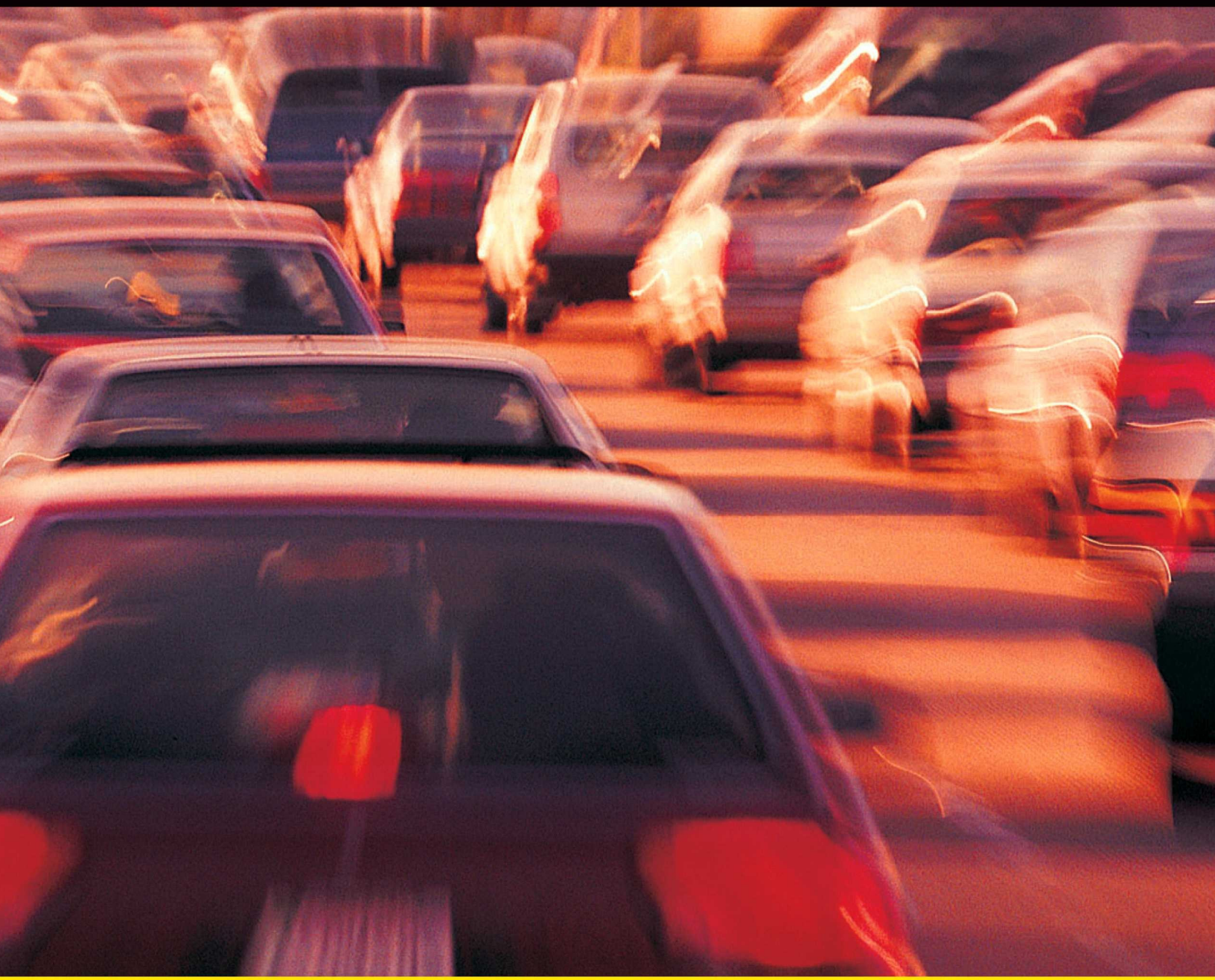


AUTOSENSE 800

USER GUIDE

AutoSense™

Revision Record

Date	Revision	Description
October 2005	-	Draft
January 2006	1.0	Initial Release
September 2009	2.0	Contact Revisions

