

---

# Contents

---

<b>Preface</b> . . . . .	ix
<b>Chapter 1. Sensors for Power Electronics</b> . . . . .	1
1.1. Overview . . . . .	1
1.2. Current sensors . . . . .	5
1.2.1. Current measuring shunts . . . . .	6
1.2.2. Current transformer . . . . .	31
1.2.3. Hall effect sensors . . . . .	41
1.3. Voltage sensors . . . . .	49
1.3.1. Challenges associated with a straightforward function . . . . .	49
1.3.2. Non-isolated measurement . . . . .	49
1.3.3. Galvanic insulation solutions . . . . .	54
1.4. Temperature sensors . . . . .	57
1.4.1. Metrological challenges . . . . .	57
1.4.2. Temperature sensor categories . . . . .	58
1.4.3. Examples of conditioning circuits . . . . .	61
1.4.4. Thermal protection of power components . . . . .	64
1.5. Measuring instruments . . . . .	66
1.5.1. Measurement selection and quality . . . . .	66
1.5.2. Operation mode selection and safety measures . . . . .	69

<b>Chapter 2. Protections for Electronic Systems</b> . . . . .	75
2.1. Introduction and definitions . . . . .	75
2.1.1. Overview of malfunctions . . . . .	75
2.1.2. Protections and standards . . . . .	77
2.1.3. Phenomena duration . . . . .	80
2.2. Protection against overcurrents . . . . .	95
2.2.1. Limiting inrush current . . . . .	95
2.2.2. Fuses . . . . .	103
2.2.3. Resettable fuses . . . . .	108
2.2.4. Semi-conductor protections . . . . .	109
2.3. Protections against overvoltages . . . . .	110
2.3.1. Gas discharge tubes . . . . .	111
2.3.2. Varistors . . . . .	114
2.3.3. Transil diodes . . . . .	116
2.3.4. Printed circuit boards . . . . .	117
2.4. Explosion-proof equipment . . . . .	119
2.4.1. ATEX certification . . . . .	119
2.4.2. Protection index (IP) concept . . . . .	125
<b>Chapter 3. Storage Systems – Principles, Technologies and Implementation</b> . . . . .	129
3.1. Introduction . . . . .	129
3.2. From capacitors to supercapacitors . . . . .	132
3.2.1. Capacitors . . . . .	132
3.2.2. Physics elements in conductivity . . . . .	141
3.2.3. A few remarks about aging . . . . .	149
3.2.4. Supercapacitors . . . . .	150
3.3. From non-rechargeable to rechargeable batteries . . . . .	157
3.3.1. History . . . . .	157
3.3.2. Daniell cell . . . . .	160
3.3.3. Power cell technologies . . . . .	162
3.3.4. Cells from the viewpoint of the user . . . . .	166
3.3.5. History and principles of accumulators . . . . .	173
3.3.6. Comparing accumulator technologies . . . . .	175

3.3.7. Key quantities, definitions and vocabulary . . . . .	178
3.3.8. Accumulator technologies . . . . .	180
3.4. Monitoring the charge states and the health state of components . . . . .	193
3.4.1. Batteries . . . . .	193
3.4.2. Dedicated integrated circuits . . . . .	198
3.4.3. The case of capacitors and supercapacitors . . . . .	201
3.5. Circuits associated with storing systems . . . . .	203
3.5.1. Decoupling capacitors . . . . .	203
3.5.2. Balancing circuits . . . . .	209
3.5.3. Battery chargers . . . . .	214
<b>Appendix 1</b> . . . . .	<b>223</b>
<b>Appendix 2</b> . . . . .	<b>255</b>
<b>Errata</b> . . . . .	<b>265</b>
<b>Bibliography</b> . . . . .	<b>267</b>
<b>Index</b> . . . . .	<b>271</b>