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Operation of the Eaton VORAD Collision Warning System and Analysis of the Recorded Data

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ABSTRACT

The Eaton VORAD Collision Warning System is utilized by many commercial trucking companies to improve and monitor vehicle and driver safety. The system is equipped with forward and side radar sensors that detect the presence and movements of vehicles around the truck to alert the driver of other vehicles' proximity. When the sensors detect that the host vehicle is closing on a vehicle ahead at a rate beyond a determined threshold, or that a nearby vehicle is located in a position that may be hazardous, the system warns the driver visually and audibly. The system also monitors parameters of the vehicle on which it is installed, such as the vehicle speed and turn rate, as well as the status of vehicle systems and controls.

The monitored data is also recorded by the VORAD system and can be extracted in the event that the vehicle is involved in an accident. The recorded data will show the movement and speed of the host vehicle as well as the position of other vehicles relative to the truck prior to the incident. This paper will discuss the operation of the VORAD system, including the installation of the system, the configuration of the CPU, and the sources from which data is obtained for the various recorded parameters, as well as the analysis and interpretation of the recorded data, such that an investigator presented with Eaton VORAD data in the course of an accident investigation has a thorough understanding of the system and its capabilities.

INTRODUCTION

In 1972 development began on an early warning system for commercial vehicles. The system ultimately designed and manufactured was the Vehicle Onboard RADar (VORAD) system. Test vehicles were equipped with various prototypes and driven thousands of miles. Several designs were tested through the years until the first prototype was field tested in 1987 and a refined version was introduced in 1991 [1]. In 1992 the VORAD T-200 radar system was introduced followed by the EVT-200 in 1995 which had the capability of recording data that could be downloaded after a vehicle trip [2]. Following the EVT-200, the EVT-300 was introduced around 1999 and currently EATON produces the VS-400. Although this paper will focus on the EVT-300, similarities exist between all the systems and models and some of the information is applicable to newer and older versions.

The Eaton VORAD EVT-300 Collision Warning System is designed to assist the driver in detecting potential hazards, and also to reduce the likelihood of accidents and promote safer driving habits. The EVT-300 Collision Warning System is a high frequency radar system that can be fitted to most commercial vehicles. The EVT-300 is designed to detect potential hazards in the surrounding area of the vehicle and to warn the driver of those potential hazards. The system can track up to 20 vehicles at one time that are traveling in front or to the side of the vehicle. If there is a potential hazard

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detected by the EVT-300, the system warns the driver by means of a small display mounted in the driver compartment which emits a series of lights and audible sounds in intervals from three seconds to half-seconds to warn the driver prior to an accident occurring [3].

DESCRIPTION OF COMPONENTS

The EVT-300 is an aftermarket unit that can be installed on a variety of commercial trucks. The system consists of an antenna assembly (forward looking radar), optional side sensor, central processing unit (CPU) with gyroscope, driver display, optional side sensor display, and wiring harness.

ANTENNA ASSEMBLY - The antenna assembly mounts to the front of the truck and transmits and receives low power, high frequency radar signals. The radar signal has a 12 degree beam width and has a range up to 350 feet, the system can monitor 20 objects simultaneously, regardless if the objects are moving or not. The signals are transmitted from the antenna assembly away from the front of the truck and towards an object within the radars range. The radar signal then reflects off the object and is received back by the antenna assembly. The system uses the Doppler effect to determine relative speeds of other vehicles in conjunction with the speed of the host vehicle. The antenna assembly then compares the difference between the transmitted signal and the received signal, and processes the data. The data is then digitally converted and sent to the central processing unit for further evaluation [4]. The total system has an accuracy of: range 5% ±3 feet, velocity 1% ±0.2 mph, Azimuth ±0.2 degrees [3].

CENTRAL PROCESSING UNIT - The central processing unit (CPU) is essentially the brain of the unit in conjunction with the forward and side sensors. The CPU not only collects the data from the sensors but also from the engine control unit, the speedometer, the internal gyroscope, brake signal, and turn signals. The CPU analyzes the data to determine if there is a potential hazard for the driver and sends the appropriate signal to the driver display unit if necessary. The CPU also has an optional function that can be used for accident reconstruction that records data in the CPU memory for several minutes prior to an accident. The data can then be downloaded by Eaton VORAD at their facilities [4]. The memory feature will be discussed in further detail later in this paper.

