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Safety Pilot Model Deployment: WSU Basic Safety Messages

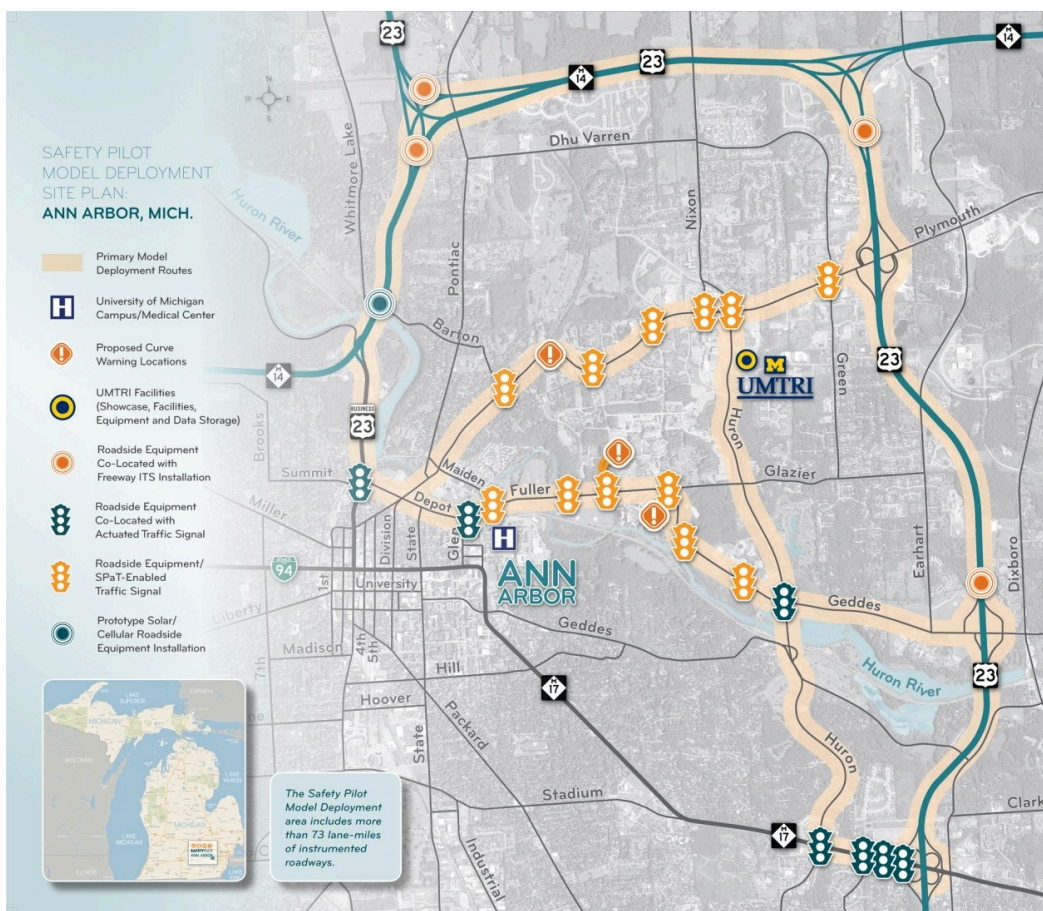
INTRODUCTION

The Safety Pilot Model Deployment (SPMD) study was run in the Ann Arbor, MI area and involved over 2,000 vehicles. The study goal was to pilot a connected-vehicle system that included roadside units (RSUs) fixed to specific intersections and vehicle-based communication units. Data were collected from RSUs as well as vehicles.