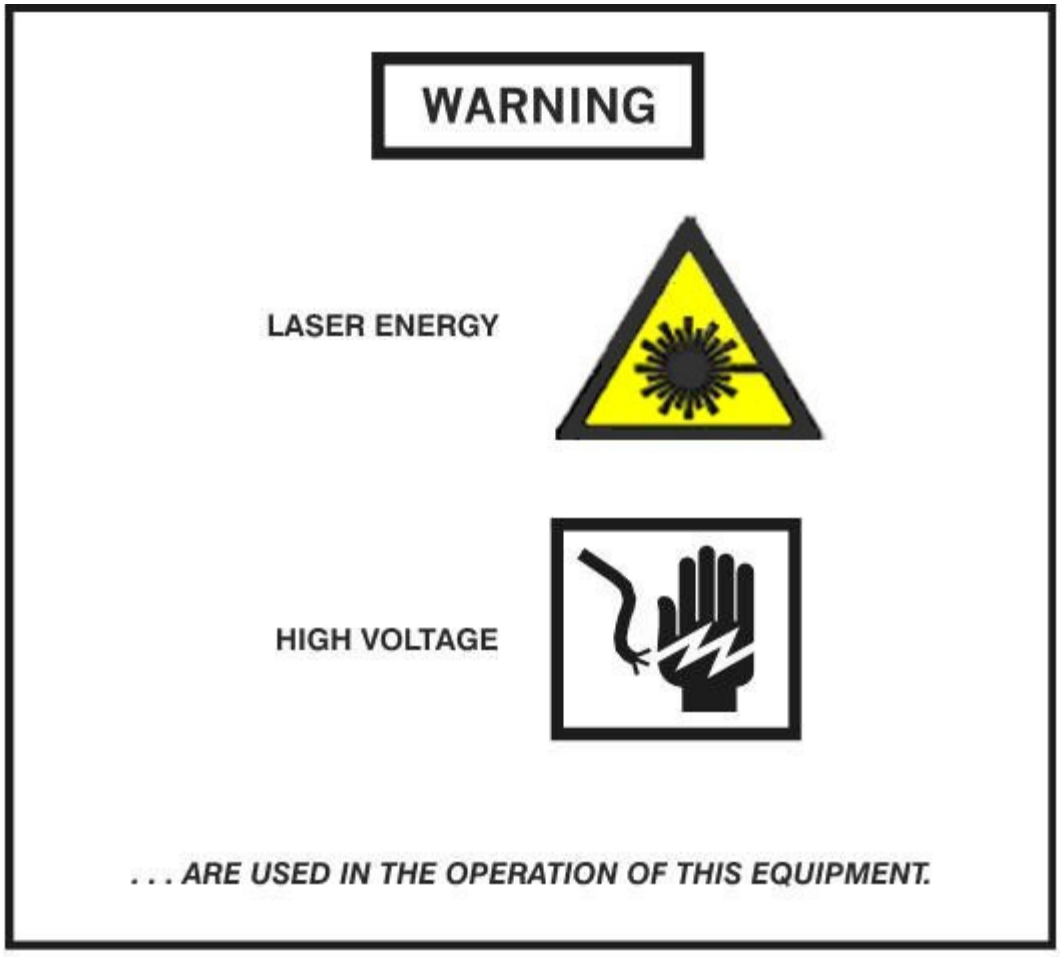
Disclaimer

The Publication No. 19409800 is subject to change without notice.

Address any AutoSense™ maintenance requirements, operational questions and repair actions or comments concerning this publication to:

OSI LaserScan
12525 Chadron Ave.
Hawthorne, CA 90250
www.osi-laserscan.com
Phone: +1 (310) 978-0516
Fax: +1 (310) 644-7213
e-mail: customerservice@osi-ls.com

Table of Contents



LASER CERTIFICATION

OSI LaserScan certifies that the AutoSense™ infrared vehicle sensor is a Class I laser product in compliance with U.S. standard 21 CFR §1040.10 and Class 1 laser product in compliance with the European laser product standards IEC 60825-1 2007. Lasers so classified by either standard are not considered to be hazardous.