GYROSCOPE - The gyroscope is located in the CPU and monitors the rate at which the vehicle is rotating or turning. The gyroscope is designed to measure the orientation of the vehicle based on the principles of angular momentum [4].

DRIVER DISPLAY UNIT - The driver display unit (DDU) has two control knobs, one for the range and the other for the volume, three colored (yellow, orange, red) warning lights, a green power light, a red system failure light, and a light sensor. The unit is also equipped with a speaker that produces audible tones to alert or warn the driver if the vehicle is near an approaching object. The unit may also have a slot to allow an optional Driver Identification Card [4].

SIDE SENSOR - The side sensor is similar to the antenna assembly in that it transmits a radar signal. The sensor can detect objects from two to ten feet from the side of the truck on either the right or left side of the vehicle, depending on which side of the vehicle the sensor is mounted. The signals are transmitted from the antenna assembly away from the front of the truck and towards an object within the radars range. The data is then sent to the CPU for processing which then determines if any lights or audible warnings are necessary for the driver [4].

SIDE SENSOR DISPLAY - The side sensor display has a yellow “no vehicle detected” indicator light and a red “vehicle detected” light. The display also has a light sensor to allow the automatic adjustment of the lights in various ambient lighting conditions [4].

WIRING HARNESS - The wiring harness is used to connect all the external inputs and sensors such as the CPU, antenna assembly, driver display unit, side sensor, and side sensor display.

INSTALLATION OF COMPONENTS

ANTENNA ASSEMBLY - The antenna assembly must be mounted at the centerline (within ±0.1”) on the front bumper of the truck at a distance between fifteen and forty-five inches above the ground. The antenna must be mounted on a stable rigid surface such as a metal bumper. However, if the vehicle is equipped with a composite aerodynamic fairing, an antenna mounting plate is recommended. The horizontal and vertical axes should be checked for proper adjusted and alignment. In the horizontal axis, the antenna should be facing straight ahead of the truck to ensure detection of objects in the same lane as the vehicle. In the vertical axis (the front face of the unit) should be mounted -0.5 degrees (facing down). The alignment during inspection can be performed with a digital level with the vehicle on a flat surface, or a surface of known slope or angle [4].

CENTRAL PROCESSING UNIT - The central processing unit can be mounted in various positions throughout the cab of the truck. Depending on the configuration of the cab and the preferences of the owner, the CPU can be mounted under the dash board, behind the driver or passenger seat, in the sleeper cab, or wherever space permits. However, the CPU must be mounted in one of three positions; flat, horizontal (sideways), or vertical (top pointing up) in any of the above suggest locations. A gyroscope that measures the rate of rotation, or rate of turn, of the vehicle is located inside the CPU. Therefore, the CPU must be mounted in the proper orientation. In either the flat, horizontal, or vertical position, the angle should not exceed ±3.0 degrees from the level plane [4].

DRIVER DISPLAY - The driver display unit should be located in a position where the driver can easily view the display and adjust the controls while driving. A typical location for the display is on top of the dash, facing the driver. The display sits atop a mounting bracket that is either bolted or adhered (double-sided tape) to the dash. If the display is difficult to see due to the angle, the bracket can be bent for a better viewing angle [4].

SIDE SENSOR DISPLAY - The side sensor display should also be located in position where the driver can easily view the display. Typically the side sensor display will be located on the right windshield A-pillar for passenger side sensors and on the left A-pillar for driver side sensors. The display will typically be mounted generally in the same line of sight as the mirrors [4].

SIDE SENSOR - The side sensor is located on the side of the tractor where the sensor can cover blind spots for the driver. Due to the different configurations of tractors, the location is typically determined by having someone walk from the front to the rear of the truck while having someone in the driver's seat to determine the blind spots. Once the blind spots are determined, the sensor is mounted in the middle of the extents of the blind spot on the side of the vehicle. The side sensor should be mounted such that the front face of the sensor is parallel to the longitudinal axis of the truck. Two sensors can be used on the same side if other blind spots exist on the side of the vehicle. The sensor should also be mounted on the outer most section of the truck body such as the side fairing or step [4].

