

ITS Data Bus—Thin Transport Layer

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Documents

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- 1. Scope**—This SAE Recommended Practice details the Thin Transport Layer of the Intelligent Transportation Systems (ITS) Data Bus, which is generally intended for in-vehicle use.

The Thin Transport Layer sits between SAE J2366-2 and J2366-7. It provides the handling of such activities as the packetizing of long messages and message reassembly. Design of the messages and headers has stressed economy, in terms of bits within a CAN 2.0B frame.

The ITS Data Bus (IDB) is a non-proprietary virtual token passing bus, designed to allow disparate consumer, vehicle, and commercial electronic components to communicate and share information across a standard, open data bus.

This document describes the Thin Transport Layer of the IDB, as shown in Figure 1.

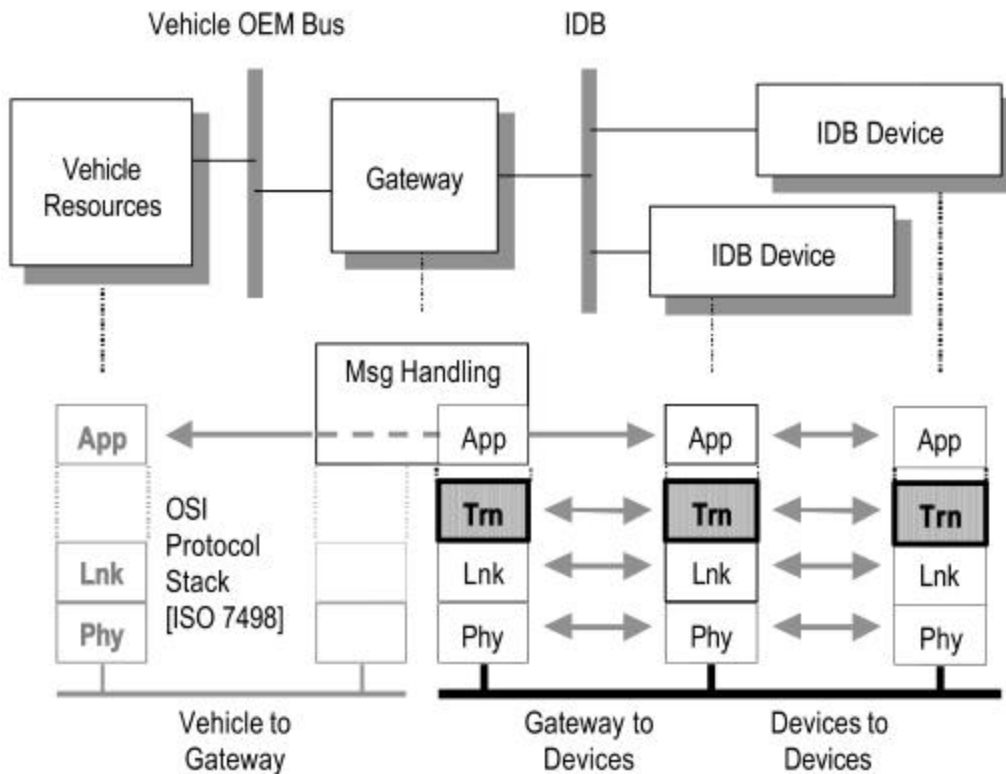


FIGURE 1—SCOPE OF J2366-4

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, <http://www.sae.org>.

SAE J2355—ITS Data Bus – Architecture Reference Model Information Report

SAE J2366-2—ITS Data Bus—Link Layer

SAE J2366-7—ITS Data Bus—Application Message Layer

2.1.2 CAN PUBLICATION—Available from Robert Bosch GmbH, Postfach 50, D-7000 Stuttgart 1, Germany

CAN Specification, Version 2.0

2.2 Related Publications—The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, <http://www.sae.org>.

SAE J1760—IDB Data Security Services (Under Development at time of this document's publication)

SAE J2366-1—ITS Data Bus—Physical Layer

SAE J2590—PMode for In-Vehicle Networks

2.2.2 ISO PUBLICATION—Available from ISO

ISO 7498:1990—Information processing systems—Open system interconnect—Basic reference model

