ibright™ Support for CAN (Controller Area Network) and OBD-II

CANOBD 2-0-20080222

Contents

Version Tracking

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1.0	12 Feb 2008	Guy Halpé	Initial Draft
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Contact Information

New Zealand

International Telematics Limited
3A, 125 The Strand
P O Box 37037
Parnell
Auckland
New Zealand
P: +64 9 379 7211
F: +64 9 379 7212

Europe

International Telematics Limited (UK)
5 Spice Court
Battersea
London
SW11 3UE
United Kingdom
P: +44 7881 820 256

North America

International Telematics Incorporated
311 West 43rd Street
Suite 304
New York
NY 10036
United States
P: +1 646 595 8482

Website and Email:

E: info@itelematic.com
W: www.internationaltelematics.com

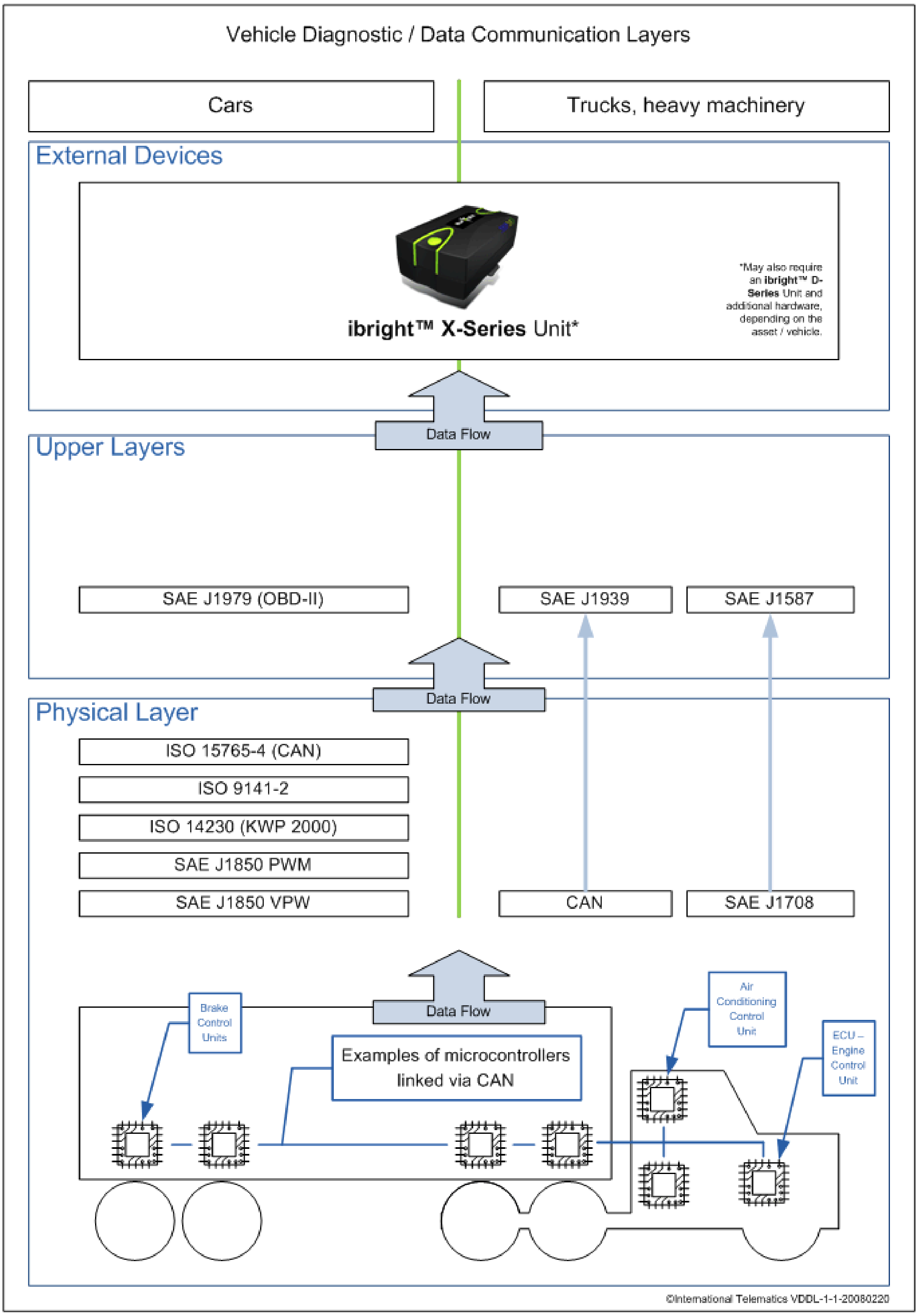
Overview: CAN and OBD-II

Modern vehicles have sophisticated electronics built into the various vehicle systems. These systems use microcontrollers, which self-contained, miniature computers, and are able to generate a wealth of data, including diagnostic information.