Each vehicle was equipped with one of four unique device packages which provide a series of data elements which communicate the vehicle's location and motion. The packages are referenced as the Integrated Safety Device (ISD); Aftermarket Safety Device (ASD); Retrofit Safety Device (RSD) and Vehicle Awareness Device (VAD). More than 75 percent of the total equipped vehicles used a VAD, which is the most primitive device. Vehicles with VAD can only transmit the data being generated and collected by their host vehicle; they are not able to receive messages transmitted from other vehicles. They mainly transmit "here I am" messages while increasing the likelihood of vehicle-to-Vehicle (V2V) and vehicle-to-infrastructure (V2I) interactions. More detailed vehicle-based data came from vehicles equipped with ISD, ASD, and RSD packages with the ability to collect, receive and transmit. Those vehicles had more advanced safety features and they also collected video data files.

This dataset contains data from the onboard wireless safety units (WSUs). This file primarily consists of GPS-based data elements and those that are obtained from the vehicle's Controller Area Network (CAN) Bus. Different brands of WSUs were used but all of the data were stored in one dataset. A series of data elements that present vehicle performance information and the state of a few of its components are also included.

The proposed layout of the test site and the location of the roadside equipment capable of communicating via Dedicated Short Range Communication (DSRC) is below:



Citation for SPMD:
 Bezzina, D., & Sayer, J. (2015, June). *Safety pilot model deployment: Test conductor team report* (Report No. DOT HS 812 171). Washington, DC: National Highway Traffic Safety Administration.

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THE PRIMARY J2735 BRAKE STATUS EVENTS VARIABLES

BrakeByte1Events End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

BrakeByte1Events J2735 Brake Status (primary)	Count	Percent	Code	Value/Description
SAS Name: Value Details the current state of specific components of the brake system per J2735 standard: the first four bits are 0 or 1 for not-applied or applied respectively for left front, right front, left rear, and right rear, in order; the fifth bit is one if brake information is unavailable; the sixth bit is unused and set to 0; and the last two bits represent the status of the Traction Control System (00=unavailable, 01=off, 10=on, 11=engaged)	N/A	N/A	N/A	No Special Values

THE MISCELLANEOUS J2735 BRAKE STATUS EVENTS VARIABLES

BrakeByte2Events End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

BrakeByte2Events J2735 Brake Status (miscellaneous)	Count	Percent	Code	Value/Description
SAS Name: Value Details the current state of specific components of the brake system: the first two bits represent the status of the Antilock Brake System (00=unavailable, 01=off, 10=on, 11=engaged); the third and fourth bits represent the status of the Stability Control Unit (00=unavailable, 01=off, 10=on); the fifth and sixth bits represent the status of BrakeBoost (00=unavailable, 01=off, 10=on); and the last two bits represent the status of the Auxiliary (parking) Brake (00=unavailable, 01=off, 10=on)	N/A	N/A	N/A	No Special Values

THE BASIC SAFETY MESSAGE UNUSUAL EVENT FLAG VARIABLES

BsmEventFlag Event Flag	Count	Percent	Code	Value/Description
<p>SAS Name: EventFlag Indicates the type (or types) of unique events that have occurred per the J2735 standard: leftmost bit indicates active hazard lights; second bit indicates that the vehicle anticipates passing the stop line at an intersection without coming to a full stop before reaching it; third bit indicates the anti-locking braking system has been activated for more than 100ms; fourth bit indicates the traction control system has been activated for more than 100ms; fifth bit indicates the stability control system has been activated for more than 100ms; sixth bit indicates the presence of hazardous materials; seventh bit indicates that the vehicle is an authorized public safety vehicle engaged in a service call and moving; eighth bit indicates the vehicle has decelerated or is decelerating at a rate of greater than 0.4g; ninth bit indicates the external lighting (headlights, park lights) of the vehicle has changed recently; tenth bit indicates the status of the front of rear wipers of the vehicle has changed recently; eleventh bit indicates the presence of a flat tire; twelfth bit indicates the vehicle has declared itself disabled; thirteenth bit indicates airbag deployment</p>	N/A	N/A	N/A	No Special Values

