## Table of Contents

Preface 5

1 Light emitting diodes 9
1.1 History of the light emitting diode 9
1.2 LED characteristics and parameters 10
1.3 PIC interface for LED circuits – design and programming 14
1.4 Case Study RGB VGA monitor tester 32
1.5 Case Study Christmas light 35
1.6 Case Study 3 channel sound to light 39

2 White light emitting diodes 44
2.1 PWM LED brightness and voltage control 44
2.2 TPS60403 charge pump voltage inverter 49
2.3 TPS61040 low power DC/DC boost converter 50
2.4 LT1054 switched-capacitor voltage converter 52
2.5 MAX1848 white LED step-up converter 53

3 7-segment Displays 55
3.1 Fundamentals of 7-segment LED displays 55
3.2 Case Study RS232 Data monitor 57
3.3 Case Study 00 to 99 minute programmable timer 65
3.4 Case Study 4 minute egg timer 69

4 B/W Liquid Crystal Displays 77
4.1 Industry standard alphanumerical LCD displays 78
4.2 Case Study ASCII string generator 87
4.3 Case Study RS232 data monitor 94
4.4 Case Study heart rate monitor -Program OXY.ASM 103
4.5 Case Study IIC real time digital clock 114

5 Graphic Liquid Crystal Displays 123
5.1 Case Study Densitron LM4068 B/W 100 x 64 pixel display 123
5.2 Case Study simple PDA using the Nokia 3310 129
5.3 Icon image editing software 136
5.4 Case Study Nokia 3310 GPS digital clock 140
5.5 Case Study Nokia 3510i Electronic compass 155
5.6 Case Study Nokia 6100 Epson display 8 bit colour 161
5.7 Case Study Nokia 6100 Philips display 16 bit colour 165
### Table of Contents

6  OEM colour Graphic Displays  
   6.1 OLIMEX  
   6.2 The MPS430-4619LCD (6100)  
   6.3 4D SYSTEMS  
   6.4 The 4D-MICRO-LCD-320-PMD2 DISPLAY  
   6.5 Display3000  
   6.6 ezLCD  
   6.7 REACHtech  

7  Appendix  
   7.1 References  

Index