3. Definitions

- 3.1 ACK**—This term is used to describe a positive acknowledgement or message indicating positive acknowledgement. An ACK indicates that an amount of information has been verified as correctly received.
- 3.2 AMH**—IDB Application Message Layer Header.
- 3.3 AML**—SAE J2366-7 Application Message Layer.
- 3.4 Bit**—A signaling unit or unit of data transmission of minimal length. It can hold either the value '0'B or '1'B.
- 3.5 Clear**—The word “clear” is used in referring to one or more bits to indicate that they each have a value of '0'B. This is also referred to as “dominant” in CAN 2.0B terminology.
- 3.6 Dominant**—A term defined in CAN 2.0B to indicate a data bit with a value of '0'B.
- 3.7 Frame**—An ordered sequence of bits, used to communicate information between the Transport Layers of IDB Nodes.
- 3.8 Frame Group**—An ordered sequence of up to 16 frames, grouped for purposes of acknowledgement.
- 3.9 IDB**—The ITS Data Bus. This document describes the Thin Transport Layer protocol for the IDB.
- 3.10 ITS**—Intelligent Transportation Systems
- 3.11 NACK or NAK**—This term is generally used to describe a negative acknowledgement or message indicating negative acknowledgement. A NAK indicates that an amount of information has been detected as incorrectly received.
- 3.12 Node**—A Node is a device on the IDB with at least one physical Node ID.
- 3.13 Octet**—An octet is a unit of data transmission that consists of 8 bits. On most commonly used microprocessors, such an 8-bit quantity is commonly referred to as a “byte”. The bits within an octet may be subdivided and/or grouped, to provide specific meanings.
- 3.14 OEM**—OEM is an acronym for Original Equipment Manufacturer. In this document it refers to the manufacturer of a vehicle.
- 3.15 OSI**—Officially known as the “ISO Reference Model of Open System Interconnection”. It refers to a model, or way of thinking about communication protocols as being divided into (usually) seven distinct layers.
- 3.16 Out Of Band**—This term refers to a data transfer event that is occurring outside of the normal operation of the Transport Layer. An example of such an event is the transmission of an “Out Of Band” message from a sender to a receiver during the regular transmission of a standard message from the same sender to the same receiver. It is also used to describe information that is passed between protocol layers without being encoded in the header or PDU.
- 3.17 PDU (Protocol Data Unit)**—Message packets exchanged between two protocol entities.
- 3.18 Recessive**—A term defined in CAN 2.0B to indicate a data bit with a value of '1'B.

3.19 Set—The word “set” is used in referring to one or more bits to indicate that they each have a value of '1'B. This is also referred to as “recessive” in CAN 2.0B terminology.

3.20 TTC—Thin Transport Control message.

3.21 TTD—Thin Transport Data message.

3.22 Time Intervals—Several critical time intervals are specified for the IDB SAE J2366-4 Protocol. Unless otherwise noted, time intervals are significant to the nearest 0.1 mS. Each is defined as follows.

3.22.1 **FRAME GROUP ACKNOWLEDGE TIMER, T_{MAXACK}** —This is the amount of time a sender shall wait for an acknowledgement of a point-to-point Frame Group from a receiver. The duration of this timer is 150.0 mS. Any acknowledgements (positive or negative) received after this timer has expired shall be discarded.

3.22.2 **INACTIVITY TIMER, $T_{INACTIVITY}$** —This is the maximum time that is allowed to elapse between frame groups of a message. Once the end of a frame group has been received that does not also end the message, no more than $T_{Inactivity}$ may elapse before the first frame of the next frame group of that same message is received. The duration of this timer is 500.0 mS.

If the time is exceeded, the receiving Node shall flush the incoming message from its buffers and queue a NAK frame for the message - see Table 1.

3.22.3 **FRAME GROUP TIMER, $T_{FRAMEGROUP}$** —This is the maximum time allowed to elapse for any given frame group to arrive (first to last frame of the group). Once the first frame of a group is received, no more than $T_{FrameGroup}$ may elapse before the last frame of that same frame group is received. (The end of the frame group may or may not be the end of the complete message.) The duration of this timer is 500.0 mS.