THE BASIC SAFETY MESSAGE HIGHLY-DYNAMIC VARIABLES VARIABLES

BsmP1 Time of Basic Safety Message Generation	Count	Percent	Code	Value/Description
SAS Name: GenTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values
BsmP1 Transmitting Device ID (Randomized)	Count	Percent	Code	Value/Description
SAS Name: TxRandom Randomly assigned ID to mask the device ID of the transmitting device for security purposes	N/A	N/A	N/A	No Special Values
BsmP1 Message Count	Count	Percent	Code	Value/Description
SAS Name: MsgCount Message ID that gets incremented by one with each BSM Minimum: 0	N/A	N/A	N/A	No Special Values
BsmP1 Deciseconds Since Ignition	Count	Percent	Code	Value/Description
SAS Name: DSecond Time in deciseconds since ignition started Minimum: 0	N/A	N/A	N/A	No Special Values
BsmP1 Latitude	Count	Percent	Code	Value/Description
SAS Name: Latitude Current latitude of the vehicle Minimum: -90 Maximum: 90	N/A	N/A	N/A	No Special Values
BsmP1 Longitude	Count	Percent	Code	Value/Description
SAS Name: Longitude Current longitude of the vehicle Minimum: -180 Maximum: 180	N/A	N/A	N/A	No Special Values
BsmP1 Elevation	Count	Percent	Code	Value/Description
SAS Name: Elevation Current elevation (in meters) of vehicle according to GPS	N/A	N/A	N/A	No Special Values
BsmP1 Speed	Count	Percent	Code	Value/Description
SAS Name: Speed Vehicle speed Minimum: 0	N/A	N/A	N/A	No Special Values
BsmP1 Heading	Count	Percent	Code	Value/Description
SAS Name: Heading Vehicle heading/direction Minimum: 0 Maximum: 360	N/A	N/A	N/A	No Special Values
BsmP1 Longitudinal Acceleration	Count	Percent	Code	Value/Description
SAS Name: Ax Longitudinal acceleration	N/A	N/A	N/A	No Special Values
BsmP1 Lateral Acceleration	Count	Percent	Code	Value/Description
SAS Name: Ay Lateral acceleration	N/A	N/A	N/A	No Special Values
BsmP1 Vertical Acceleration	Count	Percent	Code	Value/Description
SAS Name: Az "Vertical" acceleration	N/A	N/A	N/A	No Special Values
BsmP1 Yaw Rate	Count	Percent	Code	Value/Description
SAS Name: Yawrate Vehicle yaw rate	N/A	N/A	N/A	No Special Values

THE BASIC SAFETY MESSAGE HIGHLY-DYNAMIC VARIABLES VARIABLES

BsmP1 Path Count	Count	Percent	Code	Value/Description
SAS Name: PathCount Number, between 1 and 23, representing a group of points that communicate a vehicle's position and motion. Each group of points is of non-uniform size. Minimum: 0 Maximum: 23	N/A	N/A	N/A	No Special Values
BsmP1 Radius Of Curve	Count	Percent	Code	Value/Description
SAS Name: RadiusOfCurve Estimate of the radius of a curve being negotiated (in centimeters), which is derived from a number of systems and sensors. Positive and negative values reflect right and left turns, respectively, and +/- 32767 for straight paths. Minimum: -32767 Maximum: 32767	N/A	N/A	N/A	No Special Values
BsmP1 Confidence	Count	Percent	Code	Value/Description
SAS Name: Confidence Signals the accuracy and non-steady state and steady state of curvature estimate. In steady state (straight roadways or curves with constant radius of curvature), a high confidence value is reported. Minimum: 0 Maximum: 100	N/A	N/A	N/A	No Special Values

THE EXTERIOR LIGHTS EVENTS VARIABLES

ExteriorLightsEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

ExteriorLightsEvents Light Status	Count	Percent	Code	Value/Description
SAS Name: Value Describes the states of the nine exterior lights via an 8-bit string: each bit from left to right is 1 or 0 for on and off respectively, corresponding to, in order, parking lights, fog lights, daytime running lights, automatic lights, right turn signal, left turn signal, high beam headlights, and low beam headlights; bits 5 and 6 (right and left turn signal respectively) both being on signifies hazard lights	N/A	N/A	N/A	No Special Values

