

# APPENDIX A

## Glossary of Terms and Conversion Factors Used in Vehicle Data Systems<sup>1</sup>

Name / Acronym	Description	Function
<a>	Average acceleration (a)	Notation used to denote the average value of acceleration over a specific time segment or period. Also see $a_{\text{average}}$ .
$\mu\text{S}$ or US	microseconds	1/1 000 000 second = $10^{-6}$ . Used as a measure of time when describing SRS timing events, usually with multiplier.
2 <sup>s</sup> Complement Signed Numeric Byte		2 <sup>s</sup> Complement Signed Numeric Byte, where the numeric value of the lower 7 bits (Bits 0 to 6) represents a value whose sign depends on the MSB (most significant bit, Bit 7). If the MSB is "1" the value is negative, and if the MSB is "0" the value is positive. Similarly to 4, the decimal interpreted value represents an engineering unit, depending upon a value resolution specification (e.g., each count = 0.5 mph).
4WAL	Four Wheel Anti Lock	Describes 4-wheel (versus rear-wheel-only) antilock braking system
5/30 Rule	5 in./30 ms timing rule	The 5-30 rule was established on the basis of a 30 mph frontal barrier collision, wherein an unrestrained driver will have moved 5 in. forward from his or her seated position at the instant of the crash.
A/D	Analog-to digital	Used to describe an electronic function that converts an analog voltage input (usually from a sensor) into a digital value that can be used in computer calculations (also see Scale Factor and Engineering Units).
$a_{\text{average}}$	Average acceleration	Notation used to denote the average value of acceleration over a specific time segment or period. Also see <a>.
ABRS	Air Bag Restraint System	Generic name of SRS that provides an air pillow/cushion restraint to prevent contact with the steering wheel and other objects in the car. Also see SRS, ACRS, etc.
ABS	Antilock Braking System	Electronically modulated braking control system that prevents individual wheel lockup on road surfaces with varying coefficients of friction.
AC	Alternating Current	Electrical power source embodying periodically inverting voltage polarities. As distinguished from DC, direct current that defines a power supply of constant polarity.
Acceleration		A term used to denote the time rate of change of velocity.
Accelerometer	Solid state device, usually contained within the SRS ECU.	Accelerometers produce a continuous voltage output proportional to the deceleration pulse magnitude. The time pattern of that output is called the deceleration pulse (waveform, or crash signature). The cumulative time integral of the deceleration pulse is the cumulative velocity change (deceleration) of the crash vehicle.  The MPUs within the ECU compare the subject crash deceleration pulse (signature) with prestored crash test pulse patterns (known threshold signatures) to determine if the air bags should be fired.
ACRS	Air Cushion Restraint System	Generic name of SRS that provides an air pillow/cushion restraint to prevent contact with the steering wheel and other objects in the car. Also see SRS, SIR, ABRs.
Active Filter		An electronic filter that combines active circuit devices, usually op amps, with resistors and capacitors. Typically, active filters more closely match ideal filters than passive filters do.
ADC	Analog-to-digital converter	An electronic circuit that produces a digital output directly proportional to an analog signal input. Also see A/D converter.
Algorithm		A set of rules with a finite number of steps for solving a problem. In the context of this book, a computational procedure used to determine whether or not to fire the air bag(s) and/or seatbelt pretensioners in newer model cars.
Alias Frequency		A false lower-frequency component that appears in analog data that is reconstructed from original data digitized at an insufficient sampling rate. Also see Nyquist Sampling theorem.
Anti-Alias Filter		A filter that attenuates noise and high-frequency components of an analog signal prior to its sampling and conversion into a digital value, to prevent aliasing (false signal content due to undersampling of high frequency components of the source data).

<sup>1</sup> Portions of this glossary may be similar to, or reprinted from, Chapter 2, "Air Bag System Analysis," *Forensic Accident Investigation: Motor Vehicles, Vol. 2*, with the express permission of the publisher, Matthew Bender & Co, Inc., a part of LEXIS-NEXIS.

Name/Acronym	Description	Function
$a_{peak}$	Acceleration, peak value.	Maximum instantaneous value of acceleration during a particular event. Also see accelerometer, $T_{pulse}$ and $\Delta V$ .
ASCII Encoded Byte		ASCII Encoded Byte, where the value of the byte indicates an ASCII character. ASCII encoded bytes are the type of bytes sent by computers via parallel ports to printers to print text documents.
ASDM	Air Bag System Diagnostic Module	Electronic controller that continually checks the functional readiness of the air bag system. A manufacturer specific name for the generic "SRS ECU."
Asynchronous		An action that takes place at an arbitrary time, without synchronization to a reference timer or clock.
$a_{thresh}$	Acceleration Threshold	Minimum value at which sensors or an algorithm responds. Usually stated as a function of Gs vs. base ms vs. waveshape (haversine or half-sine).
Attenuation		The difference in a signal=s voltage, current, or power after passing through a device or system, i.e., the signal loss from input to output ports.
Averaging		A mathematical smoothing the results of several measurements by adding them and dividing by the number of samples.
Balun		An antenna-balancing device that matches a balanced or symmetrical load (a dipole antenna) to an unbalanced load (a coaxial-cable feed line). Balun is derived from balanced-to-unbalanced.
Bandwidth (BW)		A range of frequencies over which a system works without materially degrading the original signal.
Binary Coded Decimal Byte		Binary Coded Decimal Byte, where each 8-bit byte is split into two 4-bit halves (called nibbles) and the numeric value of each nibble represents a decimal digit.
Bit Map		A set of values that specify information in a binary value. Used to specify colors or gray levels in an image, or to provide mask values in a DTC list.
Bit Mapped Without Mask Byte		Bit Mapped Without Mask (byte), where each bit of an eight-bit byte represents a predefined binary condition (e.g., on/off), dependent upon the position of that byte within the byte.
Bit Mapped With Mask Byte		Bit Mapped With Mask Byte, where each bit of an eight bit byte represents a binary condition (e.g., on/off), dependent upon the position of that byte within the byte, and the data byte is followed by a definition (mask) byte indicating which data bits of the information byte are valid.
BNC	Electrical Connector Type	A type of coaxial cable electrical connector using positive twist-lock bayonet attaching method. Useful where vibration-induced diskconnects might affect system integrity such as in aircraft, automotive, or shock-test environments.
BNC	Bounce (abbreviation)	Term used to describe diskontinuties in air bag sensor switch signal conductivity during closure period. Sometimes stated as $BNC_{max}$ , which is the accumulated open time during which the sensor switch should have been (stayed) closed.
BOO	Brake ON OFF	See Stop Lamp Switch
Boost, Vacuum		Device to amplify operator brake pedal force input to the master cylinder. Uses engine vacuum to charge a vacuum servo or "booster diaphragm" directly in front of the master cylinder.
Boost, Hydraulic		Device to amplify operator brake pedal force input to the master cylinder. Uses motor pump to charge a hydraulic servo or "booster piston" directly in front of the master cylinder.
BPMV	Brake Pressure Modulator Valve	A valve tree assembly used to modulate brake wheel cylinder pressures and thus control individual wheel lockup on road surfaces with varying coefficients of friction.
bps	bits per second	Bit rate at which serial data are transferred. One character typically takes 10 bits (8 bits with the ASCII code, one start bit and one stop bit).
Brake Switch		Switch actuated by operator actuation of brake pedal. Can be hydraulic (i.e., on master cylinder circuit) or mechanical (i.e., on brake pedal swing arm). This switch is used to actuate or release related components such as ABS, TCC, CC, etc.
Brake Pads	Disk Brake Component	Friction apply components that are squeezed by caliper against the disk to provide stopping torque.

Name / Acronym	Description	Function
Brake Shoes	Drum Brake Component	Rectangular shaped friction apply surface on a nonrotating arced steel backing plate which is forced by the wheel cylinder(s) against the rotating brake drum to provide stopping torque.
Braking Coefficient		Ratio of braking force to vertical load.
Brushes and Slip-Ring	Rotary Connector at Steering Wheel. Spring-Tensioned Brushes (4) sliding on concentric commutators under steering wheel.	Component to electrically connect a rotating member to a stationary member. In the context of this book, a driver steering column component to electrically connect driver steering wheel air bag to its firing circuit and/or SRS ECU.
Byte		8 bits of binary data.
CAD	Computer Aided Design	Generic name of various design systems used to create engineering drawings. Can be considered the dual of various word processing programs used to create text documents.
CAE	Computer Aided Engineering	See CAD.
CAN	Controller Area Network	A network of computer controllers (microprocessors) that are constantly communicating with each other via a common serial data path.
Canister		A sealed device containing ignition capsule and gas generant. May have an inner filter.
Capacitor	Electrical Storage Device	Used to store electrical energy. In SRS systems, used to provide deployment energy in the event of a severance of battery cables in a crash, to deploy air bags and/or seat belt pretensioners.
Case		Metallic outer housing of an assembly or sensor, generally assumed to be grounded. Some systems generate diagnostic codes indicating the absence of case ground.
Checksum		A quantity added to the sum of a group of data values to make it come out even (00000000), or odd (11111111). Usually transmitted with the data to assist in error detection.
Clockspring	Rotary Connector at Steering Wheel. Helical multi-line spiral conductor contained in capsule under steering wheel.	Component to electrically connect driver steering wheel air bag to sensors and SRS ECU. Generally has superior conduction qualities when compared to slippings and brushes.
CMOS	Complementary Metal Oxide Semiconductor	A semiconductor technology chosen for its low power consumption and good noise immunity. CMOS uses both N-channel and P-channel MOSFET devices. MOSFET devices operate by using a change in conductivity caused by the varying electrical field created by a control electrode (gate) insulated from its substrate by a silicon oxide.
Cold-Junction Compensation		An artificial reference level used in thermocouple conversion circuits.
Combination Valve		Composite of three valves used to: a. Hold-off front apply till rears are pressurized (called metering function). b. proportion rear hydraulic circuit. c. close switch (Brake MIL) to alert driver to pressure imbalance in brake circuit master-cylinder output.
Compensation Port		Port in Master Cylinder that allows brake circuit fluid flow to and from the reservoir, before any piston (pedal) pressure.
Connector Assurance Latch		A redundant lock on air bag system electrical connectors (or any other critical connector) to assure that the wiring harness connector will not simply unlatch from vehicle vibration, etc. Normally, this connector assurance latch must be removed first, in order to allow disassembly of the actual electrical harness connector. Also called secondary latch.
Connector	also: plug, pigtail	A device that electrically interconnects the main wiring assembly to other components and hardware.
Consult	SRS ECU Scanner	Tool for reading internal EEPROM stored codes and crash data.
Coolant	A chemical added to the gas generant to reduce the gas temperature.	Also, a chemical mixture used in engine heat management systems.
COP	Computer Operating Properly. Also: watchdog.	Circuit used to detect device runaway or stall, and used to provide a means for restoring correct operation or alerting an operator of malfunction.
Counter		In software, a memory location used to store a count of certain occurrences. In hardware, a set of latches which are used to save accumulated values. Typically used in clocking circuits such as a time of day counter.

Name/Acronym	Description	Function
CPU	Central Processing Unit	
Crash Datagram		Parameter map of acceleration and timing parameters recorded in crash event. Read out with special SRS ECU EEPROM Scanner.
Crash Sensor	Detector for high-level deceleration impulse resulting from vehicle collision. Also called Discriminating Sensor.	
Cross Assembler		A program that runs on one computer and generates instructions for another type of computer.
Crossover Channel		Hydraulic Channel used in fixed-caliper designs (pistons on both sides of rotor) to route fluid across the caliper.
Crosstalk		Inadvertent signal generated when one or more signals interfere with another signal. Usually classed as noise degradation.
Cushion	Inflated Envelope	Also called air cushion or air pillow, i.e., the "air bag."
Cycle		One complete sequence of regular-periodic actions, i.e., an ignition on-off cycle or a wheel oscillation bounce or an electrical waveform period.
Cycle Code		Error Code saved in memory during ignition cycle in which it occurred. Usually disables the system function for that cycle only.
D/A	Digital-to-analog	An electronic circuit that produces an analog output directly proportional to a digital value input.
DAC	Digital-to-analog converter	An electronic circuit that produces an analog output directly proportional to a digital value input.
Damping		A means to dissipate energy in vibrating or oscillatory systems. Also refers to the amount of overshoot allowed, or seen, in system responses.
Data Acquisition (DAQ)		Generally, a digital system to gather and store information from external sources such as sensors, transducers, etc. Data are usually stored in computer media.
DC-DC Converter	Electrical circuit that converts input DC voltage to a higher DC output voltage.	In the context of this book, a circuit section used to create an elevated storage voltage on an energy storage capacitor for the emergency deploy reserve.
DC	Direct Current	Electrical power source embodying constant voltage polarities. As distinguished from AC, this defines a power supply embodying periodically inverting voltage polarities.
Delta V	Also shown as $\Delta V$ .	The change in linear velocity during a specific time period. Note that a $\Delta V$ of 30 mph over a period of 200 ms vs a period of 50 ms produces markedly different waveforms and peak accelerations, $a_{peak}$ .
DERM	Diagnostic Energy Reserve Module	G.M. Generation 1 SRS diagnostic and energy reserve module. Continually checks the functional readiness of the air bag system and saves DTCs and certain crash event timing data.
Diagnostic Module		A module containing electronic circuits that provides one or more of the following: system monitoring, system readiness, readiness indicator, and warning indicator prove out features.
Diffuser		A device on most inflation canisters to filter and distribute the inflation gas generant before it fills the air bag.
Digital-to-Analog Conversion		An electronic circuit that produces an analog output directly proportional to a digital value input.
DIP	Dual In-line Package	Describes the pin layout on an integrated circuit component (MPU, Clock, EEPROM, etc.).
Direct Memory Access (DMA)		The direct transfer of information between a computer's memory and a device while the computer's CPU does something else.
Dither	Vibratory control of valve position.	Method of preventing hydraulic valve clog at any particular flow rate.
DLC	Data Link Connector	Generic term describing diagnostic scanner access port to a vehicle communication network.
DMM	Digital Multimeter	Electronic test meter, combining current, voltage, resistance, etc., measurement functions, which does not significantly load the measured circuit. Also called DVM. This not the same as a legacy analog volt meter which loads the measured circuit.
DOT Class B	Explosives Classification	Explosives that produce rapid combustion and gases.