DRIVER DISPLAY AND WARNINGS

Published literature cited by Eaton shows that a collision warning system can reduce rear-end accident by 51% and lane change accidents by 47% [3]. The Eaton VORAD system is designed to improve driver and vehicle safety by warning the driver of potential hazards in front of and to the side of the vehicle. In order to warn the driver, the EVT-300 uses the driver display to flash colored lights and audible tones to direct the attention to a potential hazard. The warnings are incremental and increase as the threat becomes closer. There are three lights that are colored from left to right; yellow, orange, and red. There are several stages of warning based on levels of potential hazards. When the system detects an object 350 feet in front of the vehicle, the yellow light will illuminate. When the object or potential hazard is 3 seconds from the front of the vehicle, the yellow and orange light will illuminate. When an object is 2 seconds from the front of the vehicle, the yellow and orange light will illuminate while the speaker audibly signals one tone. When an object is 1 second from the front of the vehicle, the yellow, orange, and red light will illuminate while the speaker audibly signals double tones. When an object is 0.5 second from the front of the vehicle, the yellow, orange, and red light will illuminate while the speaker audibly signals continuous tones. The times and distances stated above are based on the "range" knob set to maximum [5].

Warnings are only displayed when a vehicle is in the lane in front of the truck equipped with the VORAD system. The range is also reduced while a vehicle is traveling on curved roads, and the warnings are disabled in sharp turns and when the brakes are applied [5].

There is also a proximity alert that will display a yellow light and two audible tones when the host vehicle is traveling less than 2 mph towards a stationary object, this alert also sounds when a vehicle rolls back towards the front of the host vehicle and the object is within 15 feet. All three lights will illuminate and an audible tone sounds when a stopped vehicle is within 220 feet and less than 3 seconds away. All three lights will illuminate and an audible tone sounds when a vehicle ahead of the VORAD equipped vehicle is moving 20% slower than the host vehicle and is within 220 feet and less than 3 seconds away [5].

SIDE SENSOR - The side sensor display contains a red and yellow light that warns the driver of the presence of a vehicle on the side of the vehicle. When there is no object detected, the yellow light is illuminated and stays on. When an object is detected and remains in the proximity of the sensor for more than one second, the red light illuminates. If there is an object detected and the driver activates the turn signal the red light illuminates and the driver display emits three audible tones. The tone is only sounded once per activation of the turn signal. At startup, the red and yellow light will briefly illuminate, which indicates the system is performing a self-test. The red and yellow light will also illuminate and stay illuminated when there is a failure of the test [5]. Both the red a yellow light will be illuminated when there is heavy rain and the side sensor will not detect objects until the weather conditions clear [4].

VEHICLE DATA ACQUISITION

The VORAD EVT-300 system obtains and utilizes information from both its own sensors and from the control systems of the vehicle on which it is installed. The data that is specific to the VORAD system, such as the presence and location of detected objects, or the turn rate of the host vehicle, is acquired directly from the sensors and processed by the VORAD system, as described above. The VORAD system can obtain data from the vehicle systems in various ways, which is dictated by the type of vehicle on which it is installed and the way in which the VORAD CPU is configured at the time of the installation. Vehicle data can be obtained either directly, by being wired to sources such as the brake pedal switch or the speedometer, or by being connected to the vehicle's central data bus. The specific configuration of the system for a particular vehicle can be found in the data reports that are extracted from the

CPU, the details of which will be discussed in the following section of this paper.