The primary communication standard that allows microcontrollers to exchange information internally, between vehicle systems, or with external devices is **CAN (Controller Area Network).** It is based on ISO standards. CAN Bus refers to the physical layer used for linking the microcontrollers as well as the data transfer subsystem that facilitates the information exchange.

This makes CAN a suitable communication standard for capture of **On-Board Diagnostic (OBD)** information. Legislation recently passed in the United States has made CAN the mandatory standard for internal microcontroller communications, so its use is growing in North America. It is most often used for vehicle OBD, but is also seeing use in other areas of industry requiring microcontroller communications - for example, agricultural machinery.

The capture and transfer of OBD data is governed by a number of signalling protocols. CAN is one of them. It is not the only way of capturing diagnostic information from vehicles, however, and many other countries use different OBD-II protocols. The diagram below shows the different layers involved in capturing OBD information to an external device such as the **ibright™** unit from International Telematics.



The protocols necessary for capturing OBD information are present in the **Upper Layers**. The **Physical Layer** shows the different standards used for the transfer of the data.

This document provides some background to the development of the CAN standard and its usage, and examines how the different layers in the diagram work with each other for the purpose of vehicle diagnostics.

CAN Development and Usage

Development of the CAN standard

A modern vehicle may have as many as 50 control units for its various systems and subsystems. Each control unit contains one or more microcontrollers.

The most critical control unit in a vehicle is the **ECU (Engine Control Unit)**.

Examples of other control units are listed below.

- Transmission
- Airbags
- Anti-lock Braking System (ABS)
- Cruise Control
- Climate Control
- Audio
- Central Locking
- Power Windows
- Power Mirrors
- Power Seat Adjustment, and more.

These control units may belong to diverse subsystems, but have a common need to communicate with each other. The CAN standard was devised to address this need.

CAN Usage

The CAN standard enjoys widespread use in modern cars.

In 2008 it became mandatory for all cars sold in the United States to use the ISO 15765-4 signalling standard (a variant of CAN).

The legislation is specific to cars, and will be progressively implemented in the United States in 2008. Effectively, this means that it will take a minimum two years to become consistently applied in the US market.

CAN is also currently in use on some larger industrial vehicles such as trucks and agricultural or construction equipment, and has been adopted as a field bus for general automation environments. This is possible as a result of CAN controllers and processors becoming more affordable. Counterbalancing this is the requirement that any official use of CAN requires a fee for the CAN Protocol License to be paid to Bosch, who developed the protocol and hold the patents.

Physical Layer - Wiring and Connections

A significant aspect of the use of the CAN standard for vehicle diagnostics is the physical layer - the wiring, connectors and related standards.

It is important to choose the correct standard for the vehicle being installed. There are many different ISO variations of the CAN physical layer, so suppliers of CAN solutions should be queried on the standards supported by their products.

A guide to the standards is provided below.

ISO 11898-2

This high-speed CAN standard uses a two-wire balanced signalling scheme. It is the most used physical layer in car powertrain applications and industrial control networks.

ISO 11898-3

This is a fault-tolerant (low-speed) CAN standard.

ISO 11992-1

This is a fault-tolerant (low speed) CAN standard for truck/trailer communications.

ISO 11898-4

This standard defines Time Triggered Communications on CAN (TTCAN). It relies on the CAN data link layer providing a system clock for the scheduling of messages.

SAE J1939

This standard uses a two-wire twisted pair configuration.

- SAE J1939-11 is a 250 kbit/s, Shielded Twisted Pair (STP) standard.
- SAE J1939-15 is a 250 kbit/s, Unshielded Twisted Pair (UTP) reduced layer standard.

SAE 1939 is widely used in agricultural & construction equipment.

ISO 11783-2

This is a 250 kbit/s Agricultural Standard using 4 unshielded twisted wires. 2 are for CAN, and 2 are for the terminating bias circuit (TBC) power and ground. This bus is used on agricultural tractors. It is intended to provide interconnectivity for any implementation based on this standard.

SAE J2411

This is a Single-Wire CAN (SWC) standard.

Physical Layer - Protocols

There are five main signalling protocols that may be used with the OBD-II interface. CAN is one of them.

ibright™ supports them all.

Note: Support of a signalling protocol is no guarantee of actually being able to establish such a link for information exchange purposes. This is because manufacturers have the discretion to enable or restrict the data flowing back to the external unit (see "Upper Layers - Diagnostic Data Standards" on page 12).

Any given vehicle is likely to implement only one of the signalling protocols below. It is often possible to make an educated guess about the protocol that is in use on a given vehicle, based on which pins are present on the **J1962 connector**.