Name/Acronym	Description	Function
DOT Class A	Explosives Classification	Explosives that detonate, maximum explosion hazard.
DOT Flammable Solid NOS		Any solid material other than an explosive which can, in normal transportation, cause fires through friction or retained heat, and burn vigorously and/or persistently when ignited.
DOT Class C	Explosives Classification	Manufactured articles that may contain Class A/B explosives in restricted quantities, minimum explosion hazard.
Drag	Residual Brake Pad Friction on Rotor	Residual brake friction can cause brake overheating and component expansion which can impair brake operations
Driver	or Device Driver	Software that controls a specific hardware device, such as a DAQ board, printer, monitor, etc.
Driving Coefficient		Ratio of driving force to vertical load.
Drop Test(er)	A test(er) using a free fall method to shock a component with a measured pulse.	Used to release a component from a specified height onto an anvil surface (steel plate or specifically damped surface) to determine damages or to impinge a specific acceleration pulse on a component.
DTC	Diagnostic Trouble Code	A formal name for system-detected error codes.
Dump		Mechanical: A function that relieves pressure or vacuum in a particular circuit (typically used when describing CC servo vacuum or braking wheel cylinder pressures, etc.).  Electronic: A function that describes downloading all the data in a particular place, such as RAM or EEPROM.
DUR	Duration. Also see DWL.	Duration time of sensor switch closure. Sometimes stated as $DUR_{min}$ , which is the minimum time during which the sensor switch should have been closed.
Dust Boot		Outer seal in wheel cylinder to prevent dust and road grit from entering piston bore and affecting piston seal. Also, seal on floating-caliper slider pins.
DUT	Device Under Test	Typical term used in industry to describe a subject device in a test apparatus.
DVM	Digital Voltmeter	Electronic test meter, combining current, voltage, resistance, etc., measurement functions that does not significantly load the measured circuit. Also called DMM. This not the same as a legacy analog volt meter which loads the measured circuit.
DWL	Dwell. Also see DUR.	Duration time of sensor switch closure. Sometimes stated as $DWL_{min}$ , which is the minimum time during which the sensor switch should have been closed.
EBCM	Electronic Brake Control Module	A term used to describe an electronic controller in an ABS system.
ECT	Electronically Controlled Transmission	A vehicle transmission whose shift (and other) functions are controlled by electromechanical components, actuated by a transmission ECU, or a section of the PCM.
ECU	Electronic Control Unit	A generic term for electronic control device (e.g., Computer or Controller). An ECU performs functional activation calculations and continually checks the functional readiness of a vehicle system.
Edge Detection		Imaging: A technique that locates an edge by examining an image for abrupt changes in pixel values.
Edge Detection		Electronics: A circuit technique that triggers on an input waveform edge (rising or falling) versus an absolute voltage level.
EDRU	Event Data Retrieval Unit	Assembly of a scanner, umbilical cables, and small printer that is used to download DERM/SDM EEPROM engineering level crash data. (G.M.)
EEPROM	Electrically Erasable Programmable Read Only Memory	A section of memory that retains data even when power is removed from the ECU. Read out by special scan tools through an ECU serial port. Such devices (EARAM, EEPROM, flash memory) are called nonvolatile memory.
EHCU	Electro Hydraulic Control Unit	A term used to describe an electronic controller in an ABS system.
EMCC	Electro-Motor Cruise Control	A cruise control device that used a motor and clutch to control the throttle of a vehicle engine (as distinguished from a vacuum servo CC system).
EMI	Electro Magnetic Interference	Electro magnetic energy that can cause unwanted performance of a system or an ECU.
EMI Tests		Exposure to electromagnetic interference with evaluation of effects.

Name/Acronym	Description	Function
Energy Capacitor		A device to store enough energy to deploy air bag in case of power failure to system during crash. Usually good for approximately 1 s.
Energy Reserve Storage Device		Device to store enough energy to deploy air bag in case of power failure to system during crash. Usually good for approximately 1 s. The electrical device is usually a capacitor that is charged to a higher-than-battery voltage by a built in DC-DC converter.
Engineering Units		Specification of the physical quantities of interest. Examples are volts, amps, psi, mph, kph, gpm, gps, etc.
EPROM	Erasable Programmable Read Only Memory	This type of memory requires exposure to ultraviolet wavelengths in order to erase previous data. Also known as PROM.
Error Code		Code saved in ECU memory after ECU has detected an abnormal condition. Modern terminology is Diagnostic Trouble Code (DTC).
ESD	Electrostatic Discharge	Static charge dissipation that can cause damage to electronic circuits.
ETR	Emergency Tensioning Retractor	Electrically ignited gas piston to increase the tension in the seat belt and remove slack just after a crash is detected and before an occupant loading occurs, thus holding passenger(s) firmly in seat during a crash impulse.
Filter (Assembly) (Mechanical)		A construction of ports, and wire and mesh material that absorbs heat and prevents solid particles from exiting an air bag inflator.
Filter (Electrical)		An electrical circuit to suppress (attenuate) unwanted signal frequencies from passing through a circuit. Used to prevent aliasing (false signal generation) associated with certain A/D sampling rates versus signal frequencies.
Floating-Caliper		Disk brake caliper that uses a single-side piston, requiring caliper to slide (compensate) as disk pad friction material wears.
Frequency		The number of periods of harmonic motion (cycles of vibration, etc.) occurring per unit time. Usual units are Hertz (Hz), which are cycles per second. Applies to mechanical objects and electrical signals.
Freeze Frame		A set of associated data saved in nonvolatile memory to provide the conditions existing as a particular DTC is confirmed and also saved in nonvolatile memory.
Gas Generant		A solid material ignited by the squib/igniter/initiator to produce gas that inflates the folded air bag envelope.
Generant		Also called inflator, which burns to create the gas volume that inflates the folded air bag envelope.
GPIB	General Purpose Interface Bus	A type of data bus used by electrical test equipment.
Gray Zone		SRS: The region between Must Fire and Must Not Fire where performance is not guaranteed. Also see Must Fire and Must Not Fire.  Electrical Binary Switching Circuits: The region between specified or defined output responses. When the voltage input to a binary electrical switching circuit is in the gray zone, the output can be either a "1" or a "0" (and is considered undefined).
Ground		An electrically neutral wire that serves as a common reference point for an electrical system. Derived from the concept of having the same common potential as the surrounding environment (earth). In power wiring, ground is normally a noncurrent-carrying circuit intended for safety (e.g., ground-fault circuit-interrupters).
Gs		Acceleration/deceleration of Gravity. 32.17 feet/s <sup>2</sup> , 21.9 mph/s, 9.81 m/s <sup>2</sup> , 35.3 kph/s <sup>2</sup> . Gs × time is used as a measure of impact impulse.
Half Sine		Waveform model of crash impulse or sensor test impulse.
Hard Pedal		A brake pedal that feels high and hard, not firmly compliant as is the usual feel with boosted brakes.
Haversine		A waveform model of crash impulse or sensor test impulse.
HCMOS	High-Density Complementary Metal Oxide Semiconductor	A semiconductor technology chosen for its low power consumption and good noise immunity.
Hexadecimal		Base-16 numbering system (0 to 9, A to F) for data bytes. Most automotive black box (computer memory) data is read out in this form and then has to be interpreted into engineering units. The interpretations are generally defined by SAE J2178-2 as "SLOT" definitions. Also see "SLOT" and (SAE J2178-2).
HHT	Hand Held Tester	Scanner type device to readout and program certain Bosch SRS ECUs.

Name/Acronym	Description	Function
HIC	Head Injury Criteria	A calculation of head resultant- acceleration (deceleration) integrated over a worst case crash time period.
High-Pass Filter		A circuit that attenuates low-frequency components in an analog signal.
http	Hypertext Transfer Protocol	The protocol that negotiates document delivery to a web browser from a web server.
Hz	Hertz	1 Hz = 1 cycle per s. An engineering unit to measure frequency.
I/O	Input/Output	Used to describe a bidirectional pin or function.
I/O Address		A specific hardware circuit and software value that is used to distinguish between the different electronic units in a system.
IC	Integrated Circuit	A complex device combining many individual electronic circuits and switches into one semiconductor die or chip. Modern ICs can have logic, filter, memory, and communications functions all on the same die.
Igniter		Also called Initiator or Squib. A pyrotechnic device, actuated by an electrical current, which ignites the inflator charge.
Impulse Tester		Simple scanner to count lamp blink codes.
Impulse		A change in momentum caused by a force. Evaluated as the average force $\times$ the time over which it acts.
Inflator	Also: generant	Chemical charge that burns to generate gas to inflate air bag. Requires "Igniter."
Initiator	Also: igniter, squib	A pyrotechnic device, actuated by an electrical current, which ignites the inflator charge.
Interrupt Handler		The software routine that takes care of an interrupt's request for service.
Interrupt		A signal that requires immediate attention from a computer's CPU.
Interrupt Vector		A type of interrupt that immediately points a computer to a new series of instructions.
IRS	Inflatable Restraint System	Also see SRS, SIR, etc.
Jerk		A term used to denote the time rate of change of acceleration. Used as a predictor of probable crash severity.
Julian Day Number		Obtained by counting days from the starting point of noon on 1 January 4713 B.C. One way of telling what day it is with the least possible ambiguity.
K byte, kb		A kilobyte of memory (1024 bytes). Four kb = 4096 bytes.
Knee Bolster, Bar, Bumper		A cushion device under the steering wheel to prevent occupant submarining and to lessen femur and tibia loads.
LAN	Local Area Network	Generic term used for fixed-location area networks (as distinguished from vehicle networks, etc.).
Latched Code		A DTC saved in memory after ignition cycle in which it occurred. Usually disables the system in which it occurred and sets a warning light (i.e., ABS, SRS function, etc).
LCD	Liquid Crystal Display	A flat panel display having higher electronic efficiency than lagacy CRTs, etc.
Leading		Item contacted first as the wheel rotor turns forward.
LED	Light Emitting Diode	A special form of electrical diode that emits light in the forward-current flow direction.
Lining		Friction material attached to pad backing plate in brake systems.
Lip Seal		Unidirectional hydraulic seal used in brake systems. Its design forces increased sealing with increased pressure in the sealing direction.
Low-Pass Filter		A circuit that attenuates the high-frequency components in an analog signal. Also see aliasing.
LSB	Least Significant Byte/Bit	The minimum (units) count of a value in a byte of data. The SLOT conversion resolution is often expressed as a value in engineering units per LSB (min count).
LSPV	Load Sensing Proportioning Valve	A device that ratios (proportions) the relative pressure applied to the rear brakes dependent on vehicle weight distribution.
Master Cylinder		Foundation Brake piston/cylinder that provides hydraulic pressure to the wheel cylinders.
MCU	Microcontroller Unit	Integrated circuit component incorporating arithmetic processing, memory, and interface circuits.

