Infrastructure Connectivity Certification Test Procedures for Infrastructure-Based Connected Automated Vehicle Components

Traveler Information Message – SAE J2735

www.its.dot.gov/index.htm

October 30, 2020

FHWA-JPO-20-795

U.S. Department of Transportation

Produced under Saxton Transportation Operations Laboratory Task Order 18-399 (Infrastructure Connectivity Certification Test Procedures for Infrastructure-based CAV Components), DTFH6116D00030L-693JJ318F000399

U.S. Department of Transportation

Office of the Assistant Secretary for Research and Technology

Federal Highway Administration

Notice

Quality Assurance Statement

The Federal Highway Administration (FHWA) provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

Technical Report Documentation Page		
1. Report No. FHWA-JPO-20-795	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle Infrastructure Connectivity Certification Test Procedures for Infrastructure-Based Connected Automated Vehicle Components Traveler Information Message – SAE J2735		**5. Report Date** October 30, 2020 **6. Performing Organization Code**
7. Author(s) Abey Yoseph, Animesh Balse, Zhitong Huang, Ed Leslie		**8. Performing Organization Report No.**
9. Performing Organization Name And Address Leidos, Inc. 11251 Roger Bacon Drive Reston, VA 20190		**10. Work Unit No. (TRAIS)** **11. Contract or Grant No.**
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Highway Administration Saxton Transportation Operations Laboratory 6300 Georgetown Pike McLean, VA 22101		**13. Type of Report and Period Covered** Test Procedures April, 2020–October, 2020 **14. Sponsoring Agency Code** HRDO
15. Supplementary Notes Deb Curtis, Government Task Manager		

16. Abstract

The successful deployment and operation of connected vehicle systems will require that devices, systems, and applications developed by different providers be compatible, interoperable, non-interfering, and, in some instances perhaps, interchangeable. In addition, some devices, systems, and applications, e.g., active safety applications, may be required to meet minimum operational performance standards. A list of questions was distributed to potential stakeholders to gather information on which aspects of the industry should be considered for certification. The results of this effort were compiled and consolidated into a list of recommendations that yielded five test plans to be addressed under this project. Two separate test plans certify signal phase and timing (SPaT) messages and applications related to the following two items: National Transportation Communications for Intelligent Transportation Systems Protocol (NTCIP) 1202 v3 objects and SAE International (SAE) J2735 messages. The other three test plans certify the MAP message, traveler information message (TIM), and personal safety message (PSM) as defined in J2735. This document contains the test plan and test design for one of the five messages: TIM. The scope of the test cases contained in this document is to evaluate the output of a TIM application which encodes elements of TIM data into an SAE J2735 TIM over available wireless technology. This test plan is intended to evaluate the format, structure, and encoding of the TIM. SAE J2735 Standard governs the TIM format and structure. The message is presented in the Abstract Syntax Notation One (ASN.1) format, which is UPER Hex encoded for broadcast. The scope for testing includes various mandatory data elements and their corresponding values, along with the verification of the various format conversions. Various sources for the TIM information would be considered. This document focuses on the ingestion of the information from its source and its eventual conversion to UPER Hex for broadcast.

17. Key Words	**18. Distribution Statement**
Certification, Test Plan, Test Case Specification, Roadside Equipment, Traveler Information Message, TIM	No restrictions.

19. Security Classif. (of this report)	**20. Security Classif. (of this page)**	**21. No. of Pages**	**22. Price**
Unclassified	Unclassified	60	N/A

Table of Contents

List of Figures

List of Tables

Test Plan Approvals

Coordination and Approvals

Contributors

Abey Yoseph ***Test Engineer***	***(Date)***	*Animesh Balse* ***Electrical Engineer***	***(Date)***
Zhitong Huang ***Transportation Engineer***	***(Date)***	*Ed Leslie* ***Electrical Engineer***	***(Date)***

Approver(s)

The signatures below constitute approval of this plan.

Deb Curtis ***Project Manager***	***(Date)***

Chapter 1. Introduction

Background

The U.S. Department of Transportation (USDOT)'s Connected Vehicle Program aims to improve safety, enhance mobility, and reduce the environmental footprint of our transportation systems through connected vehicle technology. In support of that goal, the Federal Highway Administration (FHWA) Office of Operations Research and Development (HRDO) performs transportation operations research and development (R&D) at the Saxton Transportation Operations Laboratory (STOL), established at the Turner-Fairbank Highway Research Center (TFHRC).

Connected transportation systems use connected vehicle technology to link vehicles and mobile devices to each other, to transportation infrastructure, and to the larger communication infrastructure requiring trusted communications and interoperability. USDOT is assessing services and applications that realize the full potential of connected vehicles, travelers, and infrastructure to enhance current operational practices and transform future surface transportation systems. To realize this potential, connected vehicle equipment and applications must meet minimum performance requirements; conform to common technical standards, guidelines, and specifications; and interoperate with one another. Certification testing provides a formal means of verifying that a device, application, or service conforms to these requirements.

The successful deployment and operation of connected vehicle systems requires that devices, systems, and applications developed by different providers be compatible, interoperable, non-interfering, and, in some instances, interchangeable. Some devices, systems, and applications, such as active safety applications, may be required to meet minimum operational performance standards. A list of questions was distributed to potential stakeholders to gather information on which aspects of the industry should be considered for certification. The results were compiled and consolidated into a list of recommendations that yielded five test plans to be addressed under this project. Two separate test plans certify signal phase and timing (SPaT) messages and applications related to the following two items: National Transportation Communications for Intelligent Transportation Systems Protocol (NTCIP) 1202 v3 objects and SAE International (SAE) J2735 messages. The other three test plans certify MAP, traveler information messages (TIM), and personal safety messages (PSM) and applications related to J2735. This document contains the test plan and test design for one of those five messages: TIM.

Test Scope

The scope of the test cases is to evaluate the output of a TIM application, which encodes elements of TIM data into an SAE J2735 TIM over available wireless technology. This test plan is intended to outline the evaluation and testing of the format, structure, and encoding of the TIM. SAE J2735 Standard governs the TIM format and structure. The message is represented in the Abstract Syntax Notation One (ASN.1) format, which is UPER Hex encoded for broadcast. The scope for testing includes various mandatory data elements and their corresponding values, along with verification of the various format conversions. Various sources for the TIM information would be considered. This document will focus on the ingestion of the information to ASN.1 format and its eventual conversion to UPER Hex for broadcast.

The test considers three major processes and data structures for effective testing:

- Input: TIM data.
- Processing: ASN.1 format.
- Output: UPER Hex encoded payload.

