

# Index

## A

5–30 rule, 60  
 ABS system, *see* Antilocking braking systems  
 Acceleration, inter-unit conversions, 48  
 Acceleration models, 34–42  
   barrier test crash, 34, 38  
   crash pulse model  
     defining and testing, 35–37, 40  
     evaluating against example, 37–39, 41  
 Adaptive feedback controlled  
   deployments, air bag systems, 54  
 Air bag ECU, xi–xiii  
   in-vehicle interrogation, 61, 68  
   laboratory download, xiii–xiv  
   parameters, 155  
 Air bag sensor, 50–51  
 Air bag system, 3, 6–7, 49–71  
   common components, 50  
   deployment decision matrix  
     generation 3+ systems, 125  
   deployment timeline, 60, 63  
   determining air bag deployment  
     timing, 83–85, 87–89  
   diagnosis using scanner, 7  
   distributed sensor switches, 50–54  
   intermediate generation, 53, 55  
   lamp blink code diagnostics, 53–54  
   malfunction indicator lamp, 53  
   modulated inflation, 125  
   modules, 59–60, 62  
   performance, 49–50  
   scanners, 61, 63–66  
   second generation, 53–54, 57  
   sensors, 54, 56–61  
   smart third generation, 124  
   third generation, 54  
 Aircraft data recorders, xi–xii  
   versus automotive, 151–154  
 Anthropomorphic Test Device, 44  
 Antilock braking systems, 72, 74  
   freeze frame data, 97, 99  
 Antilock braking/traction control  
   systems, 74–76  
   common components, 75, 77  
   ECUs, 77  
   format and scaling of freeze frame  
     data, 77–79  
   pumps, valves, accumulators, and  
     motors, 77  
   wheel sensors, 77  
 Antilocking braking ECU, xi–xiii  
   individual wheel speed sensor  
     feedback, 3, 5  
   parameters, 155  
 Arming sensor, 51  
   determining closure timing, 84, 88

## B

Barrier approach velocity, 37  
 Barrier equivalent velocity, 43–44  
 Barrier test-crash, 34, 38

## C

Code of Federal Regulations, 148  
 Collision avoidance sensing, 125  
 Collision pulses, 42–43  
 Controller area network, 8, 13  
   with diagnostic scanner attached, 10, 16  
   ISO specification, 8, 14  
   OBD-II, 10–11, 14, 17–19  
   protocol layers, ISO OSI vs. SAE  
     J1850, 8, 15  
 Crash data  
   case-specific analysis, 91–122  
     complex crash where cumulative  
       Delta V over fixed time period is  
       recorded, 113–118  
     crash pulse and associated freeze  
       frame data, 91–94  
     crash where peak acceleration and  
       base duration are recorded, 99,  
       101–102  
     crash where switch-sensor time  
       intervals are recorded, 95–97  
     crash where time period  
       accelerations are recorded, 102–  
       107  
     pre-event vehicle status and  
       cumulative Delta V before and  
       after impact, 116, 118–122  
     reconstruction analysis, 97–98  
     simple crash where cumulative  
       Delta V over fixed time period is  
       recorded, 107–112  
   deriving from raw hex data, 64–65  
   deriving restraint system timing  
     response, 83  
   determining air bag deployment  
     timing, 83–85, 87–89  
   determining restraint system timing  
     response, first pass analysis, 87–  
     89  
   from ECUs affected by crash and fire  
     damage, 80, 82–84  
   format and scaling of freeze frame  
     data, ABS/TCS DTCs, 77–79  
   identifying EEPROM/flash memory  
     interrogation codes, 82, 86–87  
   occupant dynamics, impact and air  
     bag deployment, 91, 95–96  
   on-vehicle diagnostic ports or  
     umbilicals, 80–81  
   parameters associated with SRS  
     deployment events, 65

pre-crash data, 61, 69  
 retrieving, 60–61, 63–71  
 sensitivity analysis and sensor  
   tolerances effect on first pass  
   timing calculation, 89–90  
 Crash data retrieval system, 61, 63–66  
 Crash pulse data, 91–94  
 Crash pulse model, defining and testing,  
   35–37, 40  
 Crash sensors, 51  
 Cruise control system, 3–4  
 Cryptoanalysis, 82