If the time is exceeded, the receiving Node shall flush the incoming message from its buffers and queue a NAK frame for the message - see Table 1.

4. Protocol Overview—This protocol is designed to meet the varied and challenging requirements for in-vehicle data communications. Some noteworthy features of the protocol:

- a. The protocol provides a packetizing and reliability layer, intended to sit between a Link Layer (e.g., SAE J2366-2) and an Application Layer (e.g., SAE J2366-7).
- b. The protocol follows the OSI protocol layering concepts.
- c. It provides the capability to transmit an Application Layer PDU “payload” of up to 2051 octets ($2^{11} + 4$) plus 8 octets of Application header information, handling fragmentation required by a Link Layer and reassembly at the destination.

NOTE— Since a DataFrameStart Frame can specify a range of 2 to 255 frames, the maximum SAE J2366-4 payload is actually $254 \times 9 + 8 = 2294$ octets. It is restricted to 2059 in this version since this is the maximum SAE J2366-7 message size.

- d. Each Node should provide a buffer to receive at least a 1 KB message from other Nodes.

4.1 Basic Concepts—One of the fundamental requirements is to make IDB-compliant devices and software “... *easy to design and implement*...” (SAE J2355 Section 4.1.2). Every attempt has been made to keep the basic concepts encapsulated in this design simple. This simple design will allow for all of the Goals and Functional requirements (from the Applications perspective), as stated in SAE J2355, to be met.

There are two primary types of SAE J2366-4 messages, Control and Data. Control messages provide the capability of Positive Acknowledgement (ACK) and Negative Acknowledgement (NAK) to re-synchronize. Data messages generally contain upper layer (e.g., SAE J2366-7) PDU “payload”.

On any given Node, there can be no more than one IDB SAE J2366-4 Transport Layer. However, other layers may be specified for interface directly with SAE J2366-2, per its documentation.

All field values or bits that are not explicitly defined by this document, or explicitly referenced to other documents are reserved for future definition by a later version of SAE J2366-4. They are **not** available for arbitrary use by specific implementations.

4.2 Frame Format Overview—Figure 2 shows the formats of the two main types of SAE J2366-4 frame. Some TTL frames provide up to 64 bits of data, while others provide up to 72 bits of data.

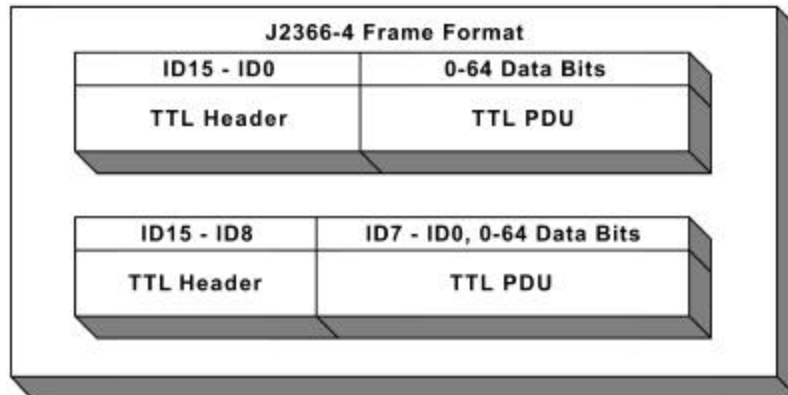


FIGURE 2—SAE J2366-4 FRAME FORMATS

4.3 Frame Elements

NOTE— The TTL Frame diagrams in the following sections show bit ID16, the SAE J2366-2 ATID bit, as a reminder that these frame definitions apply only when that bit is 'dominant', as specified by SAE J2366-2. The ID16 bit is not strictly a part of this specification.

Table 1 describes each of the Frame Types used by SAE J2366-4. Each *FrameType* value is given, along with the name of the Frame to which it corresponds and an indication as to whether the frame is a TTD or a TTC type.