WARNING SUMMARY

LASER HAZARDS

LASER LIGHT

L1-251

NEVER open the AutoSense™ and/or attempt to operate the AutoSense™ opened. Laser radiation may exceed eye safe levels.

HIGH VOLTAGE HAZARDS

HIGH VOLTAGE

L1-252

NEVER open the AutoSense™ and/or attempt to operate the AutoSense™ opened. Hazardous voltages are accessible.

⚠ AVERTISSEMENT	⚠ WARNING
Lire et comprendre le manuel d'utilisation et toutes les autres consignes de sécurité avant d'utiliser cet équipement.	Read and understand operator's manual and all other safety Instructions before using this equipment.

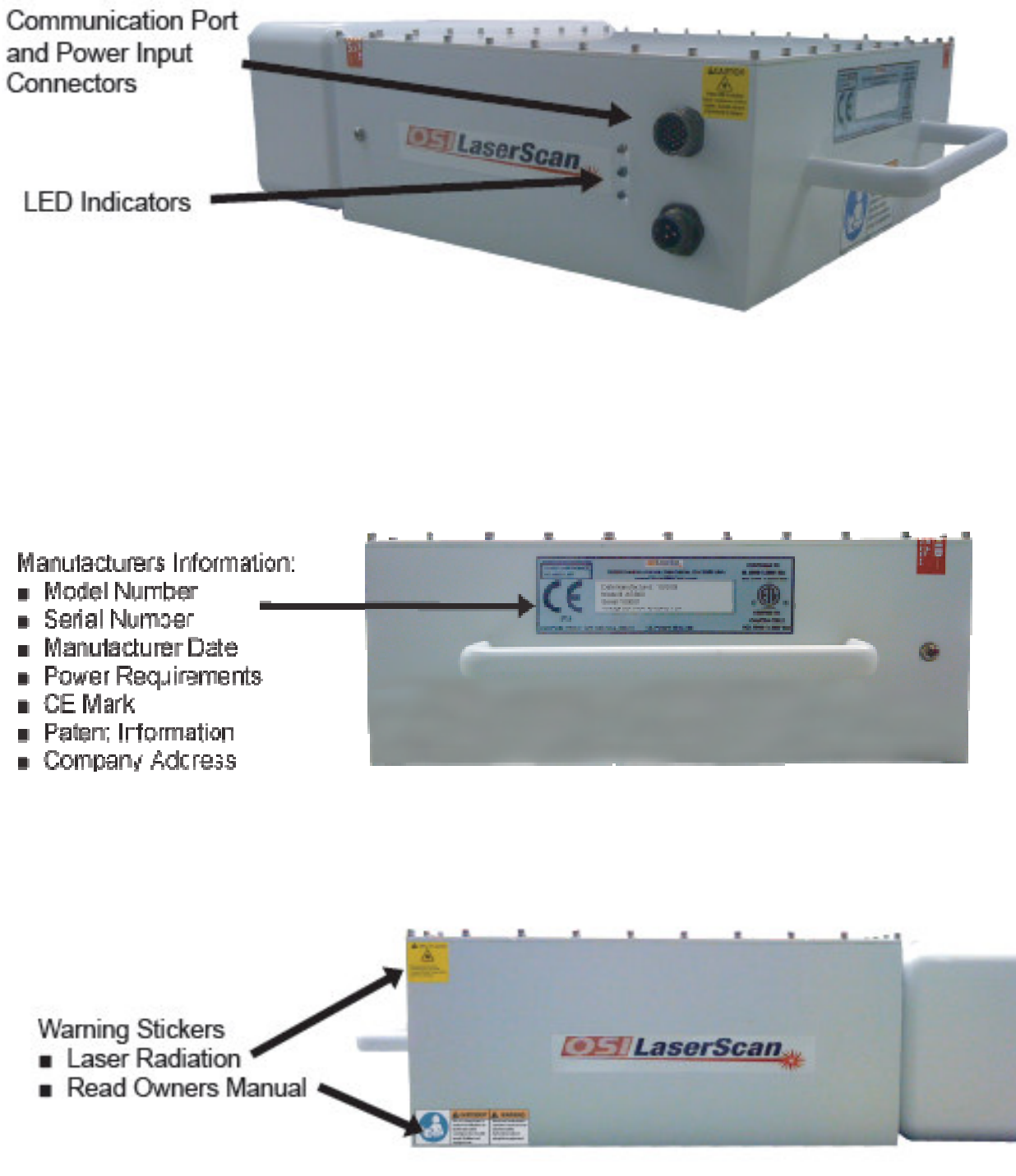


Figure A: Equipment Label and Interface Locations

Warnings/Personal Safety Precautions
AVERTISSEMENT/ PRECAUTIONS POUR votre SECURITE