Name / Acronym	Description	Function
Metering Valve		Pressure control valve used to hold off front (disk) apply till rear (drums) are pressurized (called metering function). Used to improve braking balance in light braking applications.
MIL	Malfunction Indicator Lamp	Instrument cluster warning lamp to alert driver to system malfunction. (ABS, SRS, etc.)
Module Assembly		An assembly consisting of the inflator assembly, bag, mounting plates or housing, and a protective cover.
Monotonicity		A characteristic of a properly operating DAC or ADC in which the output increases in a continuous and ratiometric fashion as the respective inputs increase. Also applies to decreases.
MOSFET	Metal Oxide Semiconductor Field Effect Transistor	A semiconductor device that operates using a change in conductivity caused by the varying electrical field created by a control electrode (gate) insulated from its substrate by a silicon oxide.
MPG	Miles Per Gallon	A term for fuel efficiency over distance.
MPU	Microprocessor Unit	An integrated circuit device that forms the central control unit of a vehicle system ECU.
ms	milliseconds	1/1000 of a second = $10^{-3}$ . Used as a measure of time when describing SRS crash events. Most crash events occur in 80 to 120 ms, although some may last as long as 200 ms.
MSB	Most Significant Byte/Bit	The maximum value bit in a byte of data. Also see LSB.
Multiple Parameter Byte		A data byte where more than one condition or value is contained within a hexadecimal value (or byte).
Must Not Fire		Threshold value, stated in units of Delta V, or $Gs \times s$ , below which the sensor must not close or the system must not fire. The region between Must Fire and Must Not Fire is known as the Gray Zone, where performance is not guaranteed.
Must Fire		Threshold value (stated in units of Delta V, or $Gs \times s$ ) above which the sensor must close or the system must fire. The region between Must Fire and Must Not Fire is known as the Gray Zone, where performance is not guaranteed.
Nibble		Half a byte (4 bits).
Noise Floor	Also: Noise Level	1) The level below which no information can be obtained from a signal. A signal that occurs below a noise floor is permanently lost. 2) The minimum discernable signal that can be detected by a receiver.
NRZ	Nonreturn to Zero	A form of data coding used in serial communications to maximize the data throughput per signal line.
NTSC	National Television System Committee. See also: PAL, RS-170	A standard for encoding color video signals. The standard is used in North America, Japan, and most of South America.
Nyquist Sampling Theorem		A theorem that states that if you sample a signal at a rate, $f$ , the samples will contain no information about signals with frequency components above $f/2$ .
ODI	Office of Defects Investigation, NHTSA	The branch of NHTSA that investigates potential vehicle defects.
OEM	Original Equipment Manufacturer	The source manufacturer of a component or system. Used to distinguish from a reseller or dealer, etc.
Ohms	Resistance unit	A measure of resistance to electrical current flow. Units are Ohms ( $\Omega$ ). A potential of one volt applied across one ohm will produce a current flow of one ampere.
Oscillograph		A time marked X-axis trace of Y-axis engineering parameters recorded on a hard copy output.
PAL	Phase Alternation Line. See also: NTSC, RS-170.	A composite color video standard used in Western Europe, India, China, and some Middle Eastern countries.
PCB	Printed Circuit Board	A phenolic or glass epoxy carrier with printed wiring interconnects between soldered components, forming an electronic assembly.
PCM	Powertrain Control Module	An engine EFI Controller often combining CC, EFI, ECT functions.
PDOF	Principal Direction of Force	A resultant vector force applied by object(s) colliding with a vehicle. A planar PDOF is the resultant of X-axis and Y-axis forces.
Pellet	also: pill, tablet	A compacted unit of gas generant that is used in the inflator.
Period	time, ms, etc.	The time period of one complete "cycle," i.e., the time it takes to complete sequence of regular-periodic actions such as a wheel oscillation bounce, etc.



Name/Acronym		Description	Function
Pigtail			A length of wire harness that has a connector installed on one end.
Piston			Actuated component inside brake cylinder bore. Wheel cylinder moves out with hydraulic pressure inside bore. Master-cylinder push-rod actuation caused hydraulic pressure to be generated inside bore (and then transmitted to wheel-cylinders).
Pixel			1) The fundamental picture element in a digital image. 2) The coordinate unit used to define the horizontal location of a pixel in an image. Pixel is actually an acronym for "picture element."
Polling			A round robin canvassing of inputs to a computer to determine which ones are active. Generally synchronized in software to a clock or external trigger.
Porosity			The gas permeability of the air bag fabric. Has to be considered along with vent holes when determining the deflation characteristics of air bags.
Port			A communications connection on a computer or a remote controller.
Primary Sensor			A sensing element employed to independently detect frontal type impacts.
PROM	Programmable Read Only Memory		A nonvolatile memory that retains its contents after power is removed. PROMs can be programmed in manufacturing or (usually once) in the field. In control ECUs, PROMs are usually used to hold program information and EEPROM/EEPROM, flash memory can be used to hold calibration-specific information. That way, calibrations can be changed electronically without a physical unit change.
Proportioning Valve			Valve to regulate the pressure to the rear brakes to prevent rear wheel lockup during hard brake application.
ps	Picoseconds		1/1 000 000 000 of a second = $10^{-9}$ .
psec	Picoseconds		1/1 000 000 000 of a second = $10^{-9}$ .
Pulse Width (PW)			The time from initial "0" (or minimum-threshold) until ending "0" (or minimum-threshold).
PWM	Pulse Width Modulation		Method of controlling valve flow rate.
RABS	Rear Anti Lock Brake System		Simplified form of antilock braking system that controls rear wheels only.
RAM	Random Access Memory		General form of computer memory, which loses its data contents when power is removed. Also see PROM.
Readiness Indicator	also: MIL		A device in the instrument panel that indicates the functionality of the electrical circuits by lighting up for a short time period after each ignition turn-on.
Recorder			A memory device in vehicle systems that records selected pre-crash and/or crash information.
RES	Resistance		Measure of resistance to electrical current flow. Units are Ohms ( $\Omega$ ).
Reservoir (Brake)			Fluid container, usually on top of master cylinder, gravity feeding into compensating port and rear chamber ports. Reservoir, but can also be remote container feeding master cylinder via hydraulic hose.
Residual Pressure			Small brake circuit pressure, usually < 10 psi, left in circuit to prevent trapped air from entering circuit. Used with drum brakes. Not used with disk brakes.
Residual Pressure Check Valve			Valve at master cylinder outlet to maintain small wheel brake circuit pressure, usually < 10 psi, to prevent trapped air from entering circuit. Used with drum brakes.
RFI	Radio Frequency Interference		Radio frequency energy that can have an effect on other equipment.
ROM	Read Only Memory		This type of memory is programmed during device manufacture and cannot subsequently be altered.
Rotor	Disk Brake Component		Disk-shaped friction apply surface which is squeezed by the disk caliper pads to provide stopping torque.
$R_{sense}$	Resistance across open sensor.		Telltale resistance to electrical current flow across open sensor. Used by the diagnostic ECU to assure that the sensor is connected, but does not provide enough current to fire the air bag. Units are Ohms ( $\Omega$ ).
RWAL	Rear Wheel Anti Lock		See RABS.
SAE	Society of Automotive Engineers		Organization of engineering professionals whose interests concern vehicle technologies.
Safing Sensor			See Arming Sensor.
Sample and Hold	SHA (sample and hold amplifier)		A circuit that acquires an analog voltage and stores it temporarily in a capacitor.

Name/Acronym	Description	Function
Scale Factor		Specification of the Engineering Units value of each count of a digital value (usually output by an A/D converter).
SCI	Serial Communications Interface	Used as an Input/Output device or function of a microcontroller device.
SCSI	Small Computer Standard Interface	Used as a standard interface to computer peripheral devices such as hard drives, CD Roms, etc.
SDM	Sensing and Diagnostic Module	Integral sensor module to determine if crash pulse is sufficient to deploy air bags. Also contains diagnostic and crash data storage functions.
Secondary Latch		A redundant lock on air bag system electrical connectors to assure wiring harness immunity from vehicle vibration, etc. Normally, this secondary lock must be removed first, in order to allow disassembly of the actual electrical harness connector. Also called connector assurance latch.
Sensitivity		A measure of the minimum change in an input signal that an instrument can detect.
Sensor	Small sealed unit, generally about the size of a pack of cigarettes.	<p>Device to detect an acceleration/deceleration pulse, can also be called a transducer.</p> <p>Sensors can be electromechanical, with moving mechanical switch elements, or they can be solid state devices with micromachined reaction pendulums. In both cases, the sensors produce an electrical output in response to the deceleration impulse.</p> <p>Electromechanical sensors produce a binary response (1, 0, switch closure).</p> <p>Accelerometers produce a continuous voltage output proportional to the deceleration pulse magnitude. The time integral of that output is called the deceleration impulse.</p>
Shorting Connector	also: shorting bar, shorting clip	Special harness connector that shorts the disconnected squib/igniter component leads to prevent stray electrical pulse input to that component. Used for Squib connections to prevent inadvertent firing from static electricity, etc. Also used in SRS ECU connectors to force SRS warning lamp on if SRS ECU is removed.
SI	International System of Units	kg, ms, N, N-m, m, etc.
Signal-to-Noise Ratio	SNR	Term used in communications to quantify the % of noninformation (noise or corruption) contained in a information signal of interest.
Signed Floating Point		A byte packet, where a combination of bytes represent a sign, exponent, and fractional part of an engineering unit, depending upon a value resolution specification.
SIP	Single In-line Package	Describes the pin layout on an MPU.
SIR	Supplemental Inflatable Restraint	G. M. System Identification for SRS.
Slip		Percentage of difference between the circumferential speed of a tire vs. the longitudinal speed of the vehicle. Zero braking occurs at 0% slip. Maximum braking occurs at 12 to 14% slip. Locked tires indicate 100% slip.
Slip-Ring and Brushes	Rotary connector at steering wheel. Spring-tensioned brushes (4) sliding on concentric commutators under steering wheel.	Connects driver air bag to sensors and ECU, allowing driver to turn the steering wheel. Largely supplanted by clock springs (multi-turn spiral springs) in modern vehicles to accomplish the same purpose.
SLOT	Scaling, Limit, Offset, Transfer Function	SLOT, in effect, defines the engineering units translation of a raw parameter value transmitted on the network (SAE J2178-2).
Snapshot		Recording function built into some test scanners that records vehicle conditions at the time of a trap parameter. Trap parameters can be a specific DTC manual, or a speed threshold, etc. error code storage. A Snapshot can be thought of as the scanner dual of freeze frames saved in on-board vehicle ECUs.
Soft Pedal		Brake pedal that has high travel and/or feels mushy, not firm.
SPI	Serial Peripheral Interface	A term used to describe a section of microprocessor architecture dealing with RS 232 or other serial data interface.
Spike		A transient disturbance of an electrical circuit. Can be caused by load variations on the AC power line, among other things.

Name / Acronym	Description	Function
Spring Rate		The unit change of force to compress (or extend) a spring relative to the unit deflection.
Squeal, inadvertent		Noise generated when the brakes are applied. Caused by some particular pad materials as pressurized against the rotors.
Squeal, intentional		Noise generated by steel extensions when pad lining thickness is low to warn the driver to have the brakes serviced. Happens when the brakes are applied. Caused by some particular pad friction materials.
Squib		Also called Initiator or Igniter. A pyrotechnic device, actuated by an electrical current, which ignites the inflator charge.
SRS Lamp		Instrument Cluster Warning Lamp to alert driver to SRS system malfunction. Also called MIL.
SRS	Supplemental Restraint System	Generic identification. Also see IRS, SIR, ABRS, ACRS, etc.
Stability		The ability of an instrument or sensor to maintain a constant output when a constant input is applied. Includes signal integrity over time and temperature.
State Encoded Byte		State Encoded Byte, where the data can represent a coding that stands for a condition or state of a parameter, system or a device. States can include day of the week, day of the month, transmission gear engaged, operational mode, etc.
Stop Lamp Switch		Switch actuated by operator actuation of brake pedal. Can be hydraulic (i.e., on master cylinder circuit) or mechanical (i.e., on brake pedal swing arm). This switch is used to actuate stop lamps on rear of vehicle.
Surge		A sudden change (usually an increase) in the voltage on a power line. A surge is similar to a spike, but it lasts longer.
Sync		The portion of a video signal that indicates the end of either a field or a line of video information, thus providing frame sync[hronization]. Also called synch.  Other uses include the name of a pulse that triggers electronic or video event data captures.
Tank Test		The firing of an air bag inflator into a closed volume at a specific temperature. Used as a measure of air bag inflator aggressivity or power.
TCC	Torque Converter Clutch	Lockup feature used in automatic transmission hydraulic component to increase transmission efficiency.
Tether(s)		Ribbons or straps inside the air bag envelope to limit the outward air bag envelope deploy distance after it is fired. Tethers are also used to "shape" the dynamic unfolding pattern of large passenger air bags, i.e., prevent face contact while allowing chest contact in the initial expansion phase.
$t_{\text{event}}$		The time duration encompassing an event under consideration.
Threshold		A level above which a system is triggered, or a level below which a system may be reset.
Throughput Rate		The maximum repetitive rate at which a data-conversion system, or a data communication system can operate with a specified accuracy.
Torque (brakes)		Measure of brake power at wheel axle. Usually Given in ft-lb.
Torque (mechanical)		Measure of attaching bolt tightness. Can affect sensor response. Usually given in in-lb. Note that tightening-torques are the only valid measure of an already-assembled bolt torque.
Torso Bag		A portion of the air bag that provides additional restraint to the upper body. See "tethers."
$T_{\text{pulse}}$		Time duration of crash acceleration pulse over a min threshold. Usually given in ms.
Trailing		Item contacted last as the wheel rotor turns forward.
TSB	Technical Service Bulletin	Notification sent to dealerships by manufacturers to notify them of a potential problem or servicing change.
TTC	Time To Close	Time (ms) after detecting $a_{\text{thresh}}$ for sensor to respond (close switch).
TTF	Time To Fire	Time (ms) after input pulse passes $a_{\text{thresh}}$ for sensor to respond (close switch).
TTL	Transistor-Transistor Logic	Standard form of bipolar transistor logic used since the early 1970s. Now largely superceded by CMOS. The TTL standard 0 and +5V signal levels are still pervasive in the industry.