The VORAD EVT 300 system obtains accident reconstruction related data from the host vehicle for three vehicle parameters: host vehicle speed, brake status, and turn signal activity. The host vehicle speed data is produced independently of the VOARAD system; the VORAD system simply monitors and records the speed data produced by the vehicle. As described above, this data can be acquired by wiring directly from the vehicle's speedometer circuitry, or from the vehicle's central data bus. In either case, the source of the vehicle speed data is the same as the data that is utilized by the vehicle's speedometer. In typical modern heavy truck installations, speedometer data is typically produced by a system that monitors the electronic pulses from a sensor reading a toothed wheel that is incorporated into the vehicle's drive train. The speedometer system is calibrated to the number of pulses per revolution of the sensing wheel, the number of revolutions per mile of the drive wheels on the truck, and the necessary gear ratios. Therefore, the accuracy and precision of the host vehicle speed data reported by the VORAD system is entirely dependent on that of the vehicle's own speed monitoring system. Changes to vehicle equipment, such as non-OEM wheels and tires, may affect the calibration of the speed monitoring system, and situational occurrences such as locked or semi-locked drive axles during braking may affect the accuracy of the data. Therefore, considerations should be made when interpreting the speed data reported by the VORAD system.

The data available regarding the status of the host vehicle's brakes is again acquired either through a direct connection to the vehicle's brake light circuitry, or through the central data bus. The EVT-300 system monitors and records only the binary status of the brake system; i.e. whether the brakes are on or off. This data corresponds with the activation of the host vehicle's brake lights. Therefore, while the system will record information as to when the vehicles brakes are applied, it does not monitor the level at which the driver applies the brakes, or the level of depression of the brake pedal. The EVT-300 system does report on the level of deceleration of the vehicle by way of a thin or thick line in the data plots that can be produced by the system, but this information is obtained by derivation of the speed data and not from the brake circuitry. The specifics of the deceleration level will be discussed in following sections of the report.

The VORAD system monitors turn signal activity directly from the turn signal light bulb circuitry. Similar to the brake system, the EVT-300 only monitors the binary status of the turn signal circuitry. In some installations with a single side radar sensor mounted on the right, the VORAD system may only monitor the status of the right-side turn signal circuitry. Otherwise, the system records turn signal activation when either the right or left turn signal or the four-way emergency flashers are activated, and it does not distinguish which type of activation is occurring. The source of the recorded turn signal activity can be determined through review of the CPU configuration and inspection of the system installation.

RECORDED DATA

One of the most valuable features of the Eaton VORAD system is its ability to provide a commercial truck driver with additional information and warnings that enhance driver awareness and ultimately highway safety. In addition to this, the VORAD system also has the ability to record and store the data that it monitors. This information can be invaluable to an accident investigator or reconstructionist should the vehicle be involved in an accident. The VORAD system records data from the truck on which it is installed that is typical of other Event Data Records that are increasingly common on heavy trucks today, such as speed, control status, and fleet maintenance information. Additionally, the VORAD system also has the ability to record information regarding other vehicles in the vicinity of the host vehicle that may be involved in the accident with the truck through the use of its radar sensor system. This additional benefit is unique relative to typical truck EDR's, and may provided evidence to a reconstructionist that would otherwise be unavailable.

SYSTEM MEMORY - The EVT-300 system is capable of recording between approximately 2 and 10 minutes of data. The total amount of recorded time is dependent on the number of objects that the system is detecting during the time period. In other words, as more objects are detected by the system, more memory is required for each time step, and the total duration of recorded time is reduced. The memory of the system acts as a rolling buffer; as the truck continues to drive, the earliest data is overwritten by the newest data. If the truck stops, the most recent data remains in the system. If it is deemed necessary (as in the event of a motor vehicle accident) the CPU memory can be frozen such that it will not be overwritten if the truck continues to drive. The memory is frozen by pushing the "Range" button on the driver display unit for approximately 5 seconds. The stored memory is confirmed by a green light on the display unit blinking 8 times. Furthermore, the system contains two memory "sections" in which it can record data. When the first memory section is frozen, data is then recorded in the second memory section. If the truck has not been driven after the first memory section has been frozen, no data will be present in the second memory section. It should be noted that in some versions of the VORAD system, the frozen memory section may be cleared if the data has not been extracted within 30 days. This will only occur if the truck has been driven or if power is supplied to the unit after the memory is frozen. The CPU contains a battery back-up system that allows the recorded data to be retained for approximately 5 years without power supplied to the CPU.