ISO 15765-4 (CAN)

This is the signalling protocol for the CAN standard. It runs at 250 kbit/s or 500 kbit/s.

ISO 9141-2

This protocol has a data rate of 10.4 kbaud, uses UART signalling, and is similar to RS-232. It is primarily used in Chrysler, European, and Asian vehicles. Message length is restricted to 11 bytes, including CRC.

ISO 14230 (KWP 2000)

This standard uses a data rate of 1.2 to 10.4 kbaud and uses KWP2000 (Keyword Protocol 2000). The physical layer is identical to ISO 9141-2, and the message may contain up to 255 bytes in the data field.

SAE J1850 PWM

This is a PWM (Pulse-Width Modulation) protocol running at 41.6 kbaud used by the Ford Motor Company. It employs a multi-master arbitration scheme called Carrier Sense Multiple Access with Non-Destructive Arbitration (CSMA/NDA). Message length is restricted to 11 bytes, including CRC.

SAE J1850 VPW

This is a VPW (Variable Pulse Width) protocol running at 10.4/41.6 kbaud used by General Motors. This protocol also uses CSMA/NDA, and message length is restricted to 11 bytes, including CRC.

Upper Layers - Diagnostic Data Standards

The data from the physical layer needs to conform to specific diagnostic standards if it is to be made available to an external device such as the **ibright™** unit. This is the upper layer, encompassing diagnostic data standards for OBD purposes.

These standards each define a method for requesting various diagnostic data, and a list of standard parameters that might be available from the microcontrollers in the physical layer. The various parameters that are available are addressed by **Parameter Identification** numbers or PIDs. Manufacturers support PIDs at their own discretion, and may also include proprietary PIDs that are not listed in the standard.

Cars use the SAE J1979 (OBD-II) standard. Trucks and heavy vehicles use the SAE J1939 standard, or an older standard, SAE J1587.

The **ibright™** Platform supports all these diagnostic standards.

Note: The installation may also require an **ibright™ D-Series** unit and additional hardware, depending on the asset or vehicle type.

Appendix 1: OBD Development Chronology

This topic is a short history of On-Board Diagnostics (OBD) development.

- 1970: The United States Congress passes the Clean Air Act and establishes the Environmental Protection Agency.
- Circa 1980: On-board computers begin appearing on consumer vehicles, largely motivated by their need for real-time tuning of fuel injection systems. Simple OBD implementations appear, though there is no standardisation in what is monitored or how it is reported.
- 1982: General Motors implements an internal standard for its OBD called the Assembly Line Communications Link (ALCL), later renamed Assembly Line Diagnostics Link (ALDL). The initial ALCL protocol communicates at 160 baud with Pulse-Width Modulation (PWM) signalling and monitors very few vehicle systems.
- 1986: An upgraded version of the ALDL protocol appears which communicates at 8192 baud with half-duplex UART signalling. This protocol is defined in GM XDE-5024B.
- Circa 1987: The California Air Resources Board (CARB) requires that all new vehicles sold in California starting in manufacturer's year 1988 (MY1988) have some basic OBD capability. The requirements they specify are generally referred to as the "OBD-I" standard, though this name is not applied until the introduction of OBD-II. The data link connector and its position are not standardised, nor is the data protocol.
- 1988: The Society of Automotive Engineers (SAE) recommends a standardised diagnostic connector and set of diagnostic test signals.
- Circa 1994: Motivated by a desire for a state-wide emissions testing program, the CARB issues the OBD-II specification and mandates that it be adopted for all cars sold in California starting in model year 1996 (see CCR Title 13 Section 1968.1 and 40 CFR Part 86 Section 86.094). The DTCs and connector suggested by the SAE are incorporated into this specification.
- 1996: The OBD-II specification is made mandatory for all cars sold in the United States.
- 2001: The European Union makes EOBD, a variant of OBD-II, mandatory for all petrol vehicles sold in the European Union, starting in MY2001 (see European Emission Standards Directive 98/69/EC).
- 2008: All cars sold in the United States are required to use the ISO 15765-4 signalling standard, a variant of CAN.

Appendix 2: OBD Reference Links

- National OBD Clearing House (http://www.clearinghouse.com/oemdb). This shows images of OBD-II ports for most vehicles.
- On-Board Diagnostics, Wikipedia (http://en.wikipedia.org/wiki/On-Board_Diagnostics). A comprehensive document on the OBD-II standard including a pin map.
- OBD-II Trouble Codes (http://www.obd-codes.com/). Detailed information on OBD-II trouble codes and diagnosis information.
- OBD-II.com (http://www.obdii.com/obdii.html). A comprehensive web reference, including OBD-II glossary terms and acronyms.