Evaluations will be performed on the following functional areas:

- Content verification for critical TIM data elements according to SAE J2735
- Format verification for generated ASN.1 TIM
- ASN.1 {J2735 (TIM) message format} to UPER Hex encoding verification

The test does not consider security (i.e., signed or encrypted messages) since those features are addressed by other test plans.

Items and Features to Be Tested

- Completeness and correctness of TIM elements
    - To successfully encode an SAE J2735 TIM, it is necessary to obtain critical elements for this message. This test plan tests the completeness and correctness of TIM critical elements. These TIM elements could be generated from various sources, such as traffic management center-generated messages and Work Zone Data Exchange standards.
- TIM formatting verification according to UPER ASN.1
    - Interoperability is important for connected automated vehicle (CAV) deployment. A key approach to interoperability is ensuring that different CAV messages are correctly and uniformly encoded. After TIM elements are encoded to a SAE J2735 TIM, the format of this message will be verified.

Analysis and Report Findings

The test conductors will analyze the test results and prepare a test report for each vendor and submit the report to the vendor. These reports provide information to vendors about implementations that do not meet, or only partially meet, the requirements that were evaluated in this test. These reports are not official approval, confirmation, or certification by USDOT. The test conductors may also support briefings with the vendor to explain the results. The test conductors may also support information exchange and collaboration on recommended next steps.

Test Objective

The objective of this document is to describe the process for certification and evaluation of implementations of the SAE J2735 TIM. The testing agency will be able to test the TIM through various stages of message creation. Certification will be used as a procurement tool for connected vehicle device deployers.

Chapter 2. Test Environment

Tests will be conducted at a certification test laboratory (CTL), such as OmniAir and its affiliates. This test is designed for the TIM J2735 message set; it include testing of various elements starting with the TIM data input to the UPER Hex output by linking the various stages to the J2735 message set directory.

Test Environment Requirements

To conduct tests, each test environment must have the following configuration and equipment:

- A power source appropriate to the device under test (DUT)
- An optional global positioning system (GPS) to provide location and system time. GPS can be provided by:
    - Access to open sky
    - A GPS repeater (license may be required)
    - A GPS simulator (for accuracy, time synchronization is required across all testing devices)
- Network backhaul to allow connection to a hardware which includes a MAP application
- A laptop with internet protocol (IP) packet sniffer and UPER decoder
- A test tool to log encoded packets over the available communication medium
- An optional TIM data broadcasting device

Qualification Criteria

The qualification will be determined at the various stages of testing. This will determine that the message is converted in the correct format while maintaining the mandatory standards and fields. Each value will be checked that it is within the acceptable range as stated in the standards documents. The CTL is expected to have sufficient resources (e.g., equipment and personnel with related expertise) to complete all tests identified in this test plan.

Chapter 3. Test Schedule, Personnel, and Documentation

This section contains a high-level test schedule, required personnel to execute tests, and a description of several documents that should be used to record test activities and results.

Test Schedule

Table 1 lists the anticipated activities of the evaluation process after a device is admitted to the certification testing process. These activities are required for each vendor under test.

Table 1. Test Activities

ID	Name	Estimated Duration
1	Initial hardware inspection	1 day
2	Initial configuration to operate in the applicable test environment	1 day
3	Full evaluation	2 weeks
4	Document results and submit final report	1 week

Personnel

The required number and qualifications of staff to complete testing activities will depend on the organization. Table 2 lists the staff anticipated to complete the activities in the estimated duration shown in Table 1.

Table 2. Test Personnel

Title	Minimum Number
Test director/manager	1
Test conductor	1
Test operator	1–2
Roadside equipment technology expert	1
Vendor representative	1 per vendor
Test observers	As desired

Test Director (Quality Assurance Manager)

The test director supervises and controls all tests, reviews and approves the test procedures, has the authority to direct all test activities, and communicates test status to all stakeholders. The test director notifies key stakeholders of the test schedule in advance of the scheduled start.

Test Conductor

The test conductor is responsible for running daily test activities and remains in contact with vendors, as needed, to communicate which tests are being run and receive support input during testing. The test conductor distributes test scripts, forms, and other pertinent information, and answers questions.

Throughout the test day, the test conductor verifies that entrance criteria have been met for each test run, verifies readiness of test participants and equipment, and announces the start and end of each testing period. The test conductor also ensures other participants execute tests according to procedures. At all times, the test conductor is responsible for judging how to proceed if incidents or exceptions occur and canceling and rescheduling tests in the event a failure prevents a test from being executed. At the end of the test period, the test conductor writes up the results of various completed test runs and incidents or exceptions that occurred. The status report is emailed to relevant stakeholders.

Test Operator

The test operator defines and executes test procedures to evaluate each device and records the outputs and overall results of each test.

Roadside Equipment Technology Expert

The roadside equipment (RSE) technology expert has extensive knowledge of the technology under test. This includes use cases, underlying and enabling technologies, communication protocols, data transfer mechanism(s), and security. The technology expert advises the test conductor, as needed.

Vendor Representative

The vendor representative supports the test conductors and test operators during all testing phases, as required. Support is provided in person or remotely. A representative of the vendor of each device being certified should be involved in the testing.

Test Observers

Test observers witness test runs at the CTL's discretion. Note: Some roles can be combined such that a single person can assume up to two roles (i.e., the test conductor can also be the test operator).

Documentation

Test Records

Specific test information, including test environment, test execution, and attendees/participants/observers, are captured for each test. Each requirement evaluated will be marked with a P or an F, indicating success (pass) or failure (fail). All failures, work-arounds, and deviations from procedure are recorded in a comments section of the form. These entries are entered electronically during testing.

Risks and Mitigation

Risks include product risks and project risks. Risks to the product include flaws in the content or structure of a message due to misunderstandings or errors in implementation, which may be expected. These risks may be mitigated by accepting from reputable manufacturers devices whose primary functionalities have gone through other qualification testing or have been used in the field. Risks to the project include lack of trained staff due to new and evolving test tools, rigid deadlines, and changing industry standards and requirements.

Other risks include the possibility of using unknown TIM data formats as input. The TIM application under test may not be robust enough to handle subtle changes in the input data, which are caused by multiple options available. This may be mitigated by defining the standard set of input variables required for conversion. Early deployers will have to adhere to the specific TIM data input formats for successful testing and implementation. Other risks involve changes to the standard that may include new elements, such as roadside safety message elements. These may be mitigated by making the test plans modular and having individual test cases that may be replaced with newer standards as they become available.

Chapter 4. Test Case Specifications

This section contains information about individual test case specifications, which are used to certify and evaluate whether an RSE could provide critical and necessary SAE J2735 TIM objects for target connected vehicle applications.