Name/Acronym	Description	Function
Tunnel Sensor		Usually a discriminating sensor on the floorpan tunnel. Is also used to describe a combined arming/discriminating sensor on the floorpan tunnel.
UART	Universal Asynchronous Receiver Transmitter	Device used to control serial communications.
Unsigned Numeric Byte		Unsigned Numeric, where the decimal interpreted value represents an engineering unit, depending upon a value resolution specification (e.g., each count = 0.5 mph).
USB	Universal Serial Bus	Advanced serial port device used in modern computers. One of the few formats standard between Apple and IBM environment machines.
UUT	Unit Under Test	See DUT
VAC	Velocity At Close	Measurement of change in velocity at the time sample period of (electromechanical) sensor switch contact closure.  Also can be Voltage, Alternating Current
Vacuum Depletion		The condition where booster vacuum necessary to amplify brake pedal forces is diminished or absent.
VCO	Voltage Controlled Oscillator	Electronic circuit used in certain signal modulation and conditioning circuits.
Velocity		A term used to denote the time rate of change of distance traveled. Typical units are: mph, fps, kph, mps, etc.
Vents		The holes in some air bag designs that control the expulsion of gas from the bag to provide controlled occupant deceleration.
VIN	Vehicle Identification Number	A 17-digit vehicle identification with specific position codes (country, manufacturer, model-year, etc.).
VSS	Vehicle Speed Sensor	Usually a magnetic or hall-effect pulse generator usually on driveshaft or transmission tailstock. Sometimes on differential carrier or speedometer cable. Used for overall vehicle speed for cruise control, PCM, PZM (BCM), Remote Keyless Entry, or Autolock inputs. VSS can also be optical.
Warning Indicator		See MIL
Warning Valve		Shuttle-type valve used to close switch (Brake MIL) to alert driver to pressure imbalance in brake circuit master cylinder output.
Watchdog		Circuit used in microcontrollers to detect electronic lockup or freeze. Also: COP.
Wired-OR		A means of connecting outputs together such that the resulting composite output state is the logical OR of the individual outputs.
Word		In computer jargon, usually 2 bytes (16 bits).
WSS	Wheel Speed Sensor	Usually a magnetic pulse generator at each monitored wheel. Provides analog pulse train proportional to individual wheel speed. WSS devices can also be optical (especially for test fixtures).

# APPENDIX A.2.1

## Conversion Factors by Unit MPH

1mile => 5280.0000 ft      63360.0000 in      1.6094 km  
 1hr => 60.0000 min      3600.0000 sec

MPH	ft/sec	ft/ms	ms/ft	ms/in	in/ms	KPH	m/s	m/ms	ms/m	ms/cm	cm/ms
1	1.4667	0.0015	681.8182	56.8182	0.0176	1.6094	0.4471	0.0004	2236.8585	22.3686	0.0447
2	2.9333	0.0029	340.9091	28.4091	0.0352	3.2188	0.8941	0.0009	1118.4292	11.1843	0.0894
3	4.4000	0.0044	227.2727	18.9394	0.0528	4.8282	1.3412	0.0013	745.6195	7.4562	0.1341
4	5.8667	0.0059	170.4545	14.2045	0.0704	6.4376	1.7882	0.0018	559.2146	5.5921	0.1788
5	7.3333	0.0073	136.3636	11.3636	0.0880	8.0470	2.2353	0.0022	447.3717	4.4737	0.2235
6	8.8000	0.0088	113.6364	9.4697	0.1056	9.6564	2.6823	0.0027	372.8097	3.7281	0.2682
7	10.2667	0.0103	97.4026	8.1169	0.1232	11.2658	3.1294	0.0031	319.5512	3.1955	0.3129
8	11.7333	0.0117	85.2273	7.1023	0.1408	12.8752	3.5764	0.0036	279.6073	2.7961	0.3576
9	13.2000	0.0132	75.7576	6.3131	0.1584	14.4846	4.0235	0.0040	248.5398	2.4854	0.4024
10	14.6667	0.0147	68.1818	5.6818	0.1760	16.0940	4.4706	0.0045	223.6858	2.2369	0.4471
11	16.1333	0.0161	61.9835	5.1653	0.1936	17.7034	4.9176	0.0049	203.3508	2.0335	0.4918
12	17.6000	0.0176	56.8182	4.7348	0.2112	19.3128	5.3647	0.0054	186.4049	1.8640	0.5365
13	19.0667	0.0191	52.4476	4.3706	0.2288	20.9222	5.8117	0.0058	172.0660	1.7207	0.5812
14	20.5333	0.0205	48.7013	4.0584	0.2464	22.5316	6.2588	0.0063	159.7756	1.5978	0.6259
15	22.0000	0.0220	45.4545	3.7879	0.2640	24.1410	6.7058	0.0067	149.1239	1.4912	0.6706
16	23.4667	0.0235	42.6136	3.5511	0.2816	25.7504	7.1529	0.0072	139.8037	1.3980	0.7153
17	24.9333	0.0249	40.1070	3.3422	0.2992	27.3598	7.5999	0.0076	131.5799	1.3158	0.7600
18	26.4000	0.0264	37.8788	3.1566	0.3168	28.9692	8.0470	0.0080	124.2699	1.2427	0.8047
19	27.8667	0.0279	35.8852	2.9904	0.3344	30.5786	8.4941	0.0085	117.7294	1.1773	0.8494
20	29.3333	0.0293	34.0909	2.8409	0.3520	32.1880	8.9411	0.0089	111.8429	1.1184	0.8941
21	30.8000	0.0308	32.4675	2.7056	0.3696	33.7974	9.3882	0.0094	106.5171	1.0652	0.9388
22	32.2667	0.0323	30.9917	2.5826	0.3872	35.4068	9.8352	0.0098	101.6754	1.0168	0.9835
23	33.7333	0.0337	29.6443	2.4704	0.4048	37.0162	10.2823	0.0103	97.2547	0.9725	1.0282
24	35.2000	0.0352	28.4091	2.3674	0.4224	38.6256	10.7293	0.0107	93.2024	0.9320	1.0729
25	36.6667	0.0367	27.2727	2.2727	0.4400	40.2350	11.1764	0.0112	89.4743	0.8947	1.1176
26	38.1333	0.0381	26.2238	2.1853	0.4576	41.8444	11.6234	0.0116	86.0330	0.8603	1.1623
27	39.6000	0.0396	25.2525	2.1044	0.4752	43.4538	12.0705	0.0121	82.8466	0.8285	1.2071
28	41.0667	0.0411	24.3506	2.0292	0.4928	45.0632	12.5176	0.0125	79.8878	0.7989	1.2518
29	42.5333	0.0425	23.5110	1.9592	0.5104	46.6726	12.9646	0.0130	77.1331	0.7713	1.2965
30	44.0000	0.0440	22.7273	1.8939	0.5280	48.2820	13.4117	0.0134	74.5619	0.7456	1.3412
31	45.4667	0.0455	21.9941	1.8328	0.5456	49.8914	13.8587	0.0139	72.1567	0.7216	1.3859
32	46.9333	0.0469	21.3068	1.7756	0.5632	51.5008	14.3058	0.0143	69.9018	0.6990	1.4306
33	48.4000	0.0484	20.6612	1.7218	0.5808	53.1102	14.7528	0.0148	67.7836	0.6778	1.4753
34	49.8667	0.0499	20.0535	1.6711	0.5984	54.7196	15.1999	0.0152	65.7900	0.6579	1.5200
35	51.3333	0.0513	19.4805	1.6234	0.6160	56.3290	15.6469	0.0156	63.9102	0.6391	1.5647
36	52.8000	0.0528	18.9394	1.5783	0.6336	57.9384	16.0940	0.0161	62.1350	0.6213	1.6094
37	54.2667	0.0543	18.4275	1.5356	0.6512	59.5478	16.5411	0.0165	60.4556	0.6046	1.6541
38	55.7333	0.0557	17.9426	1.4952	0.6688	61.1572	16.9881	0.0170	58.8647	0.5886	1.6988
39	57.2000	0.0572	17.4825	1.4569	0.6864	62.7666	17.4352	0.0174	57.3553	0.5736	1.7435
40	58.6667	0.0587	17.0455	1.4205	0.7040	64.3760	17.8822	0.0179	55.9215	0.5592	1.7882
41	60.1333	0.0601	16.6297	1.3858	0.7216	65.9854	18.3293	0.0183	54.5575	0.5456	1.8329
42	61.6000	0.0616	16.2338	1.3528	0.7392	67.5948	18.7763	0.0188	53.2585	0.5326	1.8776
43	63.0667	0.0631	15.8562	1.3214	0.7568	69.2042	19.2234	0.0192	52.0200	0.5202	1.9223
44	64.5333	0.0645	15.4959	1.2913	0.7744	70.8136	19.6704	0.0197	50.8377	0.5084	1.9670
45	66.0000	0.0660	15.1515	1.2626	0.7920	72.4230	20.1175	0.0201	49.7080	0.4971	2.0118
46	67.4667	0.0675	14.8221	1.2352	0.8096	74.0324	20.5646	0.0206	48.6274	0.4863	2.0565
47	68.9333	0.0689	14.5068	1.2089	0.8272	75.6418	21.0116	0.0210	47.5927	0.4759	2.1012
48	70.4000	0.0704	14.2045	1.1837	0.8448	77.2512	21.4587	0.0215	46.6012	0.4660	2.1459
49	71.8667	0.0719	13.9147	1.1596	0.8624	78.8606	21.9057	0.0219	45.6502	0.4565	2.1906
50	73.3333	0.0733	13.6364	1.1364	0.8800	80.4700	22.3528	0.0224	44.7372	0.4474	2.2353

