Contents

Preface **iii**
Introduction . . . iii
Conventions used in this manual . . . v
Plotting and fitting with `physica` . . . v
References . . . v

1 Introduction to `Electronics Workbench` **1**
1.1 Preliminaries . . . 1
1.2 Virtual circuits in `Electronics Workbench` . . . 1
1.3 Real and ideal meters . . . 3
1.4 Review of basic electronic components . . . 4
1.5 Digital indicators and controls . . . 5
1.6 Bit combinations control a 7-segment LED display . . . 6

2 Logic Gates **7**
2.1 Circuit assembly techniques . . . 7
2.2 Combinations of NAND gates implement other operations . . . 8
2.3 A binary counter . . . 9

3 Combinatorial and sequential logic **11**
3.1 Divide-by-two flip-flop . . . 11
3.2 A binary counter with D flip-flops . . . 12
3.3 One-of-eight decoder . . . 13
3.4 A design challenge . . . 13

4 Oscillators and clock circuits **15**
4.1 555 timer IC as a square wave generator . . . 15
4.2 Crystal oscillator and ripple counter . . . 17

5 Building a counter **19**
5.1 Building a device, stage by stage . . . 19
5.2 A virtual prototype . . . 20
5.3 Circuit realization . . . 21

6 Four-bit multipliers **23**
6.1 A summing multiplier . . . 23
6.2 A shift/add multiplier . . . 25
6.3 An array multiplier . . . 27
6.4 Look-up table multiplier . . . 27

7 PICLab project board **29**
7.1 Introduction . . . 29
7.2 Pre-assembly review of parts and tools . . . 30
7.3 Assembly of a PICLab project board . . . 33
7.4 PICLab basic functionality tests . . . 35

8 PICLab programming **37**
8.1 Assembler instructions and code development . . . 40
8.2 Loops, conditional branching, and calls to subroutines . . . 41
8.3 Macros and subroutines . . . 43
8.4 Interrupts . . . 44
8.5 Analog-to-digital conversion . . . 45
8.6 Utility subroutines and data output . . . 46

9 PICLab data acquisition project **47**
9.1 A PID temperature controller . . . 48
9.2 An ultrasonic pinger . . . 48
9.3 A chaotic dripping tap . . . 48
9.4 A universal digital knob . . . 48
9.5 An LCD bar-graph . . . 49
9.6 A joystick-controlled servomotor . . . 49
9.7 Decoding an infrared remote control . . . 49
9.8 A PIC-based mouse controller . . . 50

A Breadboards **51**

B Resistor Colour Code **54**

C Plotting with `physica` **55**

Plotting with `physica` **55**