General Test Environment Setup

Chapter 2 presented the minimum requirements for devices for executing the below test cases. Figure 1 shows a general test environment setup. A physical or virtual wireless broadcasting DUT needs to be compatible with the SAE J2735 standard messages. A computer is needed to conduct all test cases. A user desired packet capture (.pcap decoder) tool is expected to be on the device.

The following steps are necessary to configure the wireless broadcasting device and logging computer before conducting test cases.

- Configure the DUT
    - Power on the device using power-over-Ethernet (PoE) or other available power source, according to the DUT user manual
    - Connect to the DUT using an appropriate connection (e.g., Ethernet/Wi-Fi)
    - Multiple ways are available for data capture based on the functions available for the DUT:
        - Configure the device to log the encoded SAE J2735 TIM on the DUT, to be accessed by the logging device
        - Forward the TIM to the Ethernet interface pointing to the IP address of the logging device
        - Alternatively, a packet capture tool may be used over the available wireless technology to be able to capture and log the packets for further analysis on the device
- Configure personal computer (PC)
    - Power on the PC
    - Configure the DUT using secure shell or other available communication method to enable logging of encoded SAE J2735 TIM packets using any of the three methods mentioned in the section above
    - Configure a software package that can monitor and collect data on the target communication layer, or decode logged .pcap files for analysis
- Decode the message
    - The encoded SAE J2735 TIM needs to be decoded before it can be checked for mandatory fields. This can be achieved using multiple methods:
        - Configure the packet capture device to decode the SAE J2735 user datagram protocol packet to unpack the various layers and decode the payload
        - Use an available ASN.1 or other such decoder to decode the encoded payload to an object value defining output for analysis

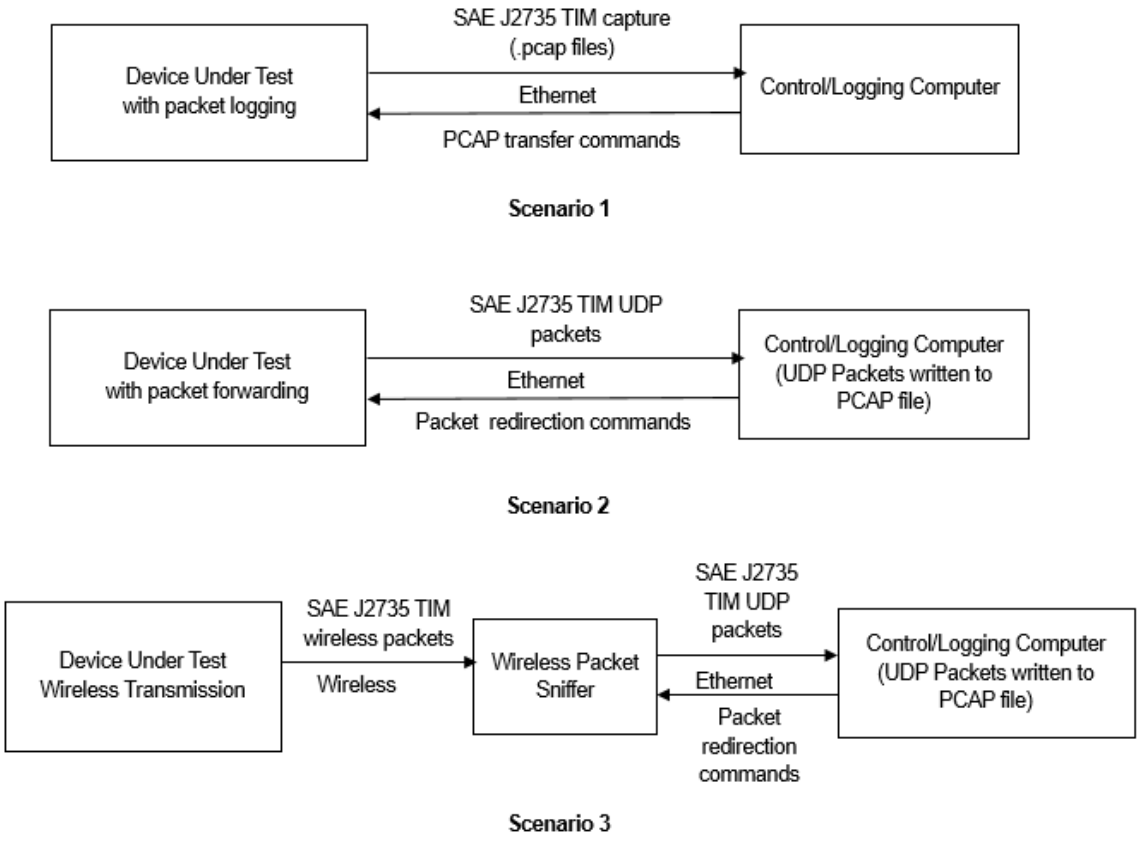

Figure 1. Diagram. Typical Test Environment Setup

The DUT can be any physical device that encodes TIM according to the J2735 standard. After configuring the DUT, logging computer, and alternatively, the wireless packet capture device, any two devices communicating through the Ethernet interface must be connected within a subnet by using an Ethernet cable or a network switch. The test operator must ensure communication between two devices is properly set up. The wireless interface of the DUT is one of the methods for collecting the output data. In scenario 1, the control/logging computer is used to configure the DUT to start logging the output interface on the DUT. Once testing is complete, the computer would then obtain logged packets from the device for analysis. In scenario 2, the DUT is configured to directly send the packets to the control/logging computer using the available interface for logging and analysis. In scenario 3, a wireless packet sniffer is used to log the packets and the control/logging computer connected to the sniffer will then obtain the packets for analysis.

In an actual implementation, the TIM may be sent to the RSE from a traffic management center or an edge device like vehicle-to-everything (V2X) Hub. The V2X Hub is open-source software developed by USDOT. It enables various connected vehicle applications like those that broadcast TIMs using the immediate forward functionality of a roadside unit (RSU) conforming with the RSU 4.1 specification.

Field Existence

The test cases in tables 3–33 evaluate whether the mandatory fields exist in the TIM broadcast from the RSE.

Table 3. DSRCmsgID existence

Test Case #	**EXIST-01**
Test Case	**DSRCmsgID existence**
Reference	*SAE J2735 2016: Section 7.40*
Objective	Verify DSRCmsgID field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	DSRCmsgID field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of DSRCmsgID values. • Certain test tools may include DSRCmsgID under "choice Index."

Table 4. msgCnt existence

Test Case #	**EXIST-02**
Test Case	**msgCnt (MsgCount) existence**
Reference	*SAE J2735 2016: Section 7.104*
Objective	Verify msgCnt field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	msgCnt field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of msgCnt values.