51	74.8000	0.0748	13.3690	1.1141	0.8976	82.0794	22.7998	0.0228	43.8600	0.4386	2.2800
52	76.2667	0.0763	13.1119	1.0927	0.9152	83.6888	23.2469	0.0232	43.0165	0.4302	2.3247
53	77.7333	0.0777	12.8645	1.0720	0.9328	85.2982	23.6939	0.0237	42.2049	0.4220	2.3694
54	79.2000	0.0792	12.6263	1.0522	0.9504	86.9076	24.1410	0.0241	41.4233	0.4142	2.4141
55	80.6667	0.0807	12.3967	1.0331	0.9680	88.5170	24.5881	0.0246	40.6702	0.4067	2.4588
56	82.1333	0.0821	12.1753	1.0146	0.9856	90.1264	25.0351	0.0250	39.9439	0.3994	2.5035
57	83.6000	0.0836	11.9617	0.9968	1.0032	91.7358	25.4822	0.0255	39.2431	0.3924	2.5482
58	85.0667	0.0851	11.7555	0.9796	1.0208	93.3452	25.9292	0.0259	38.5665	0.3857	2.5929
59	86.5333	0.0865	11.5562	0.9630	1.0384	94.9546	26.3763	0.0264	37.9129	0.3791	2.6376
60	88.0000	0.0880	11.3636	0.9470	1.0560	96.5640	26.8233	0.0268	37.2810	0.3728	2.6823
61	89.4667	0.0895	11.1773	0.9314	1.0736	98.1734	27.2704	0.0273	36.6698	0.3667	2.7270
62	90.9333	0.0909	10.9971	0.9164	1.0912	99.7828	27.7174	0.0277	36.0784	0.3608	2.7717
63	92.4000	0.0924	10.8225	0.9019	1.1088	101.3922	28.1645	0.0282	35.5057	0.3551	2.8165
64	93.8667	0.0939	10.6534	0.8878	1.1264	103.0016	28.6116	0.0286	34.9509	0.3495	2.8612
65	95.3333	0.0953	10.4895	0.8741	1.1440	104.6110	29.0586	0.0291	34.4132	0.3441	2.9059
66	96.8000	0.0968	10.3306	0.8609	1.1616	106.2204	29.5057	0.0295	33.8918	0.3389	2.9506
67	98.2667	0.0983	10.1764	0.8480	1.1792	107.8298	29.9527	0.0300	33.3859	0.3339	2.9953
68	99.7333	0.0997	10.0267	0.8356	1.1968	109.4392	30.3998	0.0304	32.8950	0.3289	3.0400
69	101.2000	0.1012	9.8814	0.8235	1.2144	111.0486	30.8468	0.0308	32.4182	0.3242	3.0847
70	102.6667	0.1027	9.7403	0.8117	1.2320	112.6580	31.2939	0.0313	31.9551	0.3196	3.1294
71	104.1333	0.1041	9.6031	0.8003	1.2496	114.2674	31.7409	0.0317	31.5050	0.3151	3.1741
72	105.6000	0.1056	9.4697	0.7891	1.2672	115.8768	32.1880	0.0322	31.0675	0.3107	3.2188
73	107.0667	0.1071	9.3400	0.7783	1.2848	117.4862	32.6351	0.0326	30.6419	0.3064	3.2635
74	108.5333	0.1085	9.2138	0.7678	1.3024	119.0956	33.0821	0.0331	30.2278	0.3023	3.3082
75	110.0000	0.1100	9.0909	0.7576	1.3200	120.7050	33.5292	0.0335	29.8248	0.2982	3.3529
76	111.4667	0.1115	8.9713	0.7476	1.3376	122.3144	33.9762	0.0340	29.4323	0.2943	3.3976
77	112.9333	0.1129	8.8548	0.7379	1.3552	123.9238	34.4233	0.0344	29.0501	0.2905	3.4423
78	114.4000	0.1144	8.7413	0.7284	1.3728	125.5332	34.8703	0.0349	28.6777	0.2868	3.4870
79	115.8667	0.1159	8.6306	0.7192	1.3904	127.1426	35.3174	0.0353	28.3147	0.2831	3.5317
80	117.3333	0.1173	8.5227	0.7102	1.4080	128.7520	35.7644	0.0358	27.9607	0.2796	3.5764
81	118.8000	0.1188	8.4175	0.7015	1.4256	130.3614	36.2115	0.0362	27.6155	0.2762	3.6212
82	120.2667	0.1203	8.3149	0.6929	1.4432	131.9708	36.6586	0.0367	27.2788	0.2728	3.6659
83	121.7333	0.1217	8.2147	0.6846	1.4608	133.5802	37.1056	0.0371	26.9501	0.2695	3.7106
84	123.2000	0.1232	8.1169	0.6764	1.4784	135.1896	37.5527	0.0376	26.6293	0.2663	3.7553
85	124.6667	0.1247	8.0214	0.6684	1.4960	136.7990	37.9997	0.0380	26.3160	0.2632	3.8000
86	126.1333	0.1261	7.9281	0.6607	1.5136	138.4084	38.4468	0.0384	26.0100	0.2601	3.8447
87	127.6000	0.1276	7.8370	0.6531	1.5312	140.0178	38.8938	0.0389	25.7110	0.2571	3.8894
88	129.0667	0.1291	7.7479	0.6457	1.5488	141.6272	39.3409	0.0393	25.4188	0.2542	3.9341
89	130.5333	0.1305	7.6609	0.6384	1.5664	143.2366	39.7879	0.0398	25.1332	0.2513	3.9788
90	132.0000	0.1320	7.5758	0.6313	1.5840	144.8460	40.2350	0.0402	24.8540	0.2485	4.0235
91	133.4667	0.1335	7.4925	0.6244	1.6016	146.4554	40.6821	0.0407	24.5809	0.2458	4.0682
92	134.9333	0.1349	7.4111	0.6176	1.6192	148.0648	41.1291	0.0411	24.3137	0.2431	4.1129
93	136.4000	0.1364	7.3314	0.6109	1.6368	149.6742	41.5762	0.0416	24.0522	0.2405	4.1576
94	137.8667	0.1379	7.2534	0.6044	1.6544	151.2836	42.0232	0.0420	23.7964	0.2380	4.2023
95	139.3333	0.1393	7.1770	0.5981	1.6720	152.8930	42.4703	0.0425	23.5459	0.2355	4.2470
96	140.8000	0.1408	7.1023	0.5919	1.6896	154.5024	42.9173	0.0429	23.3006	0.2330	4.2917
97	142.2667	0.1423	7.0291	0.5858	1.7072	156.1118	43.3644	0.0434	23.0604	0.2306	4.3364
98	143.7333	0.1437	6.9573	0.5798	1.7248	157.7212	43.8114	0.0438	22.8251	0.2283	4.3811
99	145.2000	0.1452	6.8871	0.5739	1.7424	159.3306	44.2585	0.0443	22.5945	0.2259	4.4259
100	146.6667	0.1467	6.8182	0.5682	1.7600	160.9400	44.7056	0.0447	22.3686	0.2237	4.4706

# APPENDIX A.2.2

## Conversion Factors by Unit KPH

1 km =>	1000.00 m	100000.00 cm	0.62136 mi	5280.00 ft	63360.00 in						
1 hr =>	60.00 min	3600.00 sec									
KPH	m/s	m/ms	ms/m	ms/cm	cm/ms	MPH	ft/sec	ft/ms	ms/ft	ms/in	in/ms
1	0.2778	0.0003	3600.0000	36.0000	0.0278	0.6214	0.9113	0.0009	1097.2998	91.4416	0.0109
2	0.5556	0.0006	1800.0000	18.0000	0.0556	1.2427	1.8227	0.0018	548.6499	45.7208	0.0219
3	0.8333	0.0008	1200.0000	12.0000	0.0833	1.8641	2.7340	0.0027	365.7666	30.4805	0.0328
4	1.1111	0.0011	900.0000	9.0000	0.1111	2.4854	3.6453	0.0036	274.3249	22.8604	0.0437
5	1.3889	0.0014	720.0000	7.2000	0.1389	3.1068	4.5566	0.0046	219.4600	18.2883	0.0547
6	1.6667	0.0017	600.0000	6.0000	0.1667	3.7282	5.4680	0.0055	182.8833	15.2403	0.0656
7	1.9444	0.0019	514.2857	5.1429	0.1944	4.3495	6.3793	0.0064	156.7571	13.0631	0.0766
8	2.2222	0.0022	450.0000	4.5000	0.2222	4.9709	7.2906	0.0073	137.1625	11.4302	0.0875
9	2.5000	0.0025	400.0000	4.0000	0.2500	5.5922	8.2020	0.0082	121.9222	10.1602	0.0984
10	2.7778	0.0028	360.0000	3.6000	0.2778	6.2136	9.1133	0.0091	109.7300	9.1442	0.1094
11	3.0556	0.0031	327.2727	3.2727	0.3056	6.8350	10.0246	0.0100	99.7545	8.3129	0.1203
12	3.3333	0.0033	300.0000	3.0000	0.3333	7.4563	10.9359	0.0109	91.4416	7.6201	0.1312
13	3.6111	0.0036	276.9231	2.7692	0.3611	8.0777	11.8473	0.0118	84.4077	7.0340	0.1422
14	3.8889	0.0039	257.1429	2.5714	0.3889	8.6990	12.7586	0.0128	78.3786	6.5315	0.1531
15	4.1667	0.0042	240.0000	2.4000	0.4167	9.3204	13.6699	0.0137	73.1533	6.0961	0.1640
16	4.4444	0.0044	225.0000	2.2500	0.4444	9.9418	14.5812	0.0146	68.5812	5.7151	0.1750
17	4.7222	0.0047	211.7647	2.1176	0.4722	10.5631	15.4926	0.0155	64.5470	5.3789	0.1859
18	5.0000	0.0050	200.0000	2.0000	0.5000	11.1845	16.4039	0.0164	60.9611	5.0801	0.1968
19	5.2778	0.0053	189.4737	1.8947	0.5278	11.8058	17.3152	0.0173	57.7526	4.8127	0.2078
20	5.5556	0.0056	180.0000	1.8000	0.5556	12.4272	18.2266	0.0182	54.8650	4.5721	0.2187
21	5.8333	0.0058	171.4286	1.7143	0.5833	13.0486	19.1379	0.0191	52.2524	4.3544	0.2297
22	6.1111	0.0061	163.6364	1.6364	0.6111	13.6699	20.0492	0.0200	49.8773	4.1564	0.2406
23	6.3889	0.0064	156.5217	1.5652	0.6389	14.2913	20.9605	0.0210	47.7087	3.9757	0.2515
24	6.6667	0.0067	150.0000	1.5000	0.6667	14.9126	21.8719	0.0219	45.7208	3.8101	0.2625
25	6.9444	0.0069	144.0000	1.4400	0.6944	15.5340	22.7832	0.0228	43.8920	3.6577	0.2734
26	7.2222	0.0072	138.4615	1.3846	0.7222	16.1554	23.6945	0.0237	42.2038	3.5170	0.2843
27	7.5000	0.0075	133.3333	1.3333	0.7500	16.7767	24.6059	0.0246	40.6407	3.3867	0.2953
28	7.7778	0.0078	128.5714	1.2857	0.7778	17.3981	25.5172	0.0255	39.1893	3.2658	0.3062
29	8.0556	0.0081	124.1379	1.2414	0.8056	18.0194	26.4285	0.0264	37.8379	3.1532	0.3171
30	8.3333	0.0083	120.0000	1.2000	0.8333	18.6408	27.3398	0.0273	36.5767	3.0481	0.3281
31	8.6111	0.0086	116.1290	1.1613	0.8611	19.2622	28.2512	0.0283	35.3968	2.9497	0.3390
32	8.8889	0.0089	112.5000	1.1250	0.8889	19.8835	29.1625	0.0292	34.2906	2.8576	0.3499
33	9.1667	0.0092	109.0909	1.0909	0.9167	20.5049	30.0738	0.0301	33.2515	2.7710	0.3609
34	9.4444	0.0094	105.8824	1.0588	0.9444	21.1262	30.9852	0.0310	32.2735	2.6895	0.3718
35	9.7222	0.0097	102.8571	1.0286	0.9722	21.7476	31.8965	0.0319	31.3514	2.6126	0.3828
36	10.0000	0.0100	100.0000	1.0000	1.0000	22.3690	32.8078	0.0328	30.4805	2.5400	0.3937
37	10.2778	0.0103	97.2973	0.9730	1.0278	22.9903	33.7191	0.0337	29.6568	2.4714	0.4046
38	10.5556	0.0106	94.7368	0.9474	1.0556	23.6117	34.6305	0.0346	28.8763	2.4064	0.4156
39	10.8333	0.0108	92.3077	0.9231	1.0833	24.2330	35.5418	0.0355	28.1359	2.3447	0.4265
40	11.1111	0.0111	90.0000	0.9000	1.1111	24.8544	36.4531	0.0365	27.4325	2.2860	0.4374
41	11.3889	0.0114	87.8049	0.8780	1.1389	25.4758	37.3644	0.0374	26.7634	2.2303	0.4484
42	11.6667	0.0117	85.7143	0.8571	1.1667	26.0971	38.2758	0.0383	26.1262	2.1772	0.4593
43	11.9444	0.0119	83.7209	0.8372	1.1944	26.7185	39.1871	0.0392	25.5186	2.1265	0.4702
44	12.2222	0.0122	81.8182	0.8182	1.2222	27.3398	40.0984	0.0401	24.9386	2.0782	0.4812
45	12.5000	0.0125	80.0000	0.8000	1.2500	27.9612	41.0098	0.0410	24.3844	2.0320	0.4921
46	12.7778	0.0128	78.2609	0.7826	1.2778	28.5826	41.9211	0.0419	23.8543	1.9879	0.5031
47	13.0556	0.0131	76.5957	0.7660	1.3056	29.2039	42.8324	0.0428	23.3468	1.9456	0.5140
48	13.3333	0.0133	75.0000	0.7500	1.3333	29.8253	43.7437	0.0437	22.8604	1.9050	0.5249
49	13.6111	0.0136	73.4694	0.7347	1.3611	30.4466	44.6551	0.0447	22.3939	1.8662	0.5359
50	13.8889	0.0139	72.0000	0.7200	1.3889	31.0680	45.5664	0.0456	21.9460	1.8288	0.5468
51	14.1667	0.0142	70.5882	0.7059	1.4167	31.6894	46.4777	0.0465	21.5157	1.7930	0.5577
52	14.4444	0.0144	69.2308	0.6923	1.4444	32.3107	47.3891	0.0474	21.1019	1.7585	0.5687