In the event that the VORAD memory has been frozen, the VORAD CPU can be removed from the vehicle and sent to Eaton VORAD for extraction. This process involves transferring the CPU data to a separate memory card, and then reading the extracted data using proprietary software developed by Eaton. Once the data has been transferred from the CPU to the memory card, it is automatically erased from the CPU. An important step in the extraction processes involves correlating the recorded time and date on the CPU data to the actual time of the extraction. This is done so that any discrepancy in the CPU time versus the actual time of extraction can be accounted for to determine the specific time of occurrences that may be shown in the data reports.

DATA REPORTS - After the data has been extracted by Eaton, the information can then be presented in either the form of a Basic Data Report or a Full Data Report, available from Eaton VORAD for a fee. The Basic Data Report generally includes approximately 5 minutes of data, typically correlated to the likely event of interest, such as a clear hard braking occurrence in the data. The Basic Data Report includes a series of graphical plots that depict the recorded parameters in a visual form, as well as a section that describes data presented in the graphical plots (although only in a generic sense and not specific to the subject data). The Full Data Report includes all of the data that is stored in the memory. The graphical plots of the Full Data Report do not contain any different information than that presented in the Basic Data Report; it simply includes the entire time duration of the memory. In addition to the graphical plots, the Full Data Report will also include a tabular listing of the numerical data that was utilized by the software to generate the graphical plots. The tabular data can be of particular interest to an accident reconstructionist who is interested in closely examining the recorded data. Also included in the Full Data Report is the Vehicle Information Management System (VIMS) data. The VIMS data is typically utilized to maintain and manage driver and fleet information.

AR Data Header – The AR Data header "provides information about the VORAD model, software type, vehicle ID and other pertinent system information." This data also contains information about the contents and status of the system memory. For example, the second line of the AR Data header indicates whether the CPU memory was frozen by displaying a "0" for no or a "1" for yes. There are 4 lines in the AR Data header that begin with "cr:" The first two lines refer to the first memory section, and the third and fourth lines refer to the second memory section. If no data was recorded in the second memory section, the "count" value (denoted "cnt") will read 0.

CPU Configuration – The CPU Configuration section of the data report contains information regarding the settings for the system, the installation of the system, and as well certain "checks" in place to confirm the validity of the system configuration. The data validity checks are located in the first two lines of the configuration table. The first is denoted "S,CERROR." A value of 1000 following this indicates that the system performed a successful reading of the CPU configuration. The next check is denoted "S,PERROR" and for this, a value of F indicates that no single value of the CPU configuration was read incorrectly. The remainder of the CPU configuration parameters are presented by the parameter name, followed by the value to which the parameter is set, and then a description of either the value that is indicated, or of the binary logic that applies to the parameter. The details of the CPU Configuration parameters are shown in Appendix A.

Graphical Plots – Both the Basic Data Report and the Full Data Report contain graphical plots of the data that has been extracted from the VORAD CPU. A detailed description of the data that is presented in the graphs is included with the Data Reports, therefore this paper will provide a brief overview and focus on details that are not discussed in the provided material.

There are 9 parameters represented on the graphical plots:

1. Object Distance (feet) – This plot shows the distance from the radar on the host vehicle to the various objects that the system detects. The system uses different colors on the plot to differentiate between the various objects that the system picks up. However, there may be occasions in which the object detection signal is weak or is lost for a brief period, and when the system re-establishes a signal for the object, it may assign a new color to the object when in fact it is the same object that was previously depicted. This occurrence can be recognized by examining the trend of the line shown in the graph.
2. Cross Range (feet) – This plot shows the lateral distance of the detected objects relative to the projected centerline of the host vehicle. The colors shown on this plot correspond with those of the Object Distance plot. It is noted in the provided description of this graph that this data is not adjusted relative to the turn rate data for the host vehicle. Therefore the data shown in this plot will be affected when the vehicles are driving in a curve. Although this is how the data is depicted in the graph, the CPU does account for the road curvature when issuing driver alerts.
3. Object Speed (miles per hour) – This plot shows the ground speed of the objects being detected by the radar, again with colors that correspond with those in the Object Distance plot. This data is calculated based on the recorded speed of

the host vehicle and the relative speed of the detected objects as measured by the radar.