The AutoSense™ contains voltages that can be **FATAL** and invisible laser radiation that may cause permanent eye damage if opened. Service must be performed **ONLY** by trained, experienced OSI authorized personnel. Do not attempt to open or access the inside of the AutoSense™. Read and obey all **WARNINGS** contained in the text of this User's Guide.

The AutoSense™ is equipped with several safety features designed to protect the operator under normal operating conditions. The following **WARNINGS** are contained in the text of this User's Guide:

L'AutoSense™ contient des tensions electriques qui peuvent etre **FATALE** ainsi qu'un rayonnement laser invisible qui pourait causer des degats permanents aux yeux si le dispositif est ouvert. Les revisions et reparations doivent etre effectue **SEULEMENT** par un personnel qualifie, experimente et autorise par **OSI**. Prier de ne pas tenter d'ouvrir ou d'acceder a l'interieur de l'AutoSense™. Lire et respecter toutes les consignes de securite figurant dans le mode d'emploi.

L'AutoSense™ est equipe de plusieurs dispositifs de securite concu pour proteger l'operateur dans des conditions normales d'utilisation. Les **AVERTISSEMENTS** suivant font parties du manuel de mode d'emploi :

WARNINGS

AVERTISSEMENTS

DO NOT OPEN THE AUTOSENSE™ AND/OR ATTEMPT TO OPERATE THE AUTOSENSE™ OPENED. OPERATION WITH THE AUTOSENSE™ OPENED, MAY RESULT IN EXPOSURE TO INVISIBLE CLASS 3B LASER RADIATION, AND WILL PROVIDE ACCESS TO VOLTAGE THAT CAN KILL.

NE PAS OUVRIR L'AUTOSENSE™ ET/OU TENTER DE FAIRE FONCTIONNER L'AUTOSENSE™ OUVERT. TOUT FONCTIONNEMENT DE L'AUTOSENSE™ OUVERT, PEUT ENTRAINER UNE EXPOSITION AU RAYONNEMENT LASER INVISIBLE DE CLASSE 3B, ET DONNERA ACCESS A UNE TENSION POUVANT ENTRAINER LA MORT.

DO NOT ATTEMPT TO SERVICE OR REPAIR THE AUTOSENSE™. SERVICE WILL REQUIRE ACCESS TO HARMFUL VOLTAGE THAT CAN KILL, AND MAY RESULT IN EXPOSURE TO INVISIBLE CLASS 3B LASER RADIATION. SERVICE AND REPAIR OF THE AUTOSENSE™ MUST BE PERFORMED ONLY BY OSI AUTHORIZED MAINTENANCE TECHNICIANS.

NE PAS TENTER DE FAIRE L'ENTRETIEN OU REPARER L'AUTOSENSE™. LE SERVICE D'ENTRETIEN EXIGE L'ACCES AUX TENSIONS NUISIBLES POUVANT ETRE FATALE, ET PEUT PROVOQUER L'EXPOSITION AU RAYONNEMENT LASER INVISIBLE DE CLASSE 3B. L'ENTRETIEN ET REPARATION DE L'AUTOSENSE™ DOIT ETRE EFFECTUE SEULEMENT PAR UN TECHNICIEN QUALIFIE DE OSI.

General Equipment Cautions
PRECAUTIONS General CONCERNANT L'Equipment

CAUTION

Check the AutoSense™ power requirements label on the case, prior to applying power.

AVERTIR

le Contrôle l'AutoSense™ les conditions de pouvoir étiquètent sur le cas, avant appliquer de pouvoir.