Table 5. timeStamp existence

Test Case #	EXIST-03
Test Case	**timeStamp (MinuteOfTheYear) existence**
Reference	*SAE J2735 2016: Section 7.100*
Objective	Verify timeStamp field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	timeStamp field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of timeStamp values.

Table 6. sspTimRights existence (TravelerDataFrame)

Test Case #	EXIST-04
Test Case	**TravelerDataFrame → sspTimRights (SSPindex) existence**
Reference	*SAE J2735 2016: Section 7.180*
Objective	Verify sspTimRights field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	sspTimRights field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of sspTimRights values. Note: ssp is Service Specific Permissions and this index is used to control the data elements that follow the occurrence of the index. The index relates to the SSP contents in the security CERT used to declare what content is allowed by that CERT.

Table 7. frameType existence (TravelerDataFrame)

Test Case #	EXIST-05
Test Case	**TravelerDataFrame → frameType (TravelerInfoType) existence**
Reference	*SAE J2735 2016: Section 7.202*
Objective	Verify frameType field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	frameType field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of frameType values.

Table 8. furtherInfoID existence (TravelerDataFrame)

Test Case #	EXIST-06
Test Case	**TravelerDataFrame → msgID → furtherInfoID (FurtherInfoID) existence**
Reference	*SAE J2735 2016: Section 7.48*
Objective	Verify furtherInfoID field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	furtherInfoID field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of furtherInfoID values.

Table 9. position existence (TravelerDataFrame)

Test Case #	EXIST-07
Test Case	**TravelerDataFrame → msgID → roadSignID → position (Position3D) existence**
Reference	*SAE J2735 2016: Section 6.109*
Objective	Verify position field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	position field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of position values. • OPTIONAL: The Elevation field is optional, but it should be noted if this field is implemented so the value may be verified in a later step.

Table 10. viewAngle existence (TravelerDataFrame)

Test Case #	EXIST-08
Test Case	**TravelerDataFrame → msgID → roadSignID → viewAngle existence**
Reference	*SAE J2735 2016: Section 6.109*
Objective	Verify viewAngle field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	viewAngle field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of viewAngle values.

Table 11. mutcdCode existence (TravelerDataFrame)

Test Case #	EXIST-09
Test Case	**TravelerDataFrame → msgID → roadSignID → mutcdCode existence**
Reference	*SAE J2735 2016: Section 6.109*
Objective	Verify mutcdCode field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	mutcdCode field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of mutcdCode values.

Table 12. startYear existence (TravelerDataFrame)

Test Case #	EXIST-10
Test Case	**TravelerDataFrame → startYear (DYear) existence**
Reference	*SAE J2735 2016: Section 7.42*
Objective	Verify startYear field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	startYear field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of startYear values.

Table 13. startTime existence (TravelerDataFrame)

Test Case #	EXIST-11
Test Case	**TravelerDataFrame → startTime (MinuteOfTheYear) existence**
Reference	SAE J2735 2016: Section 7.100
Objective	Verify startTime field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	startTime field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of startTime values.

Table 14. durationTime existence (TravelerDataFrame)

Test Case #	EXIST-11
Test Case	**TravelerDataFrame → durationTime (MinutesDuration) existence**
Reference	*SAE J2735 2016: Section 7.101*
Objective	Verify durationTime field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	durationTime field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of durationTime values.

Table 15. priority existence (TravelerDataFrame)

Test Case #	EXIST-13
Test Case	**TravelerDataFrame → priority (SignPriority) existence**
Reference	*SAE J2735 2016: Section 7.173*
Objective	Verify priority field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	priority field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of priority values.

Table 16. sspLocationRights existence (TravelerDataFrame)

Test Case #	EXIST-14
Test Case	**TravelerDataFrame → sspLocationRights (SSPindex) existence**
Reference	*SAE J2735 2016: Section 7.180*
Objective	Verify sspLocationRights field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	sspLocationRights field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of sspLocationRights values. Note: ssp is Service Specific Permissions.

Table 17. region existence (TravelerDataFrame)

Test Case #	EXIST-15
Test Case	**TravelerDataFrame → regions → Geographical Path → id → region (RoadRegulatorID) existence**
Reference	*SAE J2735 2016: Section 7.159*
Objective	Verify region field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	region field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of region values.

Table 18. id existence (TravelerDataFrame)

Test Case #	EXIST-16
Test Case	**TravelerDataFrame → regions → Geographical Path → id → id (RoadSegmentID) existence**
Reference	*SAE J2735 2016: Section 7.159*
Objective	Verify id field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	id field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of id values.

Table 19. anchor existence (TravelerDataFrame)

Test Case #	EXIST-17
Test Case	**TravelerDataFrame → regions → Geographical Path → anchor (lat, long) existence**
Reference	*SAE J2735 2016: Section 6.87*
Objective	Verify anchor field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	anchor field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of anchor values.

Table 20. nodeList existence (TravelerDataFrame)

Test Case #	EXIST-18
Test Case	**TravelerDataFrame → regions → Geographical Path → description → path → offset → xy → nodes → NodeXY → delta → nodeList (x,y offset from refPoint) existence**
Reference	*SAE J2735 2016: Section 6.11, 6.29, 6.72, 6.75, 6.72*
Objective	Verify nodeList (x,y offset from refPoint) field exists for each lane in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	nodeList exists for each lane in the TIM broadcast and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of nodeList values for each lane in the TIM.

Table 21. Geographical Path → regional existence (TravelerDataFrame)

Test Case #	EXIST-19
Test Case	**TravelerDataFrame → regions → Geographical Path → regional existence (in GeographicalPath)**
Reference	*SAE J2735 2016: Section 6.30*
Objective	Verify regional field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	regional field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of regional values.

Table 22. sspMsgRights1 existence (TravelerDataFrame)

Test Case #	EXIST-20
Test Case	**TravelerDataFrame → regions → sspMsgRights1 (SSPindex) existence**
Reference	*SAE J2735 2016: Section 7.180*
Objective	Verify sspMsgRights1 field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	sspMsgRights1 field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of sspMsgRights1 values. Note: ssp is Service Specific Permissions.

Table 23. sspMsgRights2 existence (TravelerDataFrame)

Test Case #	EXIST-21
Test Case	**TravelerDataFrame → regions → sspMsgRights2 (SSPindex) existence**
Reference	*SAE J2735 2016: Section 7.180*
Objective	Verify sspMsgRights2 field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	sspMsgRights2 field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of sspMsgRights2 values. Note: ssp is Service Specific Permissions.

Table 24. advisory → item → itis existence (TravelerDataFrame)

Test Case #	EXIST-22
Test Case	**TravelerDataFrame → regions → content → advisory→ item → itis (ITIScodes) existence**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify itis field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	itis field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of itis values.