## D

Dealer-diagnostic work stations, 60  
 Delta V, 30  
   cumulative, *see also* Crash data  
     crash pulses, 36  
     SRS system, 85  
 Diagnostic trouble codes, 1  
 Discriminating sensors, 51  
   electromechanical, 54, 56, 58–59  
   solid-state, 56, 59–61  
 Distributed sensor switches  
   air bag system, 50–54  
   determining air bag deployment  
     timing, 83–85, 87–89  
   with intra-ECU transistor fire control,  
     53, 55  
 DTC  
   assignments, 14, 20  
   breakdown of, 14, 21  
   crash time line and potential event-  
     triggered DTCs, 92  
   data useful in crash investigations, 14,  
     29  
   deriving from raw hex data, 64–65  
   format and scaling of freeze frame  
     data, ABS/TCS, 77–79  
   numbering systems, 45  
   retrieving, 60–61, 63–71  
   storage, 3

## E

ECU, 1  
   affect by crash and fire damage,  
     obtaining data, 80, 82–84  
   antilock braking/traction control  
     systems, 77  
   architecture, 3, 8–10  
   composite tutorial architecture, 8–9  
   data in EEPROM or flash memory,  
     80–82, 85  
   electronic data, *see* Crash data  
   future, 123  
   inter-ECU communication, 8, 12  
   multiple system, 8, 10–16  
 EEPROM, 1, 80–81

identifying interrogation codes, 82, 86–87  
 Electromechanical discriminating sensors, 54, 56, 58–59  
 Electronic control module, 1, 3  
 Electronic control unit, *see* ECU  
 Electronic fuel injection, 1  
 Electronics applications, forecasting, 123

**F**

Flash memory, 1, 80–81  
 identifying interrogation codes, 82, 86–87  
 Foundation brakes, 72–73  
 Freeze frame data, 91–94  
   ABS system, 97, 99  
   parameters associated with crash events, ABS/TCS, 79  
   SRS deployment events, 65

**G**

Geometric conventions, 30–33  
 Glossary, 128–139

**H**

Haddon matrix, 124  
 Haversine function, 34–35, 39  
   graphical characteristics, 39  
 Haversine models, applicability to Delta V data, 104, 106–107, 115–118  
 Hydraulic control units, 77

**I**

Impact velocity, 84–85, 88  
   equivalences, 42–45  
 Integrated continuous accelerometer sensors, 53–54, 57  
 ISO 8092–3, 149  
 ISO 9141, 11  
 ISO 9141–2, 11, 149  
 ISO 11898, 149  
 ISO 14229, 149  
 ISO 150311–3, 149  
 ISO/DIS 14230–1, 149  
 ISO/DIS 14230–2, 149  
 ISO/DIS 14230–3, 149  
 ISO/DIS 14230–4, 149  
 ISO/IEC 9646, 149  
 ISO specification, CAN, 8, 14

**L**

Lamp blink code diagnostics, SRS ECU, 53–54  
 Logos, 81–82, 85

**M**

Micromachined accelerometer designs, 59–60  
 Motion, physical laws, 32–37  
 Mounting bolt torque measurement, 80

**N**

Numbering systems, 45  
   decimal vs. hexadecimal, 45–46

**O**

OBD-II, 10–11, 14, 17–19  
   communication protocols, 11  
   connector, 11, 17  
   mandated and optional signal connections, 18  
   manufacturer-variations in signals, 14, 19  
 Occupant sensing, advanced, 124–125  
 On-board diagnostics-II, *see* OBD-II  
 On-vehicle diagnostic ports, 80–81

