



SURFACE VEHICLE INFORMATION REPORT

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TP1.6 Vehicle Diagnostic Protocol

RATIONALE

Some Volkswagen of America and Audi of America vehicles are equipped with ECU(s), in which a TP1.6 proprietary diagnostic communication protocol is implemented. This document is needed to specify the requirements necessary to implement the TP1.6 communication protocol in an SAE J2534 interface. Updates were made in 2022 to clarify the Channel Identifiers and correct minor errors.

TABLE OF CONTENTS

1.	SCOPE	3
2.	REFERENCES	3
2.1	Applicable Documents	3
2.1.1	SAE Publications	3
3.	TERMS AND ACRONYMS	3
4.	OVERVIEW	5
5.	CAN MESSAGE FORMAT	6
5.1	CAN-Telegram Overview for Channel Setup, Channel Acknowledge	6
5.1.1	Channel Setup Message Structure	6
5.1.2	Channel Setup Request	7
5.1.3	Channel Acknowledge Response	8
5.1.4	Static CAN-Telegram Parameters	9
5.1.5	CAN-Telegram Error Handling	9
5.1.6	CAN-Telegram Establishing a Channel and Connection	9
5.2	Transport Protocol Data Unit Telegrams on an Established Channel	10
5.2.1	Identifier (CAN ID)	10
5.2.2	Payload (CAN Data Bytes)	10
5.2.3	Transport Protocol Rules and Parameters	12
5.2.4	Transport Protocol Error Handling	14
5.2.5	CAN-Telegram Establishing a Channel and Connection	14
6.	EXAMPLES	15
6.1	CAN-Telegram Examples	15
6.1.1	Channel Set-Up with Ack	15
6.1.2	Channel Set-Up Missing Ack	15
6.2	Transport Protocol Examples	16
6.2.1	Connection Set-Up with Ack	16

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Documents

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6.2.2	Connection Set-Up Missing Ack	16
6.2.3	Sending Data with Acknowledge Request - Ready Response	16
6.2.4	Sending Data with Acknowledge Request Not Ready	17
6.2.5	Sending Data with Acknowledge Request with No Ack	17
6.2.6	Receiving Data with a T2 Timeout	17
6.2.7	Sending Data with Acknowledge Request, Receiver Not Ready, and Retransmit Block Previous Block	18
6.2.8	Data Complete, Direction Change with Ready Ack	18
6.2.9	Data Complete, Direction Change with Not Ready Ack Then Ready Ack	19
6.2.10	Data Complete, Direction Change	19
6.2.11	Data Complete, Direction Change with Not Ready Ack	20
6.2.12	Data Complete, T1 Timeout	20
6.2.13	Data Complete, Disconnect Telegram	21
7.	NOTES	21
7.1	Revision Indicator	21
Table 1	Tester source identifier	7
Table 2	ECU source identifier	7
Table 3	Destination target address range	7
Table 4	Channel setup channel IDs	8
Table 5	Channel acknowledge channel IDs	9
Table 6	Static CAN telegram parameters	9
Table 7	CAN telegram error handling	9
Table 8	General TPDU formats	11
Table 9	TPCI byte 0	11
Table 10	BS byte 1	11
Table 11	Sending priority	12
Table 12	Static transport protocol parameters	13
Table 13	Transport protocol error handling	14

1. SCOPE

This SAE Information Report defines the diagnostic communication protocol TP1.6. This document should be used in conjunction with SAE J2534-2 in order to fully implement the communication protocol in an SAE J2534 interface.

Some Volkswagen of America and Audi of America vehicles are equipped with ECU(s), in which a TP1.6 proprietary diagnostic communication protocol is implemented. The purpose of this document is to specify the requirements necessary to implement the communication protocol in an SAE J2534 interface.

This SAE Information Report describes how a tester can be connected to a vehicle to perform diagnostics using the TP1.6 protocol. Details regarding ECU to ECU communication have been left out.