CAUTION

For proper installation, it is necessary to connect all three conductors to the specified power and ground connections. A fuse or circuit breaker must be used between the AutoSense™ unit and the source of power. DO NOT USE A FUSE OR CIRCUIT BREAKER IN THE EARTH GROUND LINE.

LA PRUDENCE

Pour l'installation correcte, c'est nécessaire de connecter tous les trois conducteurs au pouvoir spécifié et les connexions de sol. Un fusible ou le disjoncteur doit être utilisé entre l'AutoSense™ l'unité et la source de pouvoir. Ne PAS UTILISER UN FUSIBLE OU DISJONCTEUR DANS LA LIGNE DE SOL DE TERRE.

CAUTION

DO NOT ATTEMPT TO OPEN THE AUTOSENSE™ HOUSING! The AutoSense™ housing is nitrogen purged and hermetically sealed prior to shipping, and should only be opened in a laboratory environment by OSI authorized personnel. All of the screws in the main housing are seal screws and should not be loosened. All calibration and internal alignment adjustments are set during final test, and no field adjustments are required. Opening the housing could damage the unit and will void the warranty.

AVERTIR ne PAS TENTER D'OUVRIR L'AUTOSENSE™ LE LOGEMENT ! L'AutoSense™ le logement est de l'azote purgé et hermétiquement scellé avant l'expédition, et devrait être seulement ouvert dans un environnement de laboratoire par OSI a autorisé le personnel. Toutes les vis dans le logement principal sont les vis de cachet et ne devraient pas être desserrées. Tout calibrage et tous ajustements d'alignement internes sont réglés pendant le test final, et aucuns ajustements de champ sont exigés. L'ouverture du logement pourrait endommager l'unité et annulera la garantie.

General Safety Practices
Consignes Generales de securite

Report all hazards. If, at any time, you detect a hazard, report the hazard, as soon as possible, to OSI LaserScan to ensure the hazard is corrected. Refer to the OSI LaserScan contact information on the front cover or page ii of this User's Guide.

Rapporter tous les problemes. Si, a aucun moment vous constatez un danger adressez-vous aussi tot que possible a OSI LaserScan pour etre sure que le probleme soit resolu. Consultez le guide de l'utilisateur a la premiere page ou a la page ii pour les coordonnees de OSI LaserScan.

PREFACE

PURPOSE

This User's Guide provides familiarization and reference information necessary for setup and operation of the AutoSense™.

HOW TO USE THIS USER'S GUIDE

First, become familiar with the **GENERAL INFORMATION** in the front matter. Then read the summary of each section, before using the Table of Contents.

The Table of Contents may be used to locate related information on any titled subject. Titled subjects are listed by their numbered paragraphs, tables, figures, and page numbers within each section.

SUMMARY

- Section 1, **INTRODUCTION**, is an overview of the AutoSense™, a general physical description of components and a list of optional equipment.
- Section 2, **GETTING STARTED**, describes removal of the AutoSense™ from the shipping container, power requirements, interface signals, and cable requirements.
- Section 3, **OPERATION OF THE AUTOSENSE™**, provides a general functional description of the AutoSense™, including sample messages, and typical installation procedures.
- Section 4, **MESSAGE PROTOCOLS OF THE AUTOSENSE™**, provides tables, describing the various messages.
- Section 5, **TROUBLESHOOTING THE AUTOSENSE™**, provides fault symptom troubleshooting procedures, if you suspect the AutoSense™ is not operating properly.
- Section 6, **MAINTENANCE INSTRUCTIONS**, provides instructions for packing and shipping the AutoSense™ to an authorized service center, if required. Information for contacting an authorized service center is also provided. There is no authorized corrective maintenance of the AutoSense™ by the user.

TRADEMARKS

Product names mentioned in this User's Guide may be trademarks and are used for identification only.

LIMITED ONE (1) YEAR WARRANTY

OSI LaserScan (OSI) warrants each AutoSense™ unit for one (1) year from the date of shipment according to the following terms.

Any part of the AutoSense™ unit manufactured or supplied by OSI and found in the reasonable judgment of OSI to be defective in material or workmanship will be repaired or replaced by OSI without charge for parts or labor.