4. Host Speed (miles per hour) – This plot shows the ground speed of the host vehicle. The actual speed data points are depicted as dots, and a line is fit to these data points. Data values for the host speed are recorded when there is a change in the speed of the vehicle.
5. Host Turn Rate (degrees per second) – This plot shows the rate of change of the directional heading of the host vehicle. It is important to recognize that this plot does not depict the vehicle's heading. The actual vehicle heading is a function of the turn rate and the speed that the vehicle is traveling. The color of the turn rate plots corresponds to calculated lateral acceleration thresholds that the vehicle reached.
6. Brake Status – This plot depicts a line that shows when the brakes are activated. The thickness of this line is determined by the rate of change of the speed data that is acquired from the vehicle. A thicker line indicates a greater rate of deceleration. The thickness of the line depicted is therefore not a direct measure of how hard the brakes are applied.
7. Alarm Status – The type of alarm that is activated is depicted by the coded color and thickness of the line. A thicker line does not indicate an increase in the volume of the alarm, although the thicker lines depict alarm levels that correspond to a greater level of emergency.
8. Side Sensor Status – Displays when an object is detected by the side sensor. The width of the line on the side sensor plot indicates whether the first or second (or both) side sensor has been activated. A narrow line indicates side sensor #1, a medium line indicates side sensor #2, and a thick line indicates that both side sensors are detecting an object. It cannot be determined from the data if a single vehicle or multiple vehicles are being detected by the side sensors.
9. Turn Signal Status – Displays when the host vehicle turn signal is activated. If only the right side turn signal is connected to the unit, the system will not record an activation when the left turn signal is activated. If both the left and right turn signals are connected to the unit, one cannot determine which direction of turn signal is activated from the data.

Tabular Data – When the Full Data Report is requested from Eaton, the tabular listing of the numerical data recorded by the system is included with the report. There are various types of records that are shown in the tabular data, and the type of the record is determined by a letter followed by a colon. Host vehicle records are updated when there is a change of value, and object records are sampled every 65 milliseconds. The record types are as follows:

- t: A record of time information – The date and time is recorded, as well as a record of whether the vehicle is stopped and if the VORAD system has been reset
- v: A record of host vehicle information – Various types of information is given for each vehicle record, depending upon which vehicle parameters have changed at the time. The time of the record is given.
- o: A record of detected object information – The object records consist of the time of the record, the objects designation symbol, as well as the distance to the object in feet (denoted "rng"), the object's speed relative to the host in feet per second (denoted "rat") and angle of the of the object measured from the projected centerline of the host vehicle (denoted "az").
- d: A record of an objects designation symbol
- b: A record of fault codes

SUMMARY

The Eaton VORAD Collision Warning System is unique tool in the commercial trucking industry that helps warn drivers of potential hazards and improves driver safety. In addition to improving highway safety the system also has the ability to store data that can be extremely helpful in the course of an accident investigation. When provided with this data it is beneficial to the investigator to have knowledge of the function and operation of the system, its proper installation, and the ways in which the data is acquired and interpreted.

This paper is only a summary of some of the capabilities of the Eaton VORAD EVT-300 and is not the totality of all available information. Furthermore, it is not necessary to inspect or verify the installation of the VORAD components to evaluate the data collected by the system and does not necessarily invalidate the data. The investigator should use engineering judgment and the physical evidence as well as accepted methods of accident reconstruction to evaluate the VORAD data.