2. REFERENCES

2.1 Applicable Documents

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J2534-1 Recommended Practice for Pass-Thru Vehicle Programming

OSEK Communication V1.0: Fault-Tolerant Communication

3. TERMS AND ACRONYMS

3.1 Ack

Acknowledge message.

3.2 AR

Acknowledge request.

3.3 BS

Block size.

3.4 CA

Connection acknowledge: Dynamic connection configuration response.

3.5 CAN Telegram

A CAN message with 11 address bits and up to 8 data bytes used to request, respond or establish a connection.

3.6 ChA

Channel acknowledge: Dynamic connection establishment response.

3.7 ChId

Channel identifier without offset.

3.8 ChS

Channel setup: Dynamic connection establishment request.

3.9 CS

Connection setup: Dynamic connection configuration request.

3.10 DC

Disconnect message.

3.11 DDC

Data direction change.

3.12 DT

Data message.

3.13 ECU

Electronic control module.

3.14 EOM

End of message.

3.15 ID or Identifier

Fixed CAN ID assigned to a module.

3.16 MNT

Maximum value during communication.

3.17 MNTC

Maximum value with connection structure.

3.18 OC

OpCode.

3.19 RNR

Passive ECU (receiver) not ready.

3.20 RR

Passive ECU (receiver) ready.

3.21 RS

Receive status.

3.22 SN

Sequence number.

3.23 TAa

Target address of active module.

3.24 TAp

Target address of passive module.

3.25 T_E

Time-out for channel structure.

3.26 T1, T3

Parameter ECU (CS/CA).

3.27 TP

Transport protocol.

3.28 TPCI

Transport protocol control information byte.

3.29 TPDU

Transport protocol data unit.

3.30 ACTIVE

An active module is the module that is sending data to a passive module.

3.31 PASSIVE

A passive module is the module that is receiving data from an active module.

3.32 IDENTIFIER

Each message in TP1.6 has an identifier which is the 11 bit address of the CAN message. Each module on the CAN bus has been assigned fixed Identifiers. The fixed Identifier is used to set-up a dynamic channel through which the data exchange can flow.

3.33 DYNAMIC CHANNEL

A dynamic channel uses dynamic assigned CAN addresses which are set-up when a channel is established. The dynamic channel CAN IDs are used to send the data between nodes.

4. OVERVIEW

This document describes the transport protocol TP1.6 which is an exclusive connection between two CAN (11 bit IDs only) participants for the transmission of large amounts of data.

The CAN-transport protocol includes an agreement for the dynamic assignment of bi-directional transport channels between control modules. It is an extension of the transport protocol that was standardized in the OSEK-communication V1.0.

The generalization of the OSEK-connection is necessary to make dynamic assignments of identifiers to transport connections and to make a discontinuation of a running data transmission and additional timings possible.

For the dynamic identifier, a unique address was assigned to each control module for all vehicles and a firm question or answer address channel. By exchanging messages, the systems assign on these channels the transport channels that must then be used.

The major attributes of the TP1.6 transport protocol are:

- Control bytes for channel structure, connection structure, structure confirmation, connection control, data transfer, and confirmation.
- Half duplex channels.
- Confirmation of each telegram or major block of telegrams including error correction.
- Interruption of a running data transmission.

5. CAN MESSAGE FORMAT

5.1 CAN-Telegram Overview for Channel Setup, Channel Acknowledge

The first step in creating a transport protocol connection is to setup a channel. Two messages, the channel setup (ChS) message and channel acknowledge (ChA) message are used to setup a channel. Channel setup and channel acknowledge messages have a fixed length of 3 data bytes (CAN DLC = 3).

The CAN-telegram for channel setup and channel acknowledge has the following structure:

Identifier	1. Byte	2. Byte	3. Byte	4. Byte	5. Byte	6. Byte	7. Byte
11 bits Source	Destination	Opcode	ChId	Not used			

Source: Fixed source address of the sending ECU (CAN 11 bit address).

Destination: TA_p for channel setup, TA_a for channel acknowledge - target address of the recipient.

Opcode: Channel Set-up 0xC0
Channel Ack-Positive Reply 0xD0
Channel Ack-Negative Reply 0xD8

ChId: Channel ID, requested lower 8 bits of the CAN ID to be used for the dynamic communication channel.

