# PREFACE

The type and the number of applications of the modern technology have driven to different solutions and approaches. Some of these solutions are based in a computer system which supports the corresponding requirements. The computers (PCs) that are used nowadays represent only one view of the reality, because they mainly support the requirements regarding the processing power, everyday applications, simplicity of using and programming, etc.

From the other point of view, there is a great number of applications that require an autonomous control system which is usually embedded in a device. In such systems, the requirements are focused on the operation autonomy, the physical size, the power consumption, etc.

Approaching these views from the aspect of architecture and programming, the core of the systems is a microprocessor or a microcontroller.

It must be noticed that the basic differences between microprocessors and microcontrollers, but also of their architecture and programming constitutes an unclear subject for many new engineering students and readers.

**This book (volume 1) constitutes a complete basic educational guide which offers important knowledge and demystifies the AVR programming. Moreover, this book has been written by taking in account the real needs of students, teachers and others who want to develop AVR based applications.**

**All the programs and applications of the book have been developed and tested in a real microcontroller, in contrast with other books where the corresponding material has been developed only theoretically with no tests in practice.**

The above lines, state the deep belief of the author that this book will constitute a useful teaching and educational tool for helping anyone understand the AVR applications. On the other hand, the book can be used by the teacher for organizing lectures and presentations as well as the laboratory exercises.

Panayotis Papazoglou, PhD

# The book structure

The book (volume 1) consists of 7 chapters which include simple exercises or laboratory activities.

The **first chapter** is a general introduction to microcontrollers regarding their features and capabilities. The chapter also includes application examples that are focused on the corresponding components such as sensors, etc.

The AVR features such as the internal architecture, the memory system and the registers are presented in the **second chapter**. These features are presented only with the needed level of details in order to be easily understandable by the reader without any hard work.

In the **third chapter**, the basic instruction set is analyzed using a great number of figures. The assembly instruction set constitutes the basic tool for developing the corresponding applications. All the instructions are presented by using practical examples as well as special figures in order to demonstrate the corresponding operation. Thus, the reader understands the operation philosophy of every instruction.

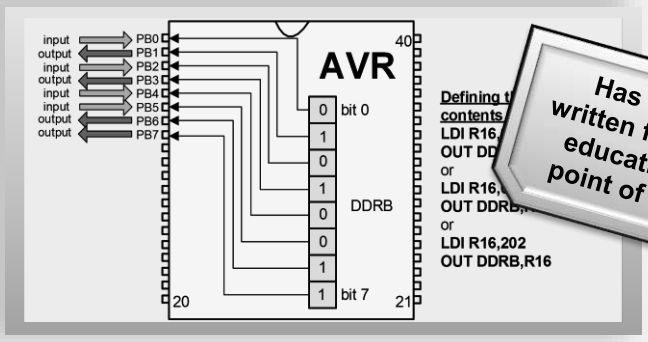
Due to the fact that the algorithm constitutes the most important component for every application and the code synthesis is based on the structured programming concepts, a whole chapter (**fourth chapter**) has been written for presenting all this knowledge. Thus, the reader is guided step by step to the correct way of thinking for developing the desired application.

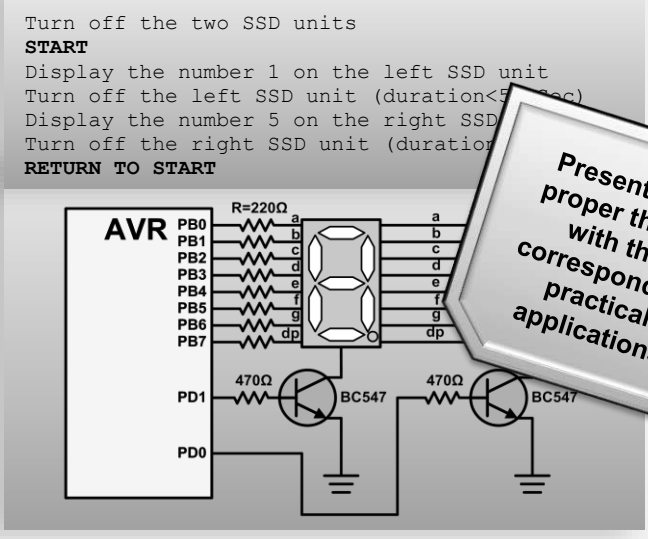
In the **fifth chapter** the reader learns for the first time how to exploit the digital input/output pins of the microcontroller. More precisely, the chapter begins with the basic knowledge on electrical circuits for understanding basic concepts as the current, voltage, etc. Next, the application of this knowledge in the external circuits of the microcontroller as well as the corresponding programming is analyzed.