THE NODE DISTANCE VERSION 2 VARIABLES

NodeDistanceV2 Latitude	Count	Percent	Code	Value/Description
SAS Name: Latitude Current latitude of the vehicle Minimum: -90 Maximum: 90	N/A	N/A	N/A	No Special Values
NodeDistanceV2 Longitude	Count	Percent	Code	Value/Description
SAS Name: Longitude Current longitude of the vehicle Minimum: -180 Maximum: 180	N/A	N/A	N/A	No Special Values
NodeDistanceV2 PrMilePt	Count	Percent	Code	Value/Description
SAS Name: PrMilePt Location of point on HMPs (in miles along path)	N/A	N/A	N/A	No Special Values
NodeDistanceV2 Distance to Node	Count	Percent	Code	Value/Description
SAS Name: DistToNode Current distance to specified node	N/A	N/A	N/A	No Special Values
NodeDistanceV2 Trip Distance	Count	Percent	Code	Value/Description
SAS Name: TripDistance Running total distance of current trip (unused; set to zero)	N/A	N/A	N/A	No Special Values
NodeDistanceV2 Road Name	Count	Percent	Code	Value/Description
SAS Name: RoadName Name of road	N/A	N/A	N/A	No Special Values
NodeDistanceV2 Road Type ID	Count	Percent	Code	Value/Description
SAS Name: RoadTypeId The type of road, based on HMPD specifications	N/A	N/A	1	City/Village Local
	N/A	N/A	2	City/Village Primary
	N/A	N/A	3	County Local
	N/A	N/A	4	County Primary
	N/A	N/A	5	Trunkline - collector/distributor
	N/A	N/A	6	Trunkline - directional turnaround
	N/A	N/A	7	Trunkline - mainline
	N/A	N/A	8	Trunkline - maintenance garage
	N/A	N/A	9	Trunkline - other
	N/A	N/A	10	Trunkline - ramp
	N/A	N/A	11	Trunkline - rest area
	N/A	N/A	12	Trunkline - service drive
	N/A	N/A	13	Trunkline - weigh station
	N/A	N/A	14	Uncertified
	N/A	N/A	15	Uncertified - Functional Class Road
NodeDistanceV2 Road Class ID	Count	Percent	Code	Value/Description
SAS Name: RoadClassId The class of road, based on HMPD specifications	N/A	N/A	1	Rural Local
	N/A	N/A	2	Rural Major Collector
	N/A	N/A	3	Rural Minor Arterial
	N/A	N/A	4	Rural Minor Collector
	N/A	N/A	5	Rural Principal Arterial
	N/A	N/A	6	Rural Principal Arterial - Interstate
	N/A	N/A	7	Rural Principal Arterial - Other Freeway
	N/A	N/A	8	Uncertified
	N/A	N/A	9	Urban Collector
	N/A	N/A	10	Urban Local
	N/A	N/A	11	Urban Minor Arterial
	N/A	N/A	12	Urban Principal Arterial
	N/A	N/A	13	Urban Principal Arterial - Interstate
	N/A	N/A	14	Urban Principal Arterial - Other Freeway
NodeDistanceV2 GPS heading	Count	Percent	Code	Value/Description
SAS Name: GpsHeading Heading with respect to true north	N/A	N/A	N/A	No Special Values

THE NODE DISTANCE VERSION 2 VARIABLES

NodeDistanceV2 Direction	Count	Percent	Code	Value/Description
SAS Name: DirNum	N/A	N/A	1	N
A simplified direction based on GPS heading	N/A	N/A	2	NW
	N/A	N/A	3	W
	N/A	N/A	4	SW
	N/A	N/A	5	S
	N/A	N/A	6	SE
	N/A	N/A	7	E
	N/A	N/A	8	NE