TABLE 1—FRAME TYPES

FrameType	TTD/TTC	Frame Name
rrr	TTD	DataFrameStart
rrd	TTD	DataFrameCont
rdr	TTD	DataFrameEnd
rdd	TTD	DataFrameSingle
drr	TTD	DataFrameReSync
drd	TTC	ACK
ddr	TTC	NAK

The basic TTL Frame format is shown in Figure 3.

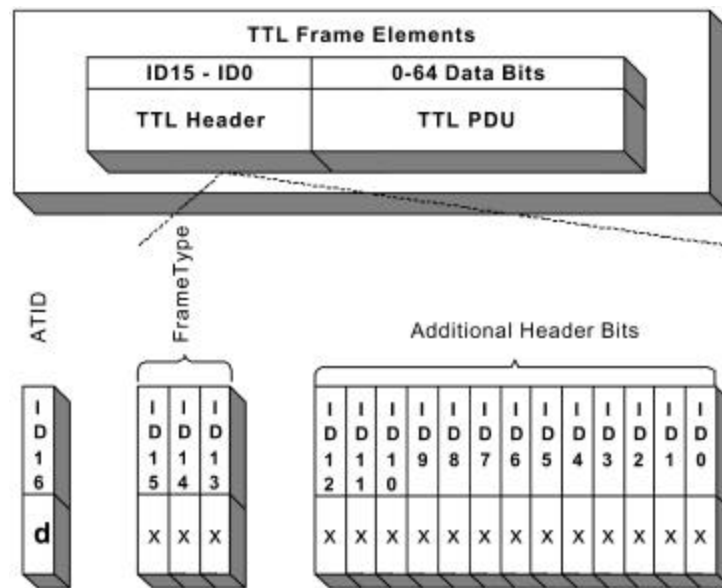


FIGURE 3—TTL FRAME ELEMENTS

- 4.3.1 DATA FRAME ELEMENTS—There are five types of SAE J2366-4 Data Frame (TTD). Each has a header that is made up of 16 bits, divided among several elements. The first element is always a 3bit *FrameType* field, as defined in Table 1. Following the *FrameType*, a TTD contains header elements defined by the *FrameType*. Succeeding paragraphs in this section detail each of the TTD header elements.
- 4.3.1.1 *DataFrameStart Frame Elements*—All SAE J2366-4 messages longer than 9 octets shall begin with a DATAFRAMESTART frame. This frame type is shown in Figure 4.

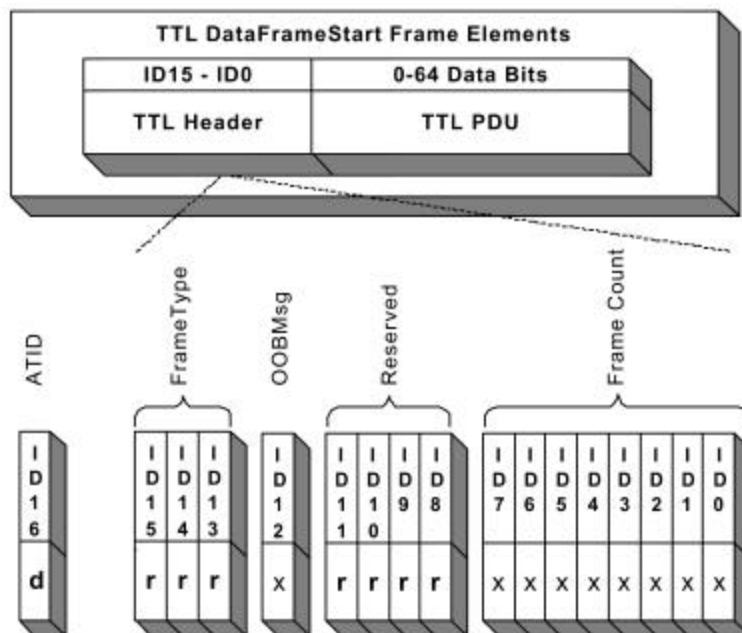


FIGURE 4—TTL DATAFRAMESTART FRAME ELEMENTS