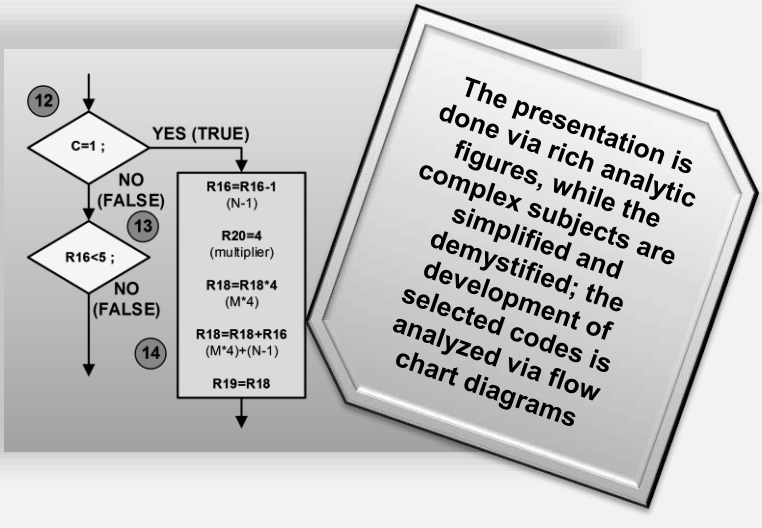
The display units (e.g. seven segment displays, LCD) are analyzed in the **sixth chapter**. The display operation is very important for the user interaction with the application as well as for debugging.

Due to the fact that the modern applications support the input of complex data and instructions by the user, it is very important to present the corresponding switch circuits that can be used as keyboards. The **seventh chapter** analyzes how to develop such a circuit as well as the programming method for using it.

# Important features of this book



# Important features of this book

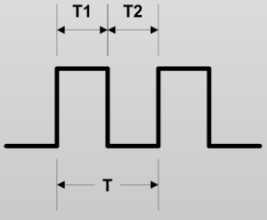
```
;**************************
;Main program
;**************************
main:
  SBI PORTB,Button;Pull Up re
                  ;activation
                  ;at pin PB0
  SBI DDRB,LED    ;The pin 1 of port B
                  ;will be set as output
scan:
      SBIC PINB,Button ;If the pin 0 (button)
                       ;is activated
                       ;(PB0=LOW=0V),
                       ;then the next
                       ;instruction
                       ;is bypassed

      RJMP scan      ;Return to check button
      SBI PORTB,LED ;LED activation
```

Well documented source code

**Step 2**

Fill the following signal attributes based on the expected measurements on pin PD0.




**T1** =

**T2** =

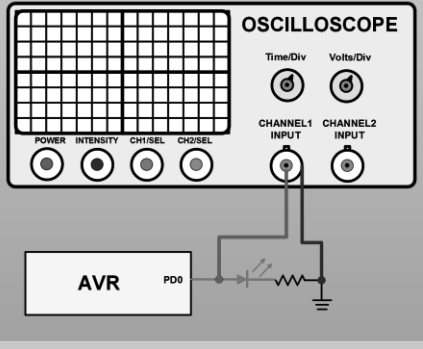
**T** =

**Frequency F** =

Laboratory activities and simple exercises are included

**Step 3**

Connect one channel of the oscilloscope as described in the next figure. Set properly the time base (Time/Div) and the voltage scale (Volts/Div) on the oscilloscope in order to display the measured signal at the right size.



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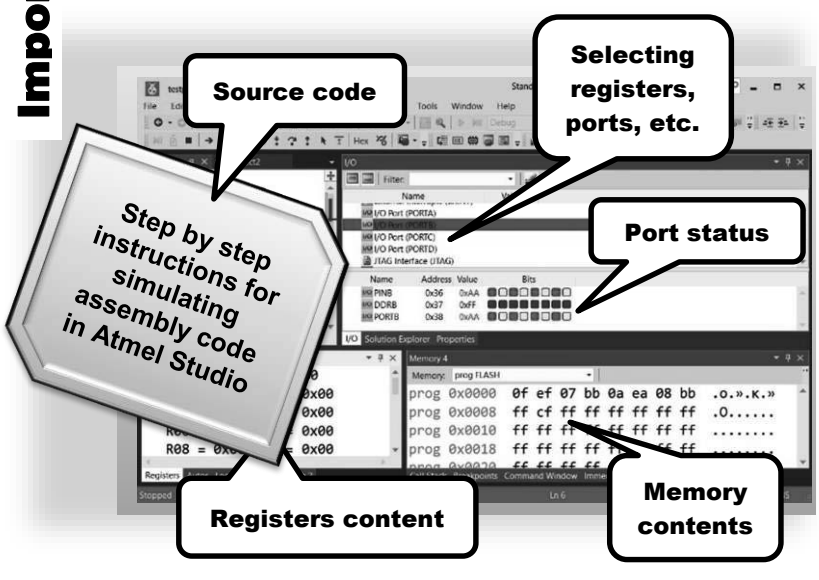


# Happy Reading!