

Contents

Preface	xiii
Chapter 1—Background and Evolution of On-Board Vehicle Data, Diagnostics, and Communication Capabilities	1
1.1 Introduction to Vehicle Electronic Feedback Control	1
1.2 Examples of On-Board Vehicle Systems with Data Memory	1
1.3 The Architecture of an ECU	3
1.4 Vehicle Environments with Multiple System ECUs	8
1.5 On-Board Diagnostics—II (OBD-II)	10
1.6 Freeze Frame Data that is Useful for Crash Analysis	14
Chapter 2—Geometric Conventions, the Physical Laws of Motion, Acceleration Models, and Numbering Systems	30
2.1 Geometric Conventions, Vehicle Trajectories, and Principal Direction of Force (PDOF)	30
2.2 The Physical Laws of Motion	32
2.3 Acceleration Models	34
2.4 Evaluating Collision Severity Using Force, Acceleration, Velocity, and Distance Relationships	39
2.5 Collision Pulse Characteristics, (Barriers, Vehicle-to-Vehicle Longitudinal, Pole Impacts, Side Impacts, Overrides)	42
2.6 Numbering Systems, Common Units, and Conversion Factors	45
Chapter 3—A Review of Air Bag System Architecture, Components, and Stored Data	49
3.1 Air Bags as a Safety Device	49
3.2 Air Bag Supplemental Restraints, Crash Pulse Input Vectors, and Design Axis Sensitivity	49
3.3 Components of Air Bag (SRS) Systems	50
3.4 Operation and Timing	60
3.5 Diagnostics, DTCs and Crash Data	60
Chapter 4—A Review of Antilock Braking and Traction Control Systems	72
4.1 Foundation Braking Systems	72
4.2 Antilock Braking Systems	72
4.3 Traction Control Systems	74
4.4 Components of ABS/TCS Units	75
4.5 ABS/TCS Diagnostics and Data Example	77

Chapter 5—Finding Data in Post Crash Vehicles and Deriving Useful Data Parameters	80
5.1 Getting at the Data via On-Vehicle Diagnostic Ports or Individual ECU Umbilicals	80
5.2 Getting at the Data In ECUs Affected by Crash and Fire Damage	80
5.3 Finding Out If An ECU Has Data in EEPROM or Flash Memory	80
5.4 Identifying ECU EEPROM/Flash Memory Interrogation Codes	82
5.5 Deriving Restraint System Deployment Timing Response from Crash Parameters	83
Chapter 6—Using ECU Electronic Data to Derive Case-Specific Analyses	91
6.1 Case Analysis Objectives and Introduction	91
6.2 The Anatomy of a Crash Pulse and Associated Freeze Frame Data	91
6.3 Occupant Dynamics with respect to a Vehicle Impact and Air Bag Deployments	91
6.4 Hypothetical Case 1, Analysis of a Crash Where Switch-Sensor Time Intervals are Recorded	95
6.5 Hypothetical Case 2, Analysis of a Crash Where Peak Acceleration and Base Duration are Recorded	101
6.6 Hypothetical Case 3, Analysis of a Crash Where Time Period Accelerations are Recorded	102
6.7 Hypothetical Case 4, Analysis of a Simple Crash where Cumulative Velocity Change Over a Fixed Period of Time Samples is Recorded	107
6.8 Hypothetical Case 5, Analysis of a Complex Crash Where Cumulative Velocity Change Over a Fixed Period of Time Samples is Recorded	112
6.9 Case 6, Extended Analysis of a 1999 Model Year Vehicle Crash—Documented via CDR Download in Chapter 3	116
6.10 Case Analysis Summary	122
Chapter 7—The Future of Vehicle Black Box Data Storage	123
7.1 Forecasting Advanced Electronics Applications in Vehicles and Complementary Event Data Storage Capabilities	123
7.2 Government and Industry Activities Concerning Ground Vehicle Event Data Recorders	123
7.3 Advanced Occupant Sensing, Collision Detection, and Safety Protection Systems	124
7.4 Wish List Parameters in Future Vehicle Crash Event Data Recorders	128

Appendix A—Glossary of Terms and Conversion Factors Used in Vehicle Data System	129
Appendix A.2.1—Conversion Factors by Unit MPH	141
Appendix A.2.2—Conversion Factors by Unit KPH	143
Appendix B—Scan Tools, Scanners, Bus Interfaces, and Manufacturer Contacts	145
Appendix C—Government Standards and Regulations (CARB, DOT/NHTSA, EPA)	149
Appendix D—Industry Standards and Specifications (SAE, ASTM, ISO, etc.)	150
Appendix E.1—Comparison of Recorded Data Parameters, Aircraft versus Automotive Black Boxes	152
Appendix E.2—Parameters in SRS and ABS ECUs	156
References	157
Bibliography	159
Index	161