The AutoSense™ unit, including any defective part, must be returned to OSI within the warranty period. All shipping expenses for warranty repair will be paid for by the buyer. OSI's responsibility with respect to warranty claims is limited to making the required repairs or replacements, and no claim of breach of warranty shall be cause for cancellation or rescission of the contract of sale of any AutoSense™ unit.

This warranty does not cover any AutoSense™ unit that has been subject to misuse, negligence or accident. This warranty does not apply to any damage to the AutoSense™ unit that is the result of improper use or maintenance. The warranty does not cover any AutoSense™ unit that has been altered or modified so as to change its intended use or for which repairs have been attempted and seals have been broken without OSI's approval. In addition, the warranty does not extend to repairs made necessary by the use of parts, system interface or accessories, which are either incompatible with the unit or adversely affect its operation.

The AutoSense™ laser components require a dry environment that is maintained by the use of dry nitrogen and desiccant internal to the sealed unit. If the dry environment is not maintained by following the instructions specified in the operation and maintenance manual the warranty will be void.

OSI reserves the right to change or improve the design of any laser system or accessory without assuming any obligation to modify any system previously manufactured.

The foregoing Express Warranty is in lieu of all warranties, express or implied

OSI's OBLIGATION UNDER THIS WARRANTY IS STRICTLY AND EXCLUSIVELY LIMITED TO THE REPAIR OR REPLACEMENT OF DEFECTIVE PARTS. OSI ASSUMES NO RESPONSIBILITY FOR INCIDENTAL, CONSEQUENTIAL OR OTHER DAMAGES INCLUDING, BUT NOT LIMITED TO: LOSS OR DAMAGE TO PROPERTY, LOSS OF REVENUE, LOSS OF USE OF THE UNIT, LOSS OF TIME OR INCONVENIENCE.

SECTION 0: DESCRIPTION OF OPERATION

A schematic diagram of the AutoSense™ 800 system is shown in FIGURE 0.1 *AutoSense™* System Schematic Diagram. The AutoSense™ laser rangefinder employs an InGaAs diode-laser transmitter and a silicon avalanche photodiode (APD) receiver in a side-by-side configuration. The transmitter consists of the diode laser and its driver circuit and a collimating lens. The optical receiver is comprised of an objective lens, narrow-band optical filter, detector/amplifier, and threshold detector.