53	14.7222	0.0147	67.9245	0.6792	1.4722	32.9321	48.3004	0.0483	20.7038	1.7253	0.5796
54	15.0000	0.0150	66.6667	0.6667	1.5000	33.5534	49.2117	0.0492	20.3204	1.6934	0.5905
55	15.2778	0.0153	65.4545	0.6545	1.5278	34.1748	50.1230	0.0501	19.9509	1.6626	0.6015
56	15.5556	0.0156	64.2857	0.6429	1.5556	34.7962	51.0344	0.0510	19.5946	1.6329	0.6124
57	15.8333	0.0158	63.1579	0.6316	1.5833	35.4175	51.9457	0.0519	19.2509	1.6042	0.6233
58	16.1111	0.0161	62.0690	0.6207	1.6111	36.0389	52.8570	0.0529	18.9190	1.5766	0.6343
59	16.3889	0.0164	61.0169	0.6102	1.6389	36.6602	53.7684	0.0538	18.5983	1.5499	0.6452
60	16.6667	0.0167	60.0000	0.6000	1.6667	37.2816	54.6797	0.0547	18.2883	1.5240	0.6562
61	16.9444	0.0169	59.0164	0.5902	1.6944	37.9030	55.5910	0.0556	17.9885	1.4990	0.6671
62	17.2222	0.0172	58.0645	0.5806	1.7222	38.5243	56.5023	0.0565	17.6984	1.4749	0.6780
63	17.5000	0.0175	57.1429	0.5714	1.7500	39.1457	57.4137	0.0574	17.4175	1.4515	0.6890
64	17.7778	0.0178	56.2500	0.5625	1.7778	39.7670	58.3250	0.0583	17.1453	1.4288	0.6999
65	18.0556	0.0181	55.3846	0.5538	1.8056	40.3884	59.2363	0.0592	16.8815	1.4068	0.7108
66	18.3333	0.0183	54.5455	0.5455	1.8333	41.0098	60.1476	0.0601	16.6258	1.3855	0.7218
67	18.6111	0.0186	53.7313	0.5373	1.8611	41.6311	61.0590	0.0611	16.3776	1.3648	0.7327
68	18.8889	0.0189	52.9412	0.5294	1.8889	42.2525	61.9703	0.0620	16.1368	1.3447	0.7436
69	19.1667	0.0192	52.1739	0.5217	1.9167	42.8738	62.8816	0.0629	15.9029	1.3252	0.7546
70	19.4444	0.0194	51.4286	0.5143	1.9444	43.4952	63.7930	0.0638	15.6757	1.3063	0.7655
71	19.7222	0.0197	50.7042	0.5070	1.9722	44.1166	64.7043	0.0647	15.4549	1.2879	0.7765
72	20.0000	0.0200	50.0000	0.5000	2.0000	44.7379	65.6156	0.0656	15.2403	1.2700	0.7874
73	20.2778	0.0203	49.3151	0.4932	2.0278	45.3593	66.5269	0.0665	15.0315	1.2526	0.7983
74	20.5556	0.0206	48.6486	0.4865	2.0556	45.9806	67.4383	0.0674	14.8284	1.2357	0.8093
75	20.8333	0.0208	48.0000	0.4800	2.0833	46.6020	68.3496	0.0683	14.6307	1.2192	0.8202
76	21.1111	0.0211	47.3684	0.4737	2.1111	47.2234	69.2609	0.0693	14.4382	1.2032	0.8311
77	21.3889	0.0214	46.7532	0.4675	2.1389	47.8447	70.1723	0.0702	14.2506	1.1876	0.8421
78	21.6667	0.0217	46.1538	0.4615	2.1667	48.4661	71.0836	0.0711	14.0679	1.1723	0.8530
79	21.9444	0.0219	45.5696	0.4557	2.1944	49.0874	71.9949	0.0720	13.8899	1.1575	0.8639
80	22.2222	0.0222	45.0000	0.4500	2.2222	49.7088	72.9062	0.0729	13.7162	1.1430	0.8749
81	22.5000	0.0225	44.4444	0.4444	2.2500	50.3302	73.8176	0.0738	13.5469	1.1289	0.8858
82	22.7778	0.0228	43.9024	0.4390	2.2778	50.9515	74.7289	0.0747	13.3817	1.1151	0.8967
83	23.0556	0.0231	43.3735	0.4337	2.3056	51.5729	75.6402	0.0756	13.2205	1.1017	0.9077
84	23.3333	0.0233	42.8571	0.4286	2.3333	52.1942	76.5516	0.0766	13.0631	1.0886	0.9186
85	23.6111	0.0236	42.3529	0.4235	2.3611	52.8156	77.4629	0.0775	12.9094	1.0758	0.9296
86	23.8889	0.0239	41.8605	0.4186	2.3889	53.4370	78.3742	0.0784	12.7593	1.0633	0.9405
87	24.1667	0.0242	41.3793	0.4138	2.4167	54.0583	79.2855	0.0793	12.6126	1.0511	0.9514
88	24.4444	0.0244	40.9091	0.4091	2.4444	54.6797	80.1969	0.0802	12.4693	1.0391	0.9624
89	24.7222	0.0247	40.4494	0.4045	2.4722	55.3010	81.1082	0.0811	12.3292	1.0274	0.9733
90	25.0000	0.0250	40.0000	0.4000	2.5000	55.9224	82.0195	0.0820	12.1922	1.0160	0.9842
91	25.2778	0.0253	39.5604	0.3956	2.5278	56.5438	82.9308	0.0829	12.0582	1.0049	0.9952
92	25.5556	0.0256	39.1304	0.3913	2.5556	57.1651	83.8422	0.0838	11.9272	0.9939	1.0061
93	25.8333	0.0258	38.7097	0.3871	2.5833	57.7865	84.7535	0.0848	11.7989	0.9832	1.0170
94	26.1111	0.0261	38.2979	0.3830	2.6111	58.4078	85.6648	0.0857	11.6734	0.9728	1.0280
95	26.3889	0.0264	37.8947	0.3789	2.6389	59.0292	86.5762	0.0866	11.5505	0.9625	1.0389
96	26.6667	0.0267	37.5000	0.3750	2.6667	59.6506	87.4875	0.0875	11.4302	0.9525	1.0498
97	26.9444	0.0269	37.1134	0.3711	2.6944	60.2719	88.3988	0.0884	11.3124	0.9427	1.0608
98	27.2222	0.0272	36.7347	0.3673	2.7222	60.8933	89.3101	0.0893	11.1969	0.9331	1.0717
99	27.5000	0.0275	36.3636	0.3636	2.7500	61.5146	90.2215	0.0902	11.0838	0.9237	1.0827
100	27.7778	0.0278	36.0000	0.3600	2.7778	62.1360	91.1328	0.0911	10.9730	0.9144	1.0936



## APPENDIX B

### Scan Tools, Scanners, Bus Interfaces, and Manufacturer Contacts

Manufacturer/Contact	Model	Vehicles	Base Price	Comments
ACCUTEST sofa.dartnet.co.uk	J1850 Network Analysis Tool (DG-JNAT-B) J1850 & OBD2 Compliance Tester (DG-JNAT-C) J1850 & OBD2 Flight Recorder & Compliance Tester (DG-JNAT-D)	GM, Ford, or Chrysler		Multiple tools and testers for diagnostics, monitoring, and troubleshooting of multiplexed automation and automotive communication networks.
Actron Manufacturing Co. 9999 Walford Ave. Cleveland, OH 44102 216-651-9200 www.actron.com	Kal Equip OBD-II System Tester 9615			Basic Scanner
Actron Manufacturing Co. 9999 Walford Ave. Cleveland, OH 44102 216-651-9200 www.actron.com	KAL Equip Scan—II CP9600	OBD-II, RS-232		Basic Scanner
Advance Electronic Diagnostics	Vehicle Communication System (VCS)	Ford, Chrysler, and GM Models, year 1996 and beyond that are J1850 compliant. VCS Driver for VLTC2W is for GM only.	\$350	PC to vehicle communications. J1850/ALDL UART PCMCIA Card \$1200 VCS Driver for Lab View \$350 Vital Signs II Software Package \$450 VCS Driver for VLTC2W-DLL (GM only)
Advanced Vehicle Technologies, Inc. (AVT) 1509 Manor View Road Davidsonville, MD 21035 410-798-4038 Michael Riley	AVT-716—Triple Interface (J1850 VPW, PWM and ISO 9141)	Any OBD-II equipped		Hardware package allows a PC terminal (with appropriate software) to communicate with a vehicle data network and capture data bus message traffic. Unit may also be used to simulate messages to connected ECUs and check for ECU/actuator responses.
Assenmacher Specialty Tools (AST) Mike Assenmacher 6440 Odell Place Boulder, CO 80301 303-530-2424  <i>Supplier</i> Technic Tool Supply Unit J, 2057 Goodyear Ave. Ventura, CA 93003 1-800-637-8738 www.technictool.com	5700 Retriever Scan Tool	VW/Audi, Seat, Skoda, BMW, Mercedes-Benz, Saab, Volvo, OBD II	\$627 (thru 1999)	VW/Audi, Seat Skoda Cartridge: \$811 C Retriever Cartridge for BMW 88-99: \$1407 Volvo Cartridge 94 - 98: \$998 OBD II Cartridge Kit for ISO Standard Vehicles: \$583.96 OBD II Cartridge Only: \$385 Mercedes Cartridge Kit: \$940 Mercedes Cartridge Only: \$890 OBD II Cable: \$180
BAUM Tools Unlimited P.O. Box 5867 Sarasota, FL 34177-5867 1-800-848-6657 www.baumtools.com	CS2000 Live Data Scanner	88-99 Mercedes, BMW, VW/Audi, Volvo, OBD II-ISO9141-2		Displays info in OE format.
B & B Electronics 707 Dayton Road P.O. Box 1040 Ottawa, IL 61350 815-433-5100 Voice 815-433-5105 Fax www.autotap.com	AutoTap AT12	1996 and above, GM and Ford cars and light trucks	\$390	Communicate with vehicle via a PC.

Manufacturer/Contact	Model	Vehicles	Base Price	Comments
CODA Products 97 Denison Street Hamilton, NSW 2303 Australia +61 (2) 4962 2576 +61 (2) 4969 3875 sales@coda.com.au orders@coda.com.au	Data Scanner, Harness 1	Australian and Import Vehicles		Coda Data Scanner Base Kit, EB to EF Falcon, Fairlane, LTD Update Lead, Mitsubishi TP to TS Magna, Lancer, Triton, Pajero, Star Wagon, L300, Nimbus, Galant Update Lead, Holden Isuzu Update Lead for four cylinder Rodeo and Jackaroo, Ford/Mazda Update Lead for late model Laser, Capri, Probe and Telstar as well as 121, 323, Astina, 626, 929 and all late Mazda, Coda VR Interface ( 3 versions), VS Commodore Software Update
Dearborn Group, Inc. 27007 Hills Tech Court Farmington Hills, MI 48331 248-488-2080 Voice 248-488-2082 Fax www.dgtech.com	Gryphon			High-speed interface for diagnostics, monitoring, and troubleshooting of multiplexed automation and automotive communication networks.
EASE Diagnostics New Milford, PA 570-465-9062 Voice 570-465-9061 Fax www.obdz.com	ST2 Scan Tool Deluxe	All vehicles OBD-II generic		Chassis options available. Laptop PC display and interface
General Motors Service Operations www.gmde.com/news	Central Server and LAN (Local Area Network)	GM		Service information in a user-friendly format—a Web-based format. Will link dealership operations.
Hickok Incorporated 10514 Dupont Avenue Cleveland, OH 44108 800-342-5080 Voice 216-541-8060 Voice www.hickok-inc.com	New Generation STAR Tester (NGS Tester) Version 14.0	Ford, Mazda		OBD II compatible
Highlander Vehicle Networking Products www.highlandertech.com/ technologies	VNIC/S Controller			—EZ-Link family of software for vehicle communication —Single-board computers based on Intel 80C196 and x86- based embedded processors —Hardware/software consulting for in- vehicle networks
Injectoclean Diagnostic Equipment www.injectoclean.com	CJScan	GM, Ford, Chrysler, most Asian and European vehicles, and OBD-II. Volkswagen 1993-98		Basic Scanner. Also, has optional kit that allows connection to a PC.
Kontron Embedded Computers Eching/Munchen Germany +49 8165 77-666 Voice +49 8165 77-219 Fax www.kontron.com sales@kontron.com	IP Lite			—Processor: Pentium 233 Mhz, Pentium II, 300 Mhz —L2 Cache: 512 kB Pipelined Burst —Ram: 64, 128 MB (PW5); up to 256 MP (PII)
Mobile Data Systems 33228 W. 12 Mile Road, Suite 352 Farmington Hills, MI 48334 248-344-8029 Voice 248-851-7305 Fax www.mobiledatasystems.com	J Cable	J1850 VPW (Chrysler), PWM (Ford), VPW (GM), and GM UART, ISO 9141 K Lines		This cable communicates with engine, transmission, and body controllers via an SAE J1962 diagnostic connector.
Molex Incorporated 2222 Wellington Court Lisle, IL 60532-1682 800-78MOLEX Voice 630-968-8356 Fax amerinfo@molex.com	OBD-II connector supplier.			4.00 mm (0.157 in.) wire-to-wire receptable housing, flange mount
MPSI 800-639-6774 Voice www.mpsilink.com	Multi-Protocol Cartridge (MPC)	All foreign/domestic OBD II vehicles		