NodeDistanceV2 Road Type	Count	Percent	Code	Value/Description
SAS Name: Roadtype	N/A	N/A	1	limited access highway
A simplified road type based on Road Type ID and Road Class ID	N/A	N/A	3	major surface
	N/A	N/A	4	minor surface
	N/A	N/A	5	local
	N/A	N/A	6	ramp

THE POSITIONAL ACCURACY RELATIVE TO SEMI-MAJOR AXIS VARIABLES

PosAccurByte1Events End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

PosAccurByte1Events Axial Quality Measure	Count	Percent	Code	Value/Description
SAS Name: Value Quality measure, reflecting the positional accuracy with respect to the semi-major axis	N/A	N/A	254	12.7 meters or more
	N/A	N/A	255	unavailable accuracy

THE POSITIONAL ACCURACY RELATIVE TO SEMI-MINOR AXIS VARIABLES

PosAccurByte2Events End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

PosAccurByte2Events Axial Quality Measure	Count	Percent	Code	Value/Description
SAS Name: Value Quality measure, reflecting the positional accuracy with respect to the semi-minor axis	N/A	N/A	254	12.7 meters or more
	N/A	N/A	255	unavailable accuracy

THE POSITIONAL ACCURACY SEMI-MAJOR AXIS ORIENTATION MOST SIGNIFICANT BYTE VARIABLES

PosAccurByte3Events End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

PosAccurByte3Events Semi-Major Axis Orientation	Count	Percent	Code	Value/Description
SAS Name: value Orientation measure of semi-major axis relative to true north (use in conjunction with PosAccurByte4Events.value - AxisOrientation = ((...Byte3Value*256) + ...Byte4Value)*0.0054932479; only unavailable accuracy if both values equal to 255)	N/A	N/A	255	unavailable accuracy

THE POSITIONAL ACCURACY SEMI-MAJOR AXIS ORIENTATION LEAST SIGNIFICANT BYTE VARIABLES

PosAccurByte4Events End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

PosAccurByte4Events Semi-Major Axis Orientation	Count	Percent	Code	Value/Description
SAS Name: value Orientation measure of semi-major axis relative to true north (use in conjunction with PosAccurByte3Events.value - AxisOrientation = ((...Byte3Value*256) + ...Byte4Value)*0.0054932479; only unavailable accuracy if both values equal to 255)	N/A	N/A	255	unavailable accuracy

THE STEERING WHEEL ANGLE EVENTS VARIABLES

SteerAngleEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

SteerAngleEvents Steering Wheel Angle	Count	Percent	Code	Value/Description
SAS Name: Value to be converted to degrees to communicate steer angle	N/A	N/A	126	189 degrees or more
	N/A	N/A	127	unavailable steering angle
	N/A	N/A	128	-189 degrees or more

THE TRIP SUMMARY VARIABLES

Summary2 End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values
Summary2 Basic Safety Messages Count	Count	Percent	Code	Value/Description
SAS Name: BsmCount Number of BSMS transmitted Minimum: 0	N/A	N/A	N/A	No Special Values
Summary2 Duration	Count	Percent	Code	Value/Description
SAS Name: Duration Total time duration, in seconds, of a trip Minimum: 0	N/A	N/A	999999	data unavailable
Summary2 Distance	Count	Percent	Code	Value/Description
SAS Name: Distance Total distance traveled, in feet, during a trip Minimum: 0	N/A	N/A	999999	data unavailable
Summary2 Maximum Speed	Count	Percent	Code	Value/Description
SAS Name: MaxSpeed Maximum speed recorded during trip Minimum: 0	N/A	N/A	N/A	No Special Values
Summary2 First Latitude	Count	Percent	Code	Value/Description
SAS Name: FirstLat Latitude of the record(er) at start of trip Minimum: -90 Maximum: 90	N/A	N/A	N/A	No Special Values
Summary2 First Longitude	Count	Percent	Code	Value/Description
SAS Name: FirstLong Longitude of the record(er) at start of trip Minimum: -180 Maximum: 180	N/A	N/A	N/A	No Special Values
Summary2 First Speed	Count	Percent	Code	Value/Description
SAS Name: FirstSpeed Speed at start of trip Minimum: 0	N/A	N/A	N/A	No Special Values
Summary2 Last Latitude	Count	Percent	Code	Value/Description
SAS Name: LastLat Latitude of the record(er) at end of trip Minimum: -90 Maximum: 90	N/A	N/A	N/A	No Special Values
Summary2 Last Longitude	Count	Percent	Code	Value/Description
SAS Name: LastLong Longitude of the record(er) at end of trip Minimum: -180 Maximum: 180	N/A	N/A	N/A	No Special Values
Summary2 Last Speed	Count	Percent	Code	Value/Description
SAS Name: LastSpeed Speed at end of trip Minimum: 0	N/A	N/A	N/A	No Special Values
Summary2 Trip Start	Count	Percent	Code	Value/Description
SAS Name: TripStart Number of days since December 30 1899	N/A	N/A	N/A	No Special Values