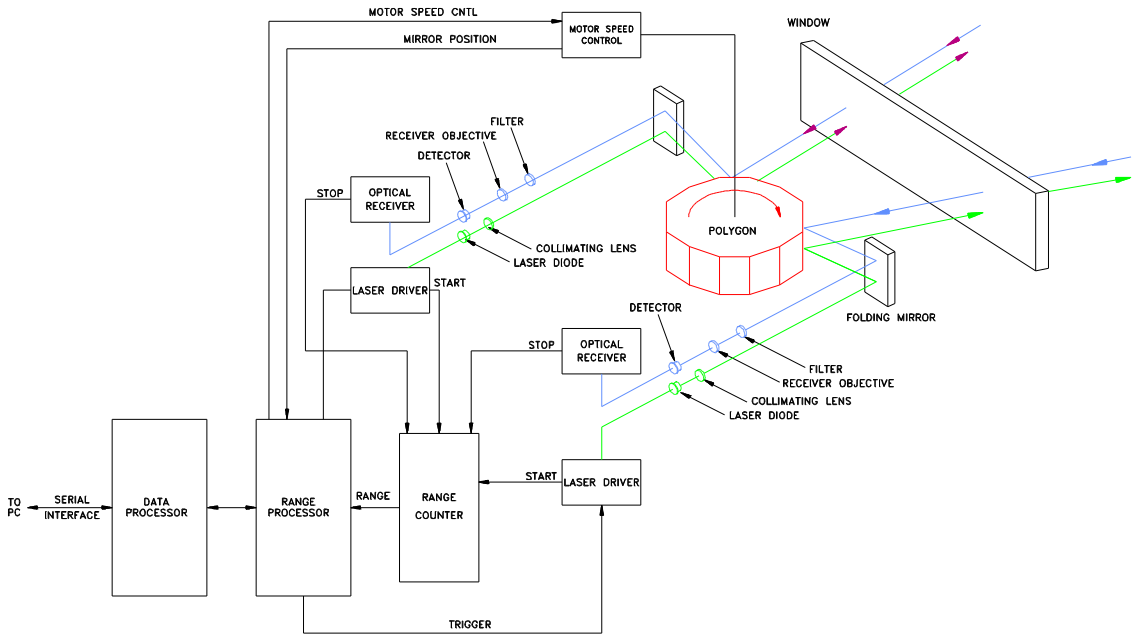


FIGURE 0.1 *AutoSense™* System Schematic Diagram

The laser diode used in the AutoSense™ is an InGaAs injection laser driven by a diode driver to produce a pulsed output. A trigger pulse from the scanner control circuit triggers the laser at the proper scan angles. The 904-nm laser emission is at an ideal wavelength for the silicon APD receiver used.

The AutoSense™ employs a rotating polygon to line scan the diode-laser rangefinder across a 12-foot-wide lane of a highway. The polygon scanner rotates continuously in one direction at a constant speed. The angle between each facet and the base of the polygon alternates between 87.50 and 92.50 for adjacent facets; as a result, successive scans are made with an angular separation of 100, which provides the two separate beams needed for speed measurements. As shown Figure 0.4, the 0.5 mrad by 12 mrad laser beam illuminates a 5 mm (0.2”) by 120 mm (4.7”) spot on the pavement that provides good in-lane resolution and optimum cross-lane coverage for two to three lanes when the laser is pulsed once every two-thirds of a degree of scan angle.

The optical detection circuitry converts optical radiation reflected from the vehicle/road to first, an equivalent electrical analog of the input radiation and finally, a logic-level signal. The logic-level signals are processed within the range counter logic to yield analog range data, which is read by the microprocessor.

An analog range-measurement technique was chosen for the AutoSense™ because of its better resolution, smaller size, simpler circuitry, lower power consumption, and lower cost when compared with digital techniques. The analog range measurement circuit, known as a time-to-amplitude converter (TAC), has an accuracy of 1 percent of measured range and a resolution of ±7.6 cm (±3 in). The TAC employs a constant-current source to charge a capacitor to obtain a linear voltage ramp whose instantaneous value is a measure of elapsed time. The circuit is designed so that the voltage across the range-measurement capacitor begins ramping down from the positive power supply when the laser fires. The ramp is stopped when either a reflected pulse is received or the end of the measurement period is reached. The TAC output is then converted to digital by a fast 10-bit A/D converter.

The pulsed time-of-flight range measurements are read by a Digital Signal Processor and converted into distance measurements. When no vehicles are present, the range measurements are equal to the range to the road. When a vehicle is present beneath the sensor, the distance to the top surface of the vehicle is measured and provides a transverse height profile of the vehicle on each scan. The vehicle speed, determined by the time interval between the interceptions of the two laser beams by the vehicle is used to space the transverse profile appropriately by straightforward geometric transformation to obtain the full three-dimensional vehicle profile. This vehicle profile is processed by the sensor to provide detection details and to classify the vehicle into the designated classification categories.

The AutoSense™ employs a scanning laser rangefinder to measure three-dimensional profiles that can be used for very accurate vehicle classification. The narrow laser beam width permits the detection of closely spaced vehicles moving at high speed; even a two-inch-wide tow bar can be detected. The AutoSense™ is ideal for applications involving electronic toll collection from vehicles at freeway speeds, where very high detection and classification accuracy is mandatory. The AutoSense™ relies on an inherent laser characteristic – narrow angular beam width – to provide the high resolution required for accurate vehicle profiling. The AutoSense™ beam-scan geometry is shown in Figure 0.2. The system scans two narrow laser beams, at a fixed angular separation, across the width of a lane at a rate of 720 scans per second (sps), (360sps on each beam). Pulsed time-of-flight range measurements provide accurate ±7.6 cm (±3 in.) profiles of a vehicle on each scan. The vehicle speed, determined from the time interval between the interceptions of the two laser beams by the vehicle, is used to space the transverse profiles appropriately to obtain the full three-dimensional vehicle profile. An algorithm, similar to those developed for military target recognition, is applied to the three-dimensional profile for vehicle-classification purposes.