Manufacturer/Contact	Model	Vehicles	Base Price	Comments
NSI www.nsi.fr/products	Diagnostic Tool Set (DTS)	BMW DS2, Mercedes Benz FB, VW/Audi VW 1281, Ford ISO 9141		Diagnostic Tester Process Viewer Test Batch Executor
North Star Laboratory 754 White Pine Road Sanatoga, PA 19464 610-326-8425 Voice www.northstarlabs.com	OBD-II Protocol	Automobiles and light trucks		
Rinda Technologies 4563 N. Elston Ave Chicago, IL 60630 773-736-6633	Diacom and Diacom Plus	GM and Chrysler cars and light trucks	Handheld scan tools	Handheld scan tools
Smart Engineering Tools, Inc. Representative: Sigmund Shvimer Smart Engineering Tools, Inc. 100 North Pond Drive, Suite D Walled Lake, MI 48390 248-669-7262 Voice 248-669-8159 Fax www.smttools.com info@smttools.com	Netway FP1 CAN, J1850, UART	Any OBD-II equipped		Software and hardware package allows a PC terminal to communicate with a vehicle data network and capture data bus message traffic. Unit may also be used to simulate messages to connected ECUs and check for ECU/ actuator responses.
Silicon Engines 2101 Oxford Road Des Plaines, IL 60018 847-803-6860 Voice 847-803-6870 Fax www.siliconengines-ltd.com	ISO-9141	Concept cars, prototypes, and low-volume vehicles		
Snap-On 3550 Snell Avenue San Jose, CA 95136-9968 800-424-7226 www.snapondiagnostics.com	MT2500 Scantool MT2400 Vantage MT2700 DIS/kv Ignition Probe	Acura, Chrysler, Ford, GM, Honda, Hyundai, Infiniti, Isuzu, Lexus, Mazda, Mitsubishi, Nissan, Subaru, and Toyota		Handheld scan tools Includes aerial print function. Includes emissions and chassis functions.
SPX Corporation 28635 Mound Road Warren, MI 48092-3499 800-328-6657 www.adspix.com	MindReader OBD II	Ford, Chrysler, GM, Asian		1981-1999+ Allen Testproducts, Bear Automotive and OTC products.
SPX Kent-Moore SPX Corporation 28635 Mound Road Warren, MI 48092-3499 800-328-6657 Voice 800-578-7375 Fax	Pro-Link Plus	Detroit Deisel DDEC III and IV, Mack Trucks VMAC III, Navistar NAVPAK, Eaton, Bendix, Meritor WABCO ABS, Caterpillar, Allison		
SPX OTC Owatonna, MN 55060-1171 800-533-6127 Voice 800-955-8329 Fax	OTC 4000 enhanced			Multi System Vehicle Scan Tool
Vetronix 2030 Alameda Padre Serra Santa Barbara, CA 93103 800-321-4889 www.vetronix.com Sales/Marketing Contact Jason Alexander	Alliance Diagnostic System	GM, Ford, Chrysler, Asian Imports		
Vetronix 2030 Alameda Padre Serra Santa Barbara, CA 93103 800-321-4889 www.vetronix.com Sales/Marketing Contact Jason Alexander	Mastertech	GM, Ford, Chrysler, Asian		

Manufacturer/Contact	Model	Vehicles	Base Price	Comments
Vetronix 2030 Alameda Padre Serra Santa Barbara, CA 93103 800-321-4889 www.vetronix.com <i>Sales/Marketing Contact</i> Jason Alexander	Tech 1A	GM, Ford, Toyota, Lexus		ABS: Delco Moraine, Bosch, Teves, Kelsey-Hayes
Vetronix 2030 Alameda Padre Serra Santa Barbara, CA 93103 800-321-4889 www.vetronix.com <i>Sales/Marketing Contact</i> James Kerr	CDR	GM		The CDR is the first publicly available scanner to provide a translation of the air bag ECU EEPROM hexadecimal data. However, not all hexadecimal data is translated. Translated data includes seat belt usage, cumulative Delta V, and four pre-impact parameter values captured at -5, -4, -3, -2, and -1 s before impact (speed, throttle %, brake apply, and engine RPM). Not all capabilities are available for all vehicle models.

## NOTES:

1. The author has endeavored to include all known and pertinent scan tools in this Appendix. No attempt to grade or qualify any of these tools is included or intended. If any scan tools have been left out, such omissions are entirely inadvertent and not intended to imply any value judgment.
2. The scan tools and/or network monitors mentioned above have varying freeze frame data retrieval capabilities. The reader should consult with specific scan tool manufacturers to verify freeze frame data capabilities for any specific system.

# APPENDIX C

## Government Standards and Regulations (CARB, DOT/NHTSA, EPA)

Regulation #	Regulation Title	Reference Source
40 CFR Parts 9, 85, and 86 [AMS-FRL-5938-8] RIN 2060-AF75	Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines: State Commitments to National Low Emission Vehicle Program AGENCY: Environmental Protection Agency (EPA). ACTION: Final Rule.	Federal Register: 7 Jan. 1998 (Vol. 63, No. 4) [Rules and Regulations] pp. 925-987
40 CFR Part 86 [FRL-5558-3] RIN 2060-AE27	Final Regulations for Revisions to the Federal Test Procedure for Emissions From Motor Vehicles AGENCY: Environmental Protection Agency (EPA). ACTION: Final rulemaking (FRM).	Federal Register: 22 Oct. 1996 (Vol. 61, No. 205) [Rules and Regulations] pp. 54851-54906
40 CFR Parts 9 and 86 [AMS-FRL-5908-8] RIN 2060-AF76	Control of Emissions of Air Pollution From Highway Heavy-Duty Engines AGENCY: Environmental Protection Agency (EPA). ACTION: Final rule.	Federal Register: 21 Oct. 1997 (Vol. 62, No. 203)] [Rules and Regulations] pp. 54693-54730
40 CFR Parts 85 and 86 [AMS-FRL-5823-7] RIN 2060-AF75	Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines: Voluntary Standards for Light-Duty Vehicles AGENCY: Environmental Protection Agency (EPA). ACTION: Final rule.	Federal Register: 6 June 1997 (Vol. 62, No. 109) [Rules and Regulations] pp. 31191-31270
40 CFR Parts 9 and 86 [FRL-5881-3]	Direct Final Rule Amending the Test Procedures for Heavy-Duty Engines, and Light-Duty Vehicles and Trucks and the Amending of Emission Standard Provisions for Gaseous Fueled Vehicles and Engines AGENCY: Environmental Protection Agency (EPA). ACTION: Direct Final Rule.	Federal Register: 5 Sep. 1997 (Vol. 62, No. 172) [Rules and Regulations] pp. 47113-47136
40 CFR Parts 9 and 86 [AMS-FRL-5268-1] RIN 2060-AE93	Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines; Regulations Requiring Availability of Information for Use of On-Board Diagnostic Systems and Emission-Related Repairs on 1994 and later Model Year Light-Duty Vehicles and Light-Duty Trucks AGENCY: Environmental Protection Agency (EPA). ACTION: Final Rule.	Federal Register: 9 Aug. 1995 (Vol. 60, No. 153) [Rules and Regulations] pp. 40474-40498
40 CFR Parts 51 and 85 [FRL-5543-7] RIN 2060-AE19	Inspection/Maintenance (I/M) Program Requirement—On-Board Diagnostic Checks; Final rule AGENCY: Environmental Protection Agency. ACTION: Final rule.	Federal Register: 6 Aug. 1996 (Vol. 61, No. 152) [Rules and Regulations] pp. 40939-40948
40 CFR Part 86 [FRL-6196-4]	Control of Air Pollution From Motor Vehicles and New Motor Vehicle Engines; Modification of Federal On-board Diagnostic Regulations for Light-Duty Vehicles and Light-Duty Trucks; Extension of Acceptance of California OBD II Requirements AGENCY: Environmental Protection Agency. ACTION: Final Rule.	Federal Register: 22 Dec. 1998 (Vol. 63, No. 245) [Rules and Regulations] pp. 70681-70697
40 CFR Part 86 [AMS-FRL-5602-3] RIN 2060-AC65	Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines: Regulations Requiring On-Board Diagnostic (OBD) Systems—Acceptance of Revised California OBD II Requirements AGENCY: Environmental Protection Agency (EPA). ACTION: Final Rule.	[Federal Register: August 30, 1996 (Volume 61, Number 170)] [Rules and Regulations] [Page 45898-45903]
40 CFR Part 86 [AMS-FRL-5225-7] RIN 2060-AC65	Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines: Regulations Requiring On-Board Diagnostic (OBD) Systems—Regulations Allowing Optional Compliance with California OBD II Requirements as Satisfying Federal OBD AGENCY: Environmental Protection Agency (EPA). ACTION: Final Rule.	[Federal Register: July 25, 1995 (Volume 60, Number 142)] [Rules and Regulations] [Page 37945]
CARB Mail Outs: Code of Regulation, Title 13	1968.1, Malfunction and Diagnostic System 21 May 1993, 1994 and Subsequent Model-Year Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles and Engines	

### Document Sources

SAE publications are available from SAE, 400 Commonwealth Drive, Warrendale, PA, 15096-0001, ph. 724-776-4841.

ISO documents are available from ANSI, 11 West 42<sup>nd</sup> Street, New York, NY 10036-8002.

EPA documents are available in the Federal Register. Contact: U.S. Environmental Protection Agency, 2565 Plymouth Road, Ann Arbor, MI, 48105, ph. 313-668-4400 or <http://www.epa.gov/fedrgstr/EPA-AIR/>.

Bosch documents are available from Robert Bosch GmbH, Postfach 50, D7000, Stuttgart, Germany.

CARB = California Air Resources Board, 2020 L Street, Sacramento, CA, 95814, ph. 916-322-2990.

## APPENDIX D

### Industry Standards and Specifications (SAE, ASTM, ISO, etc.)

Standard #	Standard/Specification Name	Current Revision level
Bosch	CAN Specification 2.0	September 1991
ISO 14229	Road Vehicles, Diagnostic Systems, Diagnostic Services Specification	
ISO/DIS 14230-1	Road Vehicles, Diagnostic Systems, Keyword Protocol 2000—Part 1: Physical Layer	
ISO/DIS 14230-2	Road Vehicles, Diagnostic Systems, Keyword Protocol 2000—Part 2: Data Link Layer	
ISO/DIS 14230-3	Road Vehicles, Diagnostic Systems, Keyword Protocol 2000—Part 3: Application Layer	
ISO/DIS 14230-4	Road Vehicles, Diagnostic Systems, Keyword Protocol 2000—Part 4: Requirements for Emission Related Systems	
ISO 9141-2:1994(E)	Road Vehicles, Diagnostic Systems, CARB Requirements for Interchange of Information, ISO/TC 22/SC 3/WG 1 -N 425 E/REV	
ISO/IEC 9646	Information Technology, Open Systems Interconnection, Conformance Testing Methodology and Framework	
ISO 15031-3	Diagnostic Connector and Related Electrical Circuits: Specification and Use	
ISO 8092-3	Road Vehicles, Flat, Quick Connection Terminations	
ISO 11898		
SAE J211	Instrumentation for Impact Test	October 1988
SAE J670e	Vehicle Dynamics Terminology	July 1976
SAE J1113/1	Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components—60 Hz to 18 GHz	July 1995
SAE J1113/2	Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components—Conducted Immunity, 30 Hz to 250 kHz	September 1996
SAE J1113/3	Conducted Immunity, 250 kHz to 500 MHz Direct Injection of Radio Frequency (RF) Power	November 1995
SAE J1113/4	Innunity to Radiated Electromagnetic Fields—Bulk Current Injection (BCI) Method	February 98
SAE J1113/11	Immunity to Conducted Transients on Power Leads	June 1995
SAE J1113/12	Electrical Interference by Conduction and Coupling—Coupling Clamp	December 1994
SAE J1113/13	Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Immunity to Static Discharge	October 1996
SAE J1113/21	Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Immunity to Radiated Electromagnetic Fields, 10 kHz to 18 Ghz, Absorber Lined Chamber	January 1998
SAE J1113/22	Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Immunity to Magnetic Fields From Power Lines	October 1996
SAE J1113/23	Electromagnetic Compatibility Measurement Procedure— Immunity to Radiated Electromagnetic Fields, 10 kHz to 200 MHz, Strip Line Method	September 1995
SAE J1113/41	Electromagnetic Susceptibility Measurements Procedures for Vehicle Components (60 Hz to 18 GHz)	July 1995
SAE J1211	A Recommended Environmental Procedure for Electronic Equipment Design	November 1978
SAE J1213-1	Glossary of Vehicle Networks for Multiplexing and Data Communications	September 1997
SAE J1547	Electromagnetic Susceptibility Measurement Procedures for Common Mode Injection	October 1988
SAE J1587	Joint SAE/TMC Electronic Data Interchange Between Microcomputer Systems in Heavy-Duty Vehicles	March 1996
SAE J1699	Verification of OBD-II Related	January 1998
SAE J1708	Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications	October 1993
SAE J1850	Class B Data Communications Network Interface	March 1998
SAE J1879	General Qualification and Production Acceptance Criteria for Integratred Circuits in Automotive Applications	October 1998

