - super cheap development board and lots of fun)Do yourself a favor by buying this book and then go to Dr. Valvano's website ([...]) where you can find all sorts of helpful info and code snippets and lab manuals from past classes that are incredibly detailed and painstakingly crafted to be of the utmost help to students.

This book is very similar to the previous volume, "Introduction to ARM Cortex-M Microcontrollers". In fact at least 1/3 of the material of the book is a copy and paste from the previous volume. I would not recommend reading this book from front cover to back cover. In my experience, I believe it is better to treat this book more as a reference manual to refer to for topics you don't quite understand. The book basically talks about how microcontrollers work, particularly, the TM4C123 and the TM4C1294. It simplifies much of the formal talk written in the datasheets for those devices, but in exchange, does not cover the entirety of the exact functionality of those devices. There has also been an inclusion of Internet of Things as a topic in the later part of the book, although it still does not explain the concept very well and instead points the reader into some examples that utilize IoT. I would not recommend this book to people wanting to just read about microcontrollers and not taking a class about it. However, since this book goes together with the actual UT Austin class EE445L, you probably aren't buying it for a leisure read.For EE445L Students:1. Go to Valvano's Website: [...] This webpage contains supplementary material that you really will need to understand what the book is saying. Also it contains the programs, that were written in the book. On this page: [...], you can find all the materials you will need for this course. If you click on the "Lectures" tab and scroll down to "Volume 2 EE445L Fall 2015 Lecture slides" and click to see all slides, you will find all powerpoint slides to help you with your labs.2. The edition number does not matter too much.3.

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