5.1.1 Channel Setup Message Structure

Channel setup messages are used to establish a data channel between two ECUs (or the tester and an ECU) for the purpose of sending large blocks of data. The channel setup message is sent from the active ECU to a passive ECU to see if it can start a dynamic channel. The receiving passive ECU must send a positive or negative response to the message. The sending active ECU will wait for the response or time-out.

The responding passive ECU must be able to accept the ChId sent by the requester as part of the CAN ID the responder will use to send messages to the requester. The responding passive ECU must fill in the ChId in the channel acknowledge message when returning a positive reply.

After receiving a channel acknowledge-positive reply, the sending and responding ECU use the dynamic channel to send and receive transport protocol data unit telegrams which will be used to send data and manage the dynamic channel.

Each ECU, either active or passive, shall support multiple dynamic channels simultaneously if it has the resources to do so. Each established dynamic channel will have a unique ChId pair and will operate independently of any other dynamic channels established on the ECU. An ECU that does not have the resources to support additional dynamic channels will reply to the channel setup message with channel acknowledge-negative reply.

5.1.2 Channel Setup Request

5.1.2.1 Source Identifier

Each ECU in a vehicle has been assigned a fixed Source Identifier (CAN 11 bit address) which must be used during the channel setup process. The default channel setup tester Source Identifier for communicating with drive ECUs is 0x200, for communicating with comfort ECUs is 0x2D0 and for communicating with infotainment ECUs is 0x2D0.

The assigned fixed Source Identifier is sometimes referred to as the “opening identifier.”

Table 1 - Tester Source Identifier

Tester Type	Tester Setup Offset	Tester Target Address Range (TAa)	Tester Source Range	Default Tester Target Address	Default Tester Source
Drive	0x200	0x00 - 0x1F	0x200 - 0x21F	0x00	0x200
Comfort	0x2D0	0x00 - 0x0F	0x2D0 - 0x2DF	0x00	0x2D0
Infotainment	0x2D0	0x00 - 0x0F	0x2D0 - 0x2DF	0x00	0x2D0

TAa is derived from the lower byte of the Channel Setup Source Identifier: When the Source Identifier is in the range of 0x200 – 0x21f then TAa = Source identifier – 0x200. When the Source Identifier is in the range of 0x2D0 – 0x2DF then TAa = Source identifier – 0x2D0.

Table 2 - ECU Source Identifier

ECU Type	ECU Setup Offset	ECU Target Address Range (TAa)	ECU Identifier Range
Drive	0x200	0x00 - 0x1F	0x200 - 0x21F
Comfort	0x2E0	0x00 - 0x1F	0x2E0 - 0x2FF
Infotainment	0x4A0	0x30 - 0x3F	0x4D0 - 0x4DF

TAa is derived from the lower byte of the Channel Setup Source Identifier: When the Source Identifier is in the range of 0x200 – 0x21f then TAa = Source identifier – 0x200. When the Source Identifier is in the range of 0x2E0 – 0x2FF then TAa = Source identifier – 0x2E0. When the Source Identifier is in the range of 0x4D0 – 0x4DF then TAa = Source identifier – 0x4A0

5.1.2.2 Destination

The destination is the target address of the passive control unit being addressed (TAp). Target address values are fixed for each ECU in the vehicle. The active requester's target address (TAa) cannot equal the destination target address (TAp).

Table 3 - Destination target address range

ECU Type	Destination range
Drive	0x00 - 0x1F
Comfort	0x00 - 0x1F
Infotainment	0x30 - 0x3F

5.1.2.3 OpCode

For a channel setup request the OpCode is always 0xC0.

5.1.2.4 Channel ID

The channel ID is the ID of the dynamic channel being requested. The channel ID (ChId) is added to the channel offset to yield the actual CAN ID used on the CAN network.

Each ECU type has a different formula for generating the channel ID. The device sending the channel setup request uses its own target address plus a constant or range of constants to generate the channel ID.