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APPENDIX

A. CPU Configuration

Appendix A: CPU Configuration

Parameter Name	Description of Settings	Comments
P,RADAR_SN	EVT-300 serial number	The serial number of the EVT-300 system
P,MIN_VOL	Minimum volume	This value indicates the minimum value to which the driver can set the unit's volume
P,SEG_START	Miles to start trip	The distance that the vehicle must travel to indicate the start of a trip segment
P,SEG_END	Minutes engine off to end trip	The time that the engine must be turned off to indicate the end of a trip segment
P,BRK_LOGIC	1 = High brake-signal logic	When the system is discretely connected to the truck's brake line, this value indicates whether voltage on the wire should be considered a brake signal on or brake signal off
P,CARD_ALARM	Missing-driver-card alarm code	The VORAD system can be set up such that the driver must use a barcode card with the system
P,RANGE_ENB	0 = Headway control inactive	A setting of 0 indicates that the driver is unable to adjust the sensitivity of some alerts. Otherwise, the driver is able to adjust sensitivity with the Range knob on the DDU
P,CREEP_BEEP	1 = Proximity alarm beep enabled	Determines the setting of a feature that produces a warning if an object is detected in front of the vehicle when starting from a standstill and creeping forward.
P,TST_R_SIG	1 = Use right turn signal input	This tests the signal coming from the right turn signal. Enabled indicates that the right turn signal input is being used
P,TST_R_BSS	1 = Right side sensor installed	This tests the signal to the right side sensor. Enabled indicates that the right side sensor is installed
P,TST_L_SIG	1 = Use left turn signal input	This tests the signal coming from the left turn signal. Enabled indicates that the left turn signal input is being used
P,TST_L_BSS	1 = Second side sensor installed	This tests the signal to the second side sensor. Enabled indicates that a second side sensor is installed
P,BLKOUT_ENB	1 = Blackout mode enabled	Enables a display light black-out feature to be activated, typically for military use
P,DUAL_BSS	1 = Two side sensors with one ss display	Enabled indicates that there are 2 side sensors and only one side sensor display

P,TWOSEC_ALERT	1 = Enable two-second audio alert	When enabled, an alert sounds if the driver is following a vehicle ahead with less than 2 seconds of separation
P,SPEED_TEST	1 = Enable discrete speedo BIST	This tests the signal from the speedometer if the speed data source is a discreet connection
P,CONSTANT_ALERT	1 = Enable constant ½ second alert	When enabled, a constant alert sounds if the driver is following a vehicle ahead with less than 0.5 seconds of separation
P,VIMS_SETUP	1 = Enable VIMS trip data	Enables VIMS data to be recorded
P,AR_SETUP	1 = Enable accident data recording	Enables accident reconstruction data to be recorded
P,SYSTEM_OFF	0 = Do not allow driver to turn VORAD off	Determines if the driver is able to turn the VORAD system off
P,JTRACS_SETUP	1 = Enable Qualcomm OmniTRACS	Enables data to be transmitted through the Qualcomm system
P,SPEED_INFO	Speed source: 0 = none; 1 = J1587; 2 = J1939; 3 = discrete	Configures the source of host vehicle speed data
P,BRAKE_INFO	Brake source: 0 = none; 1 = J1587; 2 = J1939; 3 = discrete	Configures the source of the host vehicle brake status data
P,J1587_SETUP	1 = Activate J1587 databus	Activates the SAE J1587 databus
P,J1939_SETUP	1 = Activate J1939 databus	Activates the SAE J1939 databus
P,BRAKE_TEST	1 = Disable discrete brake BIST	This tests the signal from the brake circuitry if the brake data source is a discreet connection
P,TURN_SIG_TEST	1 = Disable turn signal BIST	This tests the signal coming from the turn signal circuitry
P,SPD_BAND1	First VIMS speed band	Sets the value for the first band of the average speed histogram in the VIMS data
P,SPD_BAND2	Second VIMS speed band	Sets the value for the second band of the average speed histogram in the VIMS data
P,SPD_BAND3	Third VIMS speed band	Sets the value for the third band of the average speed histogram in the VIMS data
P,SPD_BAND4	Fourth VIMS speed band	Sets the value for the fourth band of the average speed histogram in the VIMS data
P,SPD_BAND5	Fifth VIMS speed band	Sets the value for the fifth band of the average speed histogram in the VIMS data
P,RPM_BAND1	First VIMS RPM band	Sets the value for the first band of the average RPM histogram in the VIMS data

P,RPM_BAND2	Second VIMS RPM band	Sets the value for the second band of the average RPM histogram in the VIMS data
P,RPM_BAND3	Third VIMS RPM band	Sets the value for the third band of the average RPM histogram in the VIMS data
P,RPM_BAND4	Fourth VIMS RPM band	Sets the value for the fourth band of the average RPM histogram in the VIMS data
P,DDU_SELECT	Display type: 0 = EVT DDU; 1 = IDI; 2 = DDU+	Configures the system to the type of Driver Display Unit being utilized