**P**

Passive restraint systems, 50  
 Physical laws of motion, 32–37  
 Pretensioner assemblies, 49  
 Principal direction of force, 30–33

**R**

Rebound velocity, 43  
 Regulations, 148  
 Rolamite sensor, 56, 58–59

**S**

SAE J211, 30, 44, 50–51, 56, 73, 149  
 SAE J670e, 30, 44, 50–51, 56, 73, 149  
 SAE J1113/1, 149  
 SAE J1113/2, 149  
 SAE J1113/3, 149  
 SAE J1113/4, 149  
 SAE J1113/11, 149  
 SAE J1113/12, 149  
 SAE J1113/13, 149  
 SAE J1113/21, 149  
 SAE J1113/22, 149  
 SAE J1113/23, 149  
 SAE J1113/41, 149  
 SAE J1211, 149  
 SAE J1213–1, 149  
 SAE J1538, 49  
 SAE J1547, 149  
 SAE J1587, 149  
 SAE J1699, 149  
 SAE J1708, 149  
 SAE J1850, 11, 149  
   network, 8, 13  
 SAE J1879, 149  
 SAE J1930, 149  
 SAE J1939–11, 149  
 SAE J1939–21, 150  
 SAE J1939–31, 150  
 SAE J1939–71, 150  
 SAE J1939–81, 150  
 SAE J1962, 150  
   OBD-II, 11  
 SAE J1978, 150  
 SAE J1979, 11, 150  
 SAE J2012, 150  
   PID, assignments and common system identifications, 14, 20  
 SAE J2178, 11, 150  
 SAE J2178–1, 150  
 SAE J2178–2, 45–46, 150  
 SAE J2178–2:2, 96, 102, 108, 113  
 SAE J2178–2:4, 95–97, 101–102, 104, 107–108, 113–114

SAE J2178–2:6, 95, 101, 104, 107, 113  
 SAE J2178–3, 150  
 SAE J2178–4, 150  
 SAE J2186, 150  
 SAE J2190, 150  
 SAE J2201, 150  
 SAE J2205, 150  
 SAE J2223–3, 150  
 SAE J2284, 11, 150  
 Safety protection systems, 124–125  
 Safing sensor, 51  
 Scanners, 3, 144–147  
   air bag system, 61, 63–66  
   connection, 11, 17  
 Scan tools, *see* Scanners  
 Sensors, air bag system, 54, 56–61  
 SET/NETWAY network analysis tool, 82, 87  
 Smart systems, 124  
 Smart third generation air bag system, 124  
 Solid-state discriminating sensors, 56, 59–61  
 Specifications, 149–150  
 Squib, 51, 53, 60, 62  
 SRS, *see* Air bag system  
 Standards, 149–150  
 Supplemental restraint systems, *see* Air bag system

**T**

Test Manikin, 44  
 Thomson TS 68HC811E2 MPU, 10  
 Traction control systems, 74–74  
 Twin orthogonal thick film accelerometers, 59, 61–62

**V**

Vehicle collision severity, evaluating, 39, 42–43  
 Vehicle electronic feedback control, 1–29  
   examples, 1–7  
   multiple system ECUs, 8, 10–16  
   OBD-II, 10–11, 14, 17–19  
   snapshot and freeze frame data, crash analysis, 14–15, 20–29  
 Vehicle event data recorders  
   vs. aircraft, 151–154  
   government and industry activities, 123–124  
   wish list for future, 126–127  
 Vehicle speed signal, 3  
 Vehicle trajectories, 30–33  
 Velocity, common units, 46–48  
 Velocity change vector, *see* Delta V  
 Velocity conversion factors, 46–48  
   between metric and English units, 47  
   English units, 140–141  
   metric units, 142–143  
 Vetronix crash data retrieval scanner, 124

**W**

Wheel speed sensors, 77, 97  
 Wheel speed signals, 72