Table 25. advisory → item → text existence (TravelerDataFrame)

Test Case #	EXIST-23
Test Case	**TravelerDataFrame → regions → content → advisory→ item → text (ITIStext) existence**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify text field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	text field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of text values.

Table 26. workZone → item → itis existence (TravelerDataFrame)

Test Case #	EXIST-24
Test Case	**TravelerDataFrame → regions → content → workZone→ item → itis (ITIScodes) existence**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify itis field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	itis field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of itis values.

Table 27. workzone → item → text existence (TravelerDataFrame)

Test Case #	EXIST-25
Test Case	**TravelerDataFrame → regions → content → workZone→ item → text (ITIStext) existence**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify text field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	text field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of text values.

Table 28. genericSign → item → itis existence (TravelerDataFrame)

Test Case #	EXIST-26
Test Case	**TravelerDataFrame → regions → content → genericSign→ item → itis (ITIScodes) existence**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify itis field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	itis field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of itis values.

Table 29. genericSign → item → text existence (TravelerDataFrame)

Test Case #	EXIST-27
Test Case	**TravelerDataFrame → regions → content → genericSign → item → text (ITIStext) existence**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify text field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	text field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of text values.

Table 30. speedLimit → item → itis existence (TravelerDataFrame)

Test Case #	EXIST-28
Test Case	**TravelerDataFrame → regions → content → speedLimit → item → itis (ITIScodes) existence**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify itis field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	itis field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of itis values.

Table 31. speedLimit → item → text existence (TravelerDataFrame)

Test Case #	EXIST-29
Test Case	**TravelerDataFrame → regions → content → speedLimit → item → text (ITIStext) existence**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify text field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	text field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of text values.

Table 32. exitService → item → itis existence (TravelerDataFrame)

Test Case #	EXIST-30
Test Case	**TravelerDataFrame → regions → content → exitService → item → itis (ITIScodes) existence**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify itis field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	itis field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of itis values.

Table 33. exitService → item → text existence (TravelerDataFrame)

Test Case #	EXIST-31
Test Case	**TravelerDataFrame → regions → content → exitService → item → text (ITIStext) existence**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify text field exists in the TIM broadcast from the RSE
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	TIM from the logging device and the IP address with listening port configured by the user
Data Outputs	TIM contained in a .pcap file on the test operator's computer
Exit Criteria	text field in the TIM exists and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to check for the presence of text values.

Input Verification

The test cases listed in this section evaluate whether the mandatory fields in the TIM broadcast from the RSE matches with the input.

Table 34. DSRCmsgID input verification

Test Case #	VERIFY-01
Test Case	**DSRCmsgID input verification**
Reference	*SAE J2735 2016: Section 7.40*
Objective	Verify the DSRCmsgID field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message DSRCmsgID exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with DSRCmsgID field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The DSRCmsgID data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM.

Test Case #	VERIFY-01
Test Case	**DSRCmsgID input verification**
	• The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the DSRCmsgID value with the original TIM file used for store and repeat. • Certain test tools may include DSRCmsgID under “choice Index.” • The acceptable values are: ○ Integer 31 – TIM. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 35. msgCnt input verification

Test Case #	VERIFY-02
Test Case	**msgCnt (MsgCount) input verification**
Reference	*SAE J2735 2016: Section 7.104*
Objective	Verify the msgCnt field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message msgCnt exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with msgCnt field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The msgCnt data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the msgCnt value with the original TIM file used for store and repeat. • The acceptable values are: ○ 0..127. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 36. timeStamp input verification

Test Case #	VERIFY-03
Test Case	**timeStamp (MinuteOfTheYear) input verification**
Reference	*SAE J2735 2016: Section 7.100*

Test Case #	VERIFY-03
Test Case	**timeStamp (MinuteOfTheYear) input verification**
Objective	Verify the timeStamp field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message timeStamp exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with timeStamp field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The timeStamp data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the timeStamp value with the original TIM file used for store and repeat. • The acceptable values are: ○ 0..527040. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 37. sspTimRights input verification (TravelerDataFrame)

Test Case #	VERIFY-04
Test Case	**TravelerDataFrame → sspTimRights (SSPindex) input verification**
Reference	*SAE J2735 2016: Section 7.180*
Objective	Verify the sspTimRights field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message sspTimRights exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with sspTimRights field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The sspTimRights data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the sspTimRights value with the original TIM file used for store and repeat.

Test Case #	VERIFY-04
Test Case	**TravelerDataFrame → sspTimRights (SSPindex) input verification**
	• The acceptable values are: ○ 0..31. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 38. frameType input verification (TravelerDataFrame)

Test Case #	VERIFY-05
Test Case	**TravelerDataFrame → frameType (TravelerInfoType) input verification**
Reference	*SAE J2735 2016: Section 7.202*
Objective	Verify the frameType field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message frameType exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with frameType field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The frameType data in the TIM broadcast is verified with the input and the results are documented

Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM.
	• The test operator configures the test PC to receive the encoded TIM.
	• The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the frameType value with the original TIM file used for store and repeat.
	• The acceptable values are:
	  ○ unknown (0).
	  ○ advisory (1).
	  ○ roadSignage (2).
	  ○ commercialSignage (3).
	• The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 39. furtherInfoID input verification (TravelerDataFrame)

Test Case #	VERIFY-06
Test Case	**TravelerDataFrame → msgID → furtherInfoID (FurtherInfoID) input verification**
Reference	*SAE J2735 2016: Section 7.48*

Test Case #	VERIFY-06
Test Case	**TravelerDataFrame → msgID → furtherInfoID (FurtherInfoID) input verification**
Objective	Verify the furtherInfoID field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message furtherInfoID exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with furtherInfoID field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The furtherInfoID data in the TIM broadcast is verified with the input and the results are documented

Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM.
	• The test operator configures the test PC to receive the encoded TIM.
	• The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the furtherInfoID value with the original TIM file used for store and repeat.
	• The acceptable values are:
	  ○ Zero when unknown or not present.
	  ○ octet string (size(2)).
	• The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 40. position input verification (TravelerDataFrame)

Test Case #	VERIFY-07
Test Case	**TravelerDataFrame → msgID → roadSign → position (Position3D) input verification**
Reference	*SAE J2735 2016: Section 6.109*
Objective	Verify the position field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message position exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with position field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The position data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM.

Test Case #	VERIFY-07
Test Case	**TravelerDataFrame → msgID → roadSign → position (Position3D) input verification**

	• The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the position value with the original TIM file used for store and repeat.
	• The acceptable values are:
	  ○ lat (position): -900000000..900000001, units of 1/10 micro degrees.
	  ○ lon (position): -1799999999..1800000001, units of 1/10 micro degrees.
	• The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.
	• OPTIONAL: The Elevation field is optional, but it should be checked, if included. The acceptable values are:
	  ○ -4096..61439, units of 10 centimeters.