THE TRIP SUMMARY VARIABLES

Summary2 Minimum Generated Time	Count	Percent	Code	Value/Description
SAS Name: MinGenTime Timestamp of first BSM of trip	N/A	N/A	0	not applicable

Summary2 Maximum Generated Time	Count	Percent	Code	Value/Description
SAS Name: MaxGenTime Timestamp of last BSM of trip	N/A	N/A	0	not applicable

Summary2 Basic Safety Message Count (All)	Count	Percent	Code	Value/Description
SAS Name: BSMCountAll Number of BSMS issued during trip Minimum: 0	N/A	N/A	N/A	No Special Values

Summary2 Duplicate Trip	Count	Percent	Code	Value/Description
SAS Name: DuplicateTrip TRUE iff the trip in question is redundant	N/A	N/A	N/A	No Special Values

THE THROTTLE POSITION EVENTS VARIABLES

ThrottlePositionEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

ThrottlePositionEvents Relative Throttle Position	Count	Percent	Code	Value/Description
SAS Name: Value Details the relative position of the throttle over a given trip	N/A	N/A	N/A	No Special Values

THE TRANSMISSION STATE EVENTS VARIABLES

TransStateEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

TransStateEvents Transmission State	Count	Percent	Code	Value/Description
SAS Name: Value Details the current state of specific components of the transmission	N/A	N/A	0	Transmission is in the neutral position
	N/A	N/A	1	Transmission is in the park position
	N/A	N/A	2	Transmission has engaged one of its forward gears
	N/A	N/A	3	Transmission has engaged one of its reverse gears
	N/A	N/A	4	Reserved for future use
	N/A	N/A	5	Reserved for future use
	N/A	N/A	6	Reserved for future use
	N/A	N/A	7	Unavailable value or not equipped with a transmission

THE VEHICLE LENGTH EVENTS VARIABLES

VehicleLengthEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

VehicleLengthEvents Vehicle Length	Count	Percent	Code	Value/Description
SAS Name: Value Details the length of the vehicle	N/A	N/A	N/A	No Special Values

THE VEHICLE WIDTH EVENTS VARIABLES

VehicleWidthEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

VehicleWidthEvents Vehicle Width	Count	Percent	Code	Value/Description
SAS Name: Value Details the width of the vehicle	N/A	N/A	N/A	No Special Values

THE FRONT WINDSHIELD WIPER STATUS EVENTS VARIABLES

WiperStatusFrontEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

WiperStatusFront Wiper Status	Count	Percent	Code	Value/Description
SAS Name: Value Length of vehicle	N/A	N/A	0	Unavailable
	N/A	N/A	1	Off
	N/A	N/A	2	Intermittent
	N/A	N/A	3	Low
	N/A	N/A	4	High
	N/A	N/A	126	Washer In Use
	N/A	N/A	127	Automatic washer Equipped