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The Quintessential PIC Microcontroller

Springer

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In memory of Eva Jones

ISBN 978-1-85233-309-6

British Library Cataloguing in Publication Data
Katzen, Sid
The quintessential PIC microcontroller. - (Computer communications and networks)
1. Programmable controllers
I. Title
629.8'9
ISBN 978-1-85233-309-6

Library of Congress Cataloging-in-Publication Data
Katzen, Sid.
The quintessential PIC microcontroller. / Sid Katzen.
p. cm. — (Computer communications and networks)
Includes index.
ISBN 978-1-85233-309-6 ISBN 978-1-4471-3704-7 (eBook)
DOI 10.1007/978-1-4471-3704-7
1. Programmable controllers. I. Title. II. Series.
TJ223.P76 K38 2001
629.8'9—dc21
00-066153

Originally published by Springer-Verlag London Berlin Heidelberg in 2001

Typesetting: Camera-ready by author

34/3830-543210 Printed on acid-free paper SPIN 10700872

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Preface

Microprocessors and their microcontroller derivatives are a ubiquitous, if rather invisible, part of the infrastructure of our 21st century electronic and communications society. In 1998 it was reckoned[1] that hidden in every home were about 100 microcontrollers and microprocessors; in the singing birthday card, washing machine, microwave oven, television controller, telephone, personal computer and so on. About 20 more lurked in the average family car. For example monitoring in-tire radio pressure sensors and displaying critical data through the car area network (CAN).

Around 4 billion such devices are sold each year to implement the intelligence of these smart electronic devices, ranging from smart egg timers through aircraft management systems. The evolution of the microprocessor from the first Intel device introduced 30 years ago in 1971 has revolutionised the structure of society, effectively creating the second smart industrial revolution coming to fruition at the beginning of the 21st century. Although the microprocessor is better known in its guise of powering the ubiquitous PC, in which raw computing power is the goal, sales of such microprocessors as the Intel Pentium, represent only around 2% of total volume. The vast majority of sales are of low-cost microcontrollers embedded into a dedicated-function digital electronic device, such as the smart card. Here the emphasis is the integration of the core processor with memory and input/output resources in the one chip. This integrated computing system is known as a microcontroller.

In seeking to write a book in this area the overall objective was to get the reader up to speed in designing small embedded microcontroller-based systems, rather than using microcontrollers as a vehicle to illustrate computer architecture in the traditional sense. This will hopefully give the reader the confidence that even at such an introductory level, he/she can design, construct and program a complete working embedded system.

Given the practical mature of this material, real-world hardware and software products are used throughout to illustrate the material. The microcontroller market is dominated by devices that operate on 8-bit data (although 4- and 16-bit instances are available) like early microprocessors and unlike the 64-bit Intel Pentium and Motorola Power PC 'heavy brigade'. In contrast the essence of the microcontroller lies in their high

[1]New Scientist, vol. 59, no. 2141, 4th July 1998, pp. 139.

system integration/low cost profile. Power can be increased by distributing processors throughout the system. Thus, for example, a robot arm may have a microcontroller for each joint implementing simple local processes and communicating with a more powerful processor making overall executive decisions.

In choosing a target architecture, both acceptance in the industrial market, easy availability and low cost development software has made the Microchip family one of the most popular choices as the pedagogic vehicle in learning microprocessor/microcontroller technology at all levels of electronic engineering from grade school to university. In particular the reduced instruction set together with the relatively simple innovative architecture reduces the learning curve. As well as its industrial and educational roles, the PIC families are the mainstay of hobbyist projects; as a leaf through any Electronic magazine will show.

Microchip inc. is a relatively recent entrant to the microcontroller market with its family of Havard architecture PIC devices introduced in 1989. By 1999, Microchip was the second largest producer of 8-bit units – behind only Motorola.

The book is split into three parts. Part I covers sufficient digital, logic and computer architecture to act as a foundation for the microcontroller engineering topics presented in the rest of the text. Inclusion of this material makes the text suitable for stand-alone usage, as it does not require a prerequisite digital systems module.

Part II looks mainly at the software aspects of the mid-range PIC microcontroller family, its instruction set, how to program it at assembly and high-level **C** coding levels, and how the microcontroller handles subroutines and interrupts. Although the 14-bit PIC family is the exemplar, both architecture and software are comparable to both the 12- and 16-bit ranges.

Part III moves on to the hardware aspects of interfacing and interrupt handling, with the integration of the hardware and software being a constant theme throughout. Parallel and serial input/output, timing, analog and EEPROM data handling techniques are covered. A practical build and program case study integrates the previous material into a working system, as well as illustrating simple testing strategies.

With the exception of the first two and last chapter, all chapters have both fully worked examples and self-assessment questions. As an extension to this, an associated Web site at

`http://www.engj.ulst.ac.uk/sidk/quintessential`

has the following facilities:

- Solutions to self-assessment questions.
- Further self-assessment questions.
- Additional material.

- Source code for all examples and questions in the text.
- Pointers to development software and data sheets for devices used in the book.
- Errata.
- Feedback from readers.

The manuscript was typeset on a Siemens Scenic D Pentium 133 PC by the author using a Y&Y implementation of $\LaTeX\,2_\varepsilon$ and the Lucida Bright font family. Camera-ready copy was produced in `.pdf` format and used to directly generate plates at 1270dpi resolution. Line drawings were created or modified with Autocad R13 and incorporated as encapsulated PostScript files. Photographs were taken by the author using a Olympus C-1400L 1.4 M pixel digital camera – absolutely full of microcontrollers!

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December 2000