Table 41. viewAngle input verification (TravelerDataFrame)

Test Case #	VERIFY-08
Test Case	**TravelerDataFrame → msgID → roadSign → viewAngle (HeadingSlice) input verification**
Reference	*SAE J2735 2016: Section 6.109*
Objective	Verify the viewAngle field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message viewAngle exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with viewAngle field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The viewAngle data in the TIM broadcast is verified with the input and the results are documented

Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM.
	• The test operator configures the test PC to receive the encoded TIM.
	• The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the viewAngle value with the original TIM file used for store and repeat.
	• The acceptable values are:
	  ○ viewAngle: Bit String (SIZE(16)), starting at north (000) and moving clockwise, each 22.5 degrees change is 1 bit.
	  ▪ e.g.: from 000-0 to 022-5 degrees (0),
	  from 022-5 to 045-0 degrees (1),
	  from 045-0 to 067-5 degrees (2), …
	• The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 42. mutcdCode input verification (TravelerDataFrame)

Test Case #	VERIFY-09
Test Case	**TravelerDataFrame → msgID → roadSign → mutcdCode (MUTCDCode) input verification**
Reference	*SAE J2735 2016: Section 6.109*
Objective	Verify the mutcdCode field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message mutcdCode exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with position field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The mutcdCode data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the mutcdCode value with the original TIM file used for store and repeat. • The acceptable values are: o mutcdCode: none (0). regulatory (1). warning (2). maintenance (3). motoristService (4). guide (5). rec (6). • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 43. TravelerDataFrame → startYear input verification

Test Case #	VERIFY-10
Test Case	**TravelerDataFrame → startYear (DYear) input verification**
Reference	*SAE J2735 2016: Section 7.42*
Objective	Verify the startYear field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message startYear exists
Data Inputs	Encoded TIM and user-generated TIM input source

Test Case #	VERIFY-10
Test Case	**TravelerDataFrame → startYear (DYear) input verification**
Data Outputs	A report verifying the value associated with startYear field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The startYear data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the startYear value with the original TIM file used for store and repeat. • The acceptable values are: ○ 0..4095. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 44. startTime input verification (TravelerDataFrame)

Test Case #	VERIFY-11
Test Case	**TravelerDataFrame → startTime (MinuteOfTheYear) input verification**
Reference	*SAE J2735 2016: Section 7.100*
Objective	Verify the startTime field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message startTime exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with startTime field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The startTime data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the startTime value with the original TIM file used for store and repeat. • The acceptable values are: ○ 0..527040. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 45. durationTime input verification (TravelerDataFrame)

Test Case #	VERIFY-12
Test Case	**durationTime (MinutesDuration) input verification**
Reference	*SAE J2735 2016: Section 7.101*
Objective	Verify the durationTime field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message durationTime exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with durationTime field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The durationTime data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the durationTime value with the original TIM file used for store and repeat. • The acceptable values are: ○ 0..32000. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 46. priority input verification (TravelerDataFrame)

Test Case #	VERIFY-13
Test Case	**TravelerDataFrame → priority (SignPriority) input verification**
Reference	*SAE J2735 2016: Section 7.173*
Objective	Verify the priority field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message priority exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with priority field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The priority data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM.

Test Case #	VERIFY-13
Test Case	**TravelerDataFrame → priority (SignPriority) input verification**
	• The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the priority value with the original TIM file used for store and repeat. • The acceptable values are: ○ 0..7. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 47. sspLocationRights input verification (TravelerDataFrame)

Test Case #	VERIFY-14
Test Case	**TravelerDataFrame → sspLocationRights (SSPindex) input verification**
Reference	*SAE J2735 2016: Section 7.180*
Objective	Verify the sspLocationRights field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message sspLocationRights exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with sspLocationRights field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The sspLocationRights data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the sspLocationRights value with the original TIM file used for store and repeat. • The acceptable values are: ○ 0..31. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 48. region input verification (TravelerDataFrame)

Test Case #	VERIFY-15
Test Case	**TravelerDataFrame → regions → Geographical Path → id → region (RoadRegulatorID) input verification**
Reference	*SAE J2735 2016: Section 7.159*
Objective	Verify the region field in the TIM broadcast from the RSE matches with the input source

Test Case #	VERIFY-15
Test Case	**TravelerDataFrame → regions → Geographical Path → id → region (RoadRegulatorID) input verification**
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message region exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with region field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The region data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the region value with the original TIM file used for store and repeat. • The acceptable values are: ○ region: 0..65535. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 49. id input verification (TravelerDataFrame)

Test Case #	VERIFY-16
Test Case	**TravelerDataFrame → regions → Geographical Path → id → id (RoadSegmentID) input verification**
Reference	*SAE J2735 2016: Section 7.159*
Objective	Verify the id field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message id exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with id field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The id data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the id value with the original TIM file used for store and repeat. • The acceptable values are:

Test Case #	VERIFY-16
Test Case	**TravelerDataFrame → regions → Geographical Path → id → id (RoadSegmentID) input verification**
	○ id: 0..65535. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 50. anchor input verification (TravelerDataFrame)

Test Case #	VERIFY-17
Test Case	**TravelerDataFrame → regions → Geographical Path → anchor (lat, long) input verification**
Reference	*SAE J2735 2016: Section 6.87*
Objective	Verify the anchor field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message anchor exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with anchor field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The anchor data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the anchor value with the original TIM file used for store and repeat. • The acceptable values are: ○ lat (position): -900000000..900000001, units of 1/10 micro degrees. ○ lon (position): -1799999999..1800000001, units of 1/10 micro degrees. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 51. nodeList input verification(TravelerDataFrame)

Test Case #	VERIFY-18
Test Case	**TravelerDataFrame → regions → Geographical Path → description → path → offset → xy → nodes → NodeXY → delta → nodeList (x,y offset from refPoint) input verification**
Reference	*SAE J2735 2016: Section 6.87*
Objective	Verify the nodeList in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message nodeList exists

Test Case #	VERIFY-18
Test Case	**TravelerDataFrame → regions → Geographical Path → description → path → offset → xy → nodes → NodeXY → delta → nodeList (x,y offset from refPoint) input verification**
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with nodeList by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The nodeList data in the TIM broadcast is verified with the input and the results are documented

Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM.
	• The test operator configures the test PC to receive the encoded TIM.
	• The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the nodeList value with the original TIM file used for store and repeat.
	• **This field provides a choice between nodes XY1-XY6 and LatLon. Validation should be conducted on all of these nodes individually.**
	  ○ The node-XY1 acceptable values are:
	  ▪ X: -512..511.
	  ▪ Y: -512..511.
	  ○ The node-XY2 acceptable values are:
	  ▪ X: -1024..1023.
	  ▪ Y: -1024..1023.
	  ○ The node-XY3 acceptable values are:
	  ▪ X: -2048..2047.
	  ▪ Y: -2048..2047.
	  ○ The node-XY4 acceptable values are:
	  ▪ X: -4096..4095.
	  ▪ Y: -4096..4095.
	  ○ The node-XY5 acceptable values are:
	  ▪ X: -8192..8191.
	  ▪ Y: -8192..8191.
	  ○ The node-XY6 acceptable values are:
	  ▪ X: -32768..32767.
	  ▪ Y: -32768..32767.
	  ○ The node-LatLon acceptable values are:
	  ▪ X: -1799999999..1800000001.
	  ▪ Y: -1799999999..1800000001.
	• The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 52. regional input verification (TravelerDataFrame)

Test Case #	VERIFY-19
Test Case	**TravelerDataFrame → regions → Geographical Path → regional input verification**
Reference	*SAE J2735 2016: Section 6.30*
Objective	Verify the regional field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message regional exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with regional field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The regional data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the regional value with the original TIM file used for store and repeat. • The acceptable values are: ○ Sequence (size(1..4)) of RegionalExtension. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 53. sspMsgRights1 input verification (TravelerDataFrame)

Test Case #	VERIFY-20
Test Case	**TravelerDataFrame → regions → sspMsgRights1 (SSPindex) input verification**
Reference	*SAE J2735 2016: Section 7.180*
Objective	Verify the sspMsgRights1 field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message sspMsgRights1 exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with sspMsgRights1 field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The sspMsgRights1 data in the TIM broadcast is verified with the input and the results are documented

Test Case #	VERIFY-20
Test Case	**TravelerDataFrame → regions → sspMsgRights1 (SSPindex) input verification**
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the sspMsgRights1 value with the original TIM file used for store and repeat. • The acceptable values are: ○ 0..31. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 54. sspMsgRights2 input verification (TravelerDataFrame)

Test Case #	VERIFY-21
Test Case	**TravelerDataFrame → regions → sspMsgRights2 (SSPindex) input verification**
Reference	*SAE J2735 2016: Section 7.180*
Objective	Verify the sspMsgRights2 field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message sspMsgRights2 exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with sspMsgRights2 field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The sspMsgRights2 data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the sspMsgRights2 value with the original TIM file used for store and repeat. • The acceptable values are: ○ 0..31. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 55. advisory → item → itis input verification (TravelerDataFrame)

Test Case #	VERIFY-22
Test Case	**TravelerDataFrame → regions → content → advisory→ item → itis (ITIScodes) input verification**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify the itis field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message itis exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with itis field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The itis data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the itis value with the original TIM file used for store and repeat. • The acceptable values are: o itis: 0..65535. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 56. advisory → item → text input verification (TravelerDataFrame)

Test Case #	VERIFY-23
Test Case	**TravelerDataFrame → regions → content → advisory→ item → text (ITIStext) input verification**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify the text field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message text exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with text field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The text data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM.

Test Case #	VERIFY-23
Test Case	**TravelerDataFrame → regions → content → advisory→ item → text (ITIStext) input verification**
	• The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the text value with the original TIM file used for store and repeat. • The acceptable values are: ○ text: SIZE(1..500). • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 57. workZone → item → itis input verification (TravelerDataFrame)

Test Case #	VERIFY-24
Test Case	**TravelerDataFrame → regions → content → workZone→ item → itis (ITIScodes input verification**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify the itis field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message itis exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with itis field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The itis data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the itis value with the original TIM file used for store and repeat. • The acceptable values are: ○ itis: 0..65535. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 58. workZone → item → text input verification (TravelerDataFrame)

Test Case #	VERIFY-25
Test Case	**TravelerDataFrame → regions → content → workZone → item → text (ITIStext) input verification**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify the text field in the TIM broadcast from the RSE matches with the input source

Test Case #	VERIFY-25
Test Case	**TravelerDataFrame → regions → content → workZone → item → text (ITIStext) input verification**
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message text exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with text field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The text data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the text value with the original TIM file used for store and repeat. • The acceptable values are: ○ text: SIZE(1..500). • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 59. genericSign → item → itis input verification (TravelerDataFrame)

Test Case #	VERIFY-26
Test Case	**TravelerDataFrame → regions → content → genericSign → item → itis (ITIScodes) input verification**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify the itis field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message itis exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with itis field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The itis data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the itis value with the original TIM file used for store and repeat. • The acceptable values are:

Test Case #	VERIFY-26
Test Case	**TravelerDataFrame → regions → content → genericSign → item → itis (ITIScodes) input verification**
	○ itis: 0..65535. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 60. genericSign → item → text input verification (TravelerDataFrame)

Test Case #	VERIFY-27
Test Case	**TravelerDataFrame → regions → content → genericSign → item → text (ITIStext) input verification**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify the text field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message text exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with text field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The text data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the text value with the original TIM file used for store and repeat. • The acceptable values are: ○ text: SIZE(1..500). • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 61. speedLimit → item → itis input verification (TravelerDataFrame)

Test Case #	VERIFY-28
Test Case	**TravelerDataFrame → regions → content → speedLimit → item → itis (ITIScodes) input verification**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify the itis field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message itis exists
Data Inputs	Encoded TIM and user-generated TIM input source

Test Case #	VERIFY-28
Test Case	**TravelerDataFrame → regions → content → speedLimit → item → itis (ITIScodes) input verification**
Data Outputs	A report verifying the value associated with itis field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The itis data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the itis value with the original TIM file used for store and repeat. • The acceptable values are: ○ itis: 0..65535. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 62. speedLimit → item → text input verification (TravelerDataFrame)

Test Case #	VERIFY-29
Test Case	**TravelerDataFrame → regions → content → speedLimit → item → text (ITIStext) input verification**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify the text field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message text exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with text field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The text data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the text value with the original TIM file used for store and repeat. • The acceptable values are: ○ text: SIZE(1..500). • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 63. exitService → item → itis input verification (TravelerDataFrame)

Test Case #	VERIFY-30
Test Case	**TravelerDataFrame → regions → content → exitService → item → itis (ITIScodes) input verification**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify the itis field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message itis exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with itis field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The itis data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the itis value with the original TIM file used for store and repeat. • The acceptable values are: o itis: 0..65535. • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Table 64. exitService → item → text input verification (TravelerDataFrame)

Test Case #	VERIFY-31
Test Case	**TravelerDataFrame → regions → content → exitService → item → text (ITIStext) input verification**
Reference	*SAE J2735 2016: Section 8.32*
Objective	Verify the text field in the TIM broadcast from the RSE matches with the input source
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard and the message text exists
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the value associated with text field by comparing the encoded TIM logs to the user-generated TIM input source
Exit Criteria	The text data in the TIM broadcast is verified with the input and the results are documented
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIM. • The test operator configures the test PC to receive the encoded TIM.