Standard #	Standard/Specification Name	Current Revision level
SAE J1930	Electrical/Electronic Systems Diagnostic Terms Definitions, Abbreviations & Acronyms	May 1998
SAE J1939-11	Recommended Practice for Serial Control and Communications Vehicle Network—Physical Layer—250 K bits/sec, Shielded Twisted Pair	December 1994
SAE J1939-21	Recommended Practice for Serial Control and Communications Vehicle Network—Data Link Layer	July 1994
SAE J1939-31	Recommended Practice for Serial Control and Communications Vehicle Network—Network Layer	December 1997
SAE J1939-71	Recommended Practice for Serial Control and Communications Vehicle Network—Vehicle Application Layer	May 1996
SAE J1939-81	Recommended Practice for Serial Control and Communications Vehicle Network—Network Management	July 1997
SAE J1962	Diagnostic Connector	February 1998
SAE J1978	OBD-II Scan Tool	February 1998
SAE J1979	E/E Diagnostic Test Modes	September 1997
SAE J2008	Recommended Organization of Vehicle Service Information	
SAE J2012	Recommended Message Format and Messages for Diagnostic Trouble Codes	July 1996
SAE J2178	Class B Data Communications Network Messages	January 1995
SAE J2178-1	Class B Data Communications Network Messages: Detailed Header Formats and Physical Address Assignments	January 1995
SAE J2178-2	Class B Data Communications Network Messages—Part 2—Data Parameter Definitions	May 1997
SAE J2178-3	Class B Data Communications Network Messages—Part 3—Frame IDS for Single-Byte Forms of Headers	June 1998
SAE J2178-4	Class B Data Communications Network Messages—Part 4—Message Definitions for Three Byte Headers	February 1995
SAE J2186	E/E Data Link Security	October 1996
SAE J2190	Enhanced E/E Diagnostic Test Modes	June 1993
SAE J2201	Universal Interface for OBD-II Scan	June 1993
SAE J2205	Expanded Diagnostic Protocol for OBD-II Scan Tools	December 1995
SAE J2223-3	Connections for On-board Road Vehicle Electrical Wiring Harnesses, Part 3, Multipole Connectors, Flat Blade	February 1994
SAE J2284	High Speed CAN (HSC) for Passenger Vehicle Applications	February 1999

#### Document Sources

SAE publications are available from SAE, 400 Commonwealth Drive, Warrendale, PA, 15096-0001, ph. 724-776-4841.

ISO documents are available from ANSI, 11 West 42<sup>nd</sup> Street, New York, NY 10036-8002.

EPA documents are available in the Federal Register. Contact: U.S. Environmental Protection Agency, 2565 Plymouth Road, Ann Arbor, MI, 48105, ph. 313-668-4400 or <http://www.epa.gov/fedrgstr/EPA-AIR/>.

Bosch documents are available from Robert Bosch GmbH, Postfach 50, D7000, Stuttgart, Germany.

CARB = California Air Resources Board, 2020 L Street, Sacramento, CA, 95814, ph. 916-322-2990.

## APPENDIX E.1

### A Comparison of Commercial Aircraft Digital Flight Data Recorder Requirements (DFDR) versus Passenger and Truck Land Vehicle ECU EEPROM or Flash Memory Data.

#	Commercial Aircraft Digital Flight Data Recorder Data Parameters (1)						Land Vehicle Data (2)	
	DFDR Parameter	No FDAU, mfg. Before 10/11/91	w/FDAU, Before 10/11/91	Digital Data and ARINC 717 DFDAU, mfg. Before 10/11/91	Mfg. After 10/11/91	Mfg. After 8/18/00	Most Comparable Land Vehicle Data Parameter (in Various Vehicles)	Typical Source ECU
1	Time	x	x	x	x	x	Ignition Cycle	SRS, PCM
2	Pressure Altitude	x	x	x	x	x		
3	Indicated Airspeed	x	x	x	x	x	Vehicle Speed	PCM,BCM
4	Heading—primary flight crew reference (if selectable, record discrete, true, or magnetic)	x	x	x	x	x		
5	Normal Acceleration (Vertical)	x	x	x	x	x		
6	Pitch Attitude	x	x	x	x	x		
7	Roll Attitude	x	x	x	x	x		
8	Manual radio transmitter keying or CVR/DFDR synchronization reference	x	x	x	x	x		
9	Thrust/power of each engine—primary flight crew reference	x	x	x	x	x	Engine Power Level	PCM
10	Autopilot engagement status	x	x	x	x	x	Cruise Control Status	PCM
11	Longitudinal Acceleration	x	x	x	x	x	Saved as $a_{\text{sample}}$ or $\Delta V_{\text{sample}} = \langle a_{\text{sample}} \rangle t_{\text{sample}}$	SRS
12	Pitch control input	x	x	x	x	x		
13	Lateral control input	x	x	x	x	x		
14	Rudder pedal input	x	x	x	x	x		
15	Primary pitch control surface position	x	x	x	x	x		
16	Primary lateral control surface position	x	x	x	x	x		
17	Primary Yaw control surface position	x	x	x	x	x		
18	Lateral acceleration	x	x	x	x	x		
19	Pitch trim surface position or (82), if currently recorded		x	x	x	x		
20	Trailing edge flap or cockpit flap control selection (except when (85) applies)		x	x	x	x		
21	Leading edge flap or cockpit flap control selection (except when (86) applies)		x	x	x	x		
22	Each thrust reverser position (or equivalent for propeller airplane)		x	x	x	x		
23	Ground spoiler position or speed brake selection (except when (87) applies)				x	x		
24	Outside or total air temperature				x	x		



#	Commercial Aircraft Digital Flight Data Recorder Data Parameters (1)						Land Vehicle Data (2)	
	DFDR Parameter	No FDAU, mfg. Before 10/11/91	w/FDAU, Before 10/11/91	Digital Data and ARINC 717 DFDAU, mfg. Before 10/11/91	Mfg. After 10/11/91	Mfg. After 8/18/00	Most Comparable Land Vehicle Data Parameter (in Various Vehicles)	Typical Source ECU
25	Automatic Flight Control System (AFCS) modes and engagement status, including autothrottle				x	x		
26	Radio altitude (when information source installed)				x	x		
27	Localizer deviation, MLS Azimuth				x	x		
28	Glideslope deviation, MLS Elevation				x	x		
29	Marker beacon passage				x	x		
30	Master warning				x	x	MIL Status SRS, ABS, PCM	SRS, ABS, PCM
31	Air/ground sensor (primary airplane system reference nose or main gear)				x	x		
32	Angle of attack (when information source installed)				x	x		
33	Hydraulic pressure low (each system)				x	x		
34	Ground speed (when information source installed)				x	x	Vehicle Speed	ABS
35	Ground proximity warning system					x	Other vehicle proximity	BCM
36	Landing gear position or landing gear cockpit control selection					x		
37	Drift angle (when information source installed)					x		
38	Wind speed and direction (when information source installed)					x		
39	Latitude and longitude (when equipped)					x	GPS Data, when equipped	BCM
40	Stick shaker/pusher (when equipped)					x		
41	Windshear (when equipped)					x		
42	Throttle/power lever position					x	Accel % or Throttle %	PCM
43	Additional engine parameters (Appendix M)					x		
44	Traffic alert and collision avoidance system					x		
45	DME 1 and 2 distances					x		
46	Nav 1 and 2 selected frequency					x		
47	Selected barometric setting (when information source installed)					x		
48	Selected altitude (when equipped)					x		
49	Selected speed (when information source installed)					x	Vehicle Speed (VSS) Wheel Speeds (WSS)	PCM ABS
50	Selected mach (when information source installed)					x		

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#		Commercial Aircraft Digital Flight Data Recorder Data Parameters (1)					Land Vehicle Data (2)	
DFDR Parameter		No FDAU, mfg. Before 10/11/91	w/FDAU, Before 10/11/91	Digital Data and ARINC 717 DFDAU, mfg. Before 10/11/91	Mfg. After 10/11/91	Mfg. After 8/18/00	Most Comparable Land Vehicle Data Parameter (in Various Vehicles)	Typical Source ECU
51	Selected vertical speed (when information source installed)					x		
52	Selected heading (when information source installed)					x		
53	Selected flight path (when information source installed)					x		
54	Selected decision height (when information source installed)					x		
55	EFIS display format					x		
56	Multi-function/engine/alerts display format					x		
57	Thrust command (when information source installed)					x		
58	Thrust target (when information source installed)							
59	Fuel quantity in CG trim tank (when information source installed)							
60	Primary Navigation System Reference							
61	Icing (when information source installed)							
62	Engine warning each engine vibration (when information source installed)							
63	Engine warning each engine over temp (when information source installed)							
64	Engine warning each engine oil pressure low (when information source installed)							
65	Engine warning each engine over speed (when information source installed)							
66	Yaw trim surface position							
67	Roll trim surface position							
68	Brake pressure (selected system)						Brake Boost Vacuum Warning	PCM
69	Brake pedal application (left and right)						Brake Apply Status	ABS, PCM
70	Yaw or sideslip angle (when information source installed)							
71	Engine bleed valve position (when information source installed)							
72	De-icing or anti-icing system selection (when information source installed)							
73	Computed center of gravity (when information source installed)							
74	AC electrical bus status							
75	DC electrical bus status							

# Commercial Aircraft Digital Flight Data Recorder Data Parameters (1)						Land Vehicle Data (2)	
DFDR Parameter	No FDAU, mfg. Before 10/11/91	w/FDAU, Before 10/11/91	Digital Data and ARINC 717 DFDAU, mfg. Before 10/11/91	Mfg. After 10/11/91	Mfg. After 8/18/00	Most Comparable Land Vehicle Data Parameter (in Various Vehicles)	Typical Source ECU
76 APU bleed valve position (when installed)							
77 Hydraulic pressure (each system)							
78 Loss of cabin pressure							
79 Computer failure							
80 Heads-up display (when installed)							
81 Para-visual display (when installed)							
82 Cockpit trim control input position—pitch							
83 Cockpit trim control input position—roll							
84 Cockpit trim control input position—yaw							
85 Trailing edge flap and cockpit flap control position							
86 Leading edge flap and cockpit flap control position							
87 Ground spoiler position and speed brake selection							
88 All cockpit flight control input forces (control wheel, control column, rudder pedal)							

(1) Recorded continuously in flight operation.

(2) Usually only available when an “event” has occurred. Events can be the storage of a DTC or a vehicle impact.

## APPENDIX E.2

### Parameters in SRS and ABS ECUs

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#### SRS ECU Parameters:

1. Crash/Near Crash History Fault Codes
2. Crash/Near Crash Ignition Cycle Fault Codes
3. Crash/Near Crash Active Fault Codes
4. Global History Fault Codes
5. Crash/Near Crash Internal ECU Fault Codes
6. Global Internal ECU Fault Codes
7. Total Ignition Cycle Count
8. Crash/Near Crash Ignition Cycle Count
9. Crash/Near Crash Warning Lamp Status
10. Crash/Near Crash Delta V Data
11. Crash/Near Crash Algorithm Enable Status
12. Crash/Near Crash Jerk Threshold Exceeded Status
13. Crash/Near Crash Energy Boundary Threshold Exceeded Status
14. Crash/Near Crash Velocity Boundary Threshold Exceeded Status
15. Crash/Near Crash Driver Seatbelt Status
16. Crash/Near Crash Passenger Seatbelt Status
17. Time between Near Crash and Crash (each crash event)
18. Crash Algorithm Enable to Overlap or Arming Sensor Closure Time
19. Crash Algorithm Enable to Crash Time
20. Crash Algorithm Enable to Discriminating Sensor Closure Time
21. Near Crash Algorithm Enable to Max Delta V
22. Near Crash Max Delta V
23. Vehicle Speed Before Algorithm Enable
24. Engine Speed Before Algorithm Enable
25. Throttle Position Before Algorithm Enable
26. Brake Switch Status Before Algorithm Enable
27. Seat Occupancy Detection/Discrimination
28. Side Air Bag Data
29. Passenger Air Bag On/Off Switch State

#### ABS ECU Parameters:

1. Wheel Speed
2. Active Faults
3. History Faults
4. Brake Switch Status
5. Number of ABS Occurrences
6. Number of Ignition Cycles Before First Fault
7. Number of Ignition Cycles After First Fault
8. Warning Lamp Status
9. Vehicle Speed
10. Pump Motor
11. Valve Relay
12. Engine Torque
13. Solenoids
14. ABS State
15. Engine Speed