Test Case #	VERIFY-31
Test Case	**TravelerDataFrame → regions → content → exitService → item → text (ITIStext) input verification**
	• The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare the text value with the original TIM file used for store and repeat. • The acceptable values are: ○ text: SIZE(1..500). • The test operator repeats the test with an invalid input, and verifies that an invalid output is not produced.

Multiple Traveler Information Message File Verification

Table 65. Check if the DUT can handle generation of several TIMs

Test Case #	SAMPLE-01
Test Case	**TIM File sample verification**
Reference	*SAE J2735 2016: Section 5.6*
Objective	Verify that the RSE can broadcast various TIM
Entrance Criteria	The RSE under test is compatible with the SAE J2735 2016 standard
Data Inputs	Encoded TIM and user-generated TIM input source
Data Outputs	A report verifying the RSE can broadcast various TIM messages from different sources by comparing the encoded TIM logs to the test operator generated TIM input source
Exit Criteria	The TIM broadcast are consistent with the input and the results are documented **Note: The RSE should be able to continually produce different TIMs at a rate of 10 ms (i.e., 100 TIMs at 1 sec).**
Test Procedures	• The test operator configures the DUT to produce and transmit the encoded TIMs. • The test operator configures the test PC to receive the encoded TIMs. • The test operator uses the converted SAE J2735 TIM in the ASN.1 or other human readable format to compare with the original TIM files used. • Any inconsistencies between the encoded TIMs and the input TIM files are noted.

References

Leidos, Infrastructure Connectivity Certification Test Procedures for Infrastructure-based CAV Components - Findings and Recommendations, Deliverable for STOL2 TO 18-399, March 19, 2019.

Balse, A., Huang, Z., Leslie, E., Infrastructure Connectivity Certification Test Procedures for Infrastructure-based CAV Components, Signal Phase and Timing – SAE J2735, FHWA-JPO-20-801, December 23, 2019.

Huang, Z., Leslie, E., Balse, A., Infrastructure Connectivity Certification Test Procedures for Infrastructure-based CAV Components, Signal Phase and Timing – NTCIP 1202v03, FHWA-JPO-20-802, December 23, 2019.

Balse, A., Huang, Z., Leslie, E., Infrastructure Connectivity Certification Test Procedures for Infrastructure-based CAV Components, MAP – SAE J2735, FHWA-JPO-20-803, December 23, 2019.

SAE International, J2735 Dedicated Short Range Communications Message Set Dictionary (r63), March, 2016.

AASHTO/ITE/NEMA, NTCIP 1202v03.26 Object Definitions for Actuated Signal Controllers (ASC) Interface, Draft v03.26, October 27, 2018.

Manual on Uniform Traffic Control Devices for Streets and Highways, 2009 Edition Including Revision 1 dated May 2012 and Revision 2 dated May 2012, May 2012.

V2X Hub, https://github.com/usdot-fhwa-OPS/V2X-Hub.

SAE International, J2540 ITIS Phrase Lists (International Traveler Information Systems), November, 2009.

Appendix A. List of Acronyms

CAV	connected automated vehicle
CTL	certification test laboratory
DUT	device under test
FHWA	Federal Highway Administration
GPS	global positioning system
HRDO	Office of Operations Research and Development
IP	internet protocol
NTCIP	National Transportation Communications for Intelligent Transportation Systems Protocol
PC	personal computer
PoE	power-over-Ethernet
PSM	personal safety message
R&D	research and development
RSE	roadside equipment
RSU	roadside unit
SAE	SAE International
SPaT	signal phase and timing
SSP	Service Specific Permissions
STOL	Saxton Transportation Operations Laboratory
TFHRC	Turner-Fairbank Highway Research Center
TIM	traveler information message
USDOT	U.S. Department of Transportation

V2X	vehicle-to-everything

Appendix B. Test Values for Traveler Information Message Fields

Field under test	Lowest acceptable value	Highest acceptable value	Within acceptable range	Positive invalid value	Negative invalid value
DSRCmsgID	31	31	31	32	-1
msgCnt	0	127	64	128	-1
timeStamp	0	527040	128	527041	-1
sspTimRights	0	31	15	32	-1
TravelerDataFrame → frameType	0	3	2	4	-1
roadSign → position → lat	-900000000	900000001	128	900000002	-900000001
roadSign → position → lon	-1799999999	1800000001	128	1800000002	-1800000000
roadSign → viewAngle	000	360	180	361	-1
roadSign → mutcdCode	0	6	3	7	-1
TravelerDataFrame → startYear	0	4095	128	4096	-1
TravelerDataFrame → startTime	0	527040	128	527041	-1
TravelerDataFrame → durationTime	0	32000	128	32001	-1
TravelerDataFrame → priority	0	7	3	8	-1
TravelerDataFrame → sspLocationRights	0	8191	128	8192	-1
GeographicalPath → id → region (RoadRegulatorId)	0	65535	128	65536	-1
GeographicalPath → id → id (RoadSegmentID)	0	65535	128	65536	-1

GeographicalPath → anchor → position → lat	-900000000	900000001	128	900000002	-900000001
GeographicalPath → anchor → position → lon	-1799999999	1800000001	128	1800000002	-1800000000
node-XY1	-512	511	128	512	-513
node-XY2	-1024	1023	128	1024	-1025
node-XY3	-2048	2047	128	2048	-2049
node-XY4	-4096	4095	128	4096	-4097
node-XY5	-8192	8191	128	8192	-8193
node-XY6	-32768	32767	128	32768	-32769
node-LatLon	X: -1799999999 Y: -1799999999	X: 1800000001 Y: 1800000001	X: 128 Y: 128	X: 1800000002 Y: 1800000002	X: -1800000000 Y: -1800000000
TravelerDataFrame → regions → sspMsgRights1	0	8191	128	8192	-1
TravelerDataFrame → regions → sspMsgRights2	0	8191	128	8192	-1
advisory → itis	0	65535	128	65536	-1
workZone → itis	0	65535	128	65536	-1
genericSign → itis	0	65535	128	65536	-1
speedLimit → itis	0	65535	128	65536	-1
exitService → itis	0	65535	128	65536	-1

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free “Help Line” 866-367-7487
www.its.dot.gov

FHWA-JPO-20-795

U.S. Department of Transportation