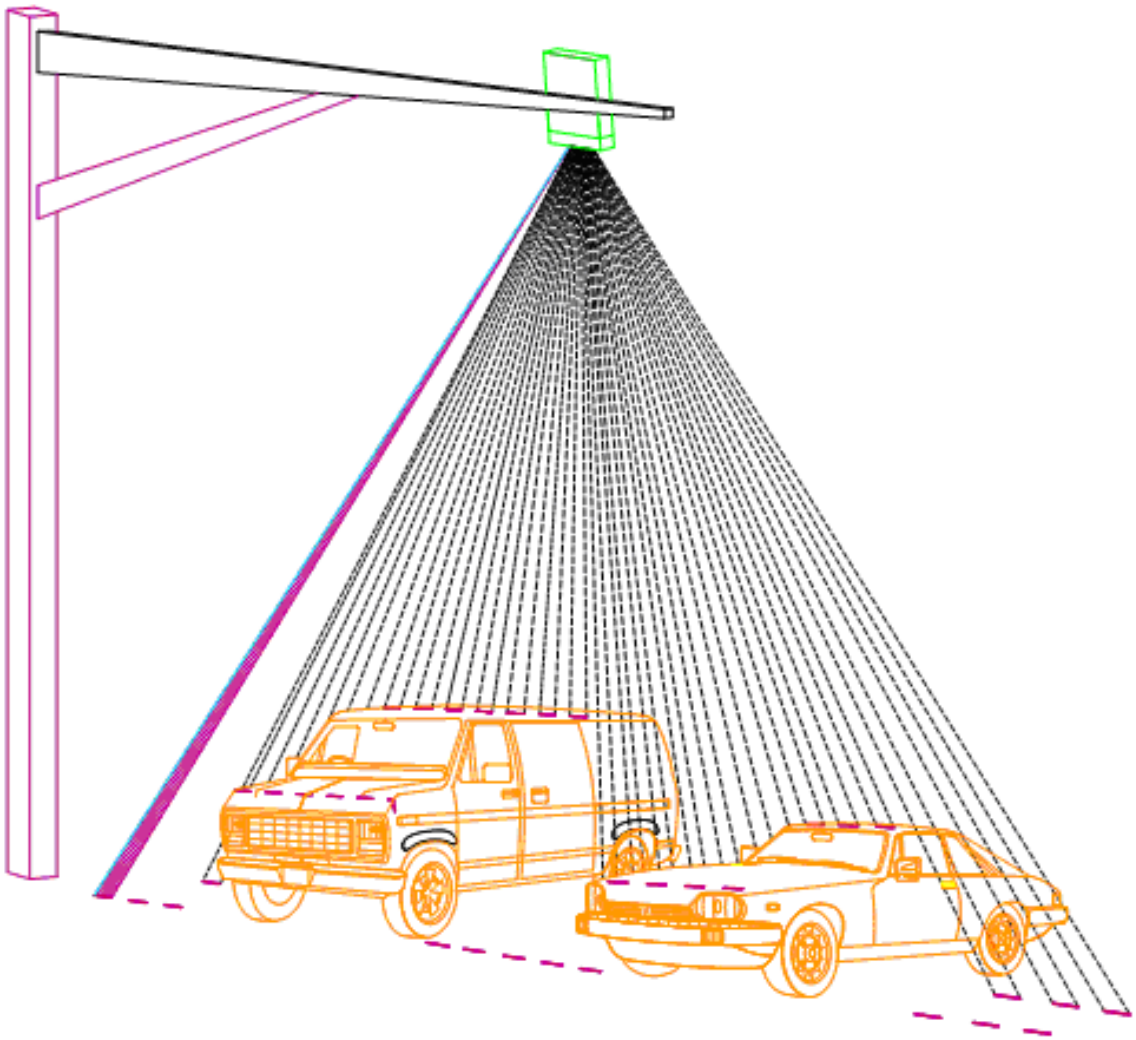


FIGURE 0.2 AutoSense 800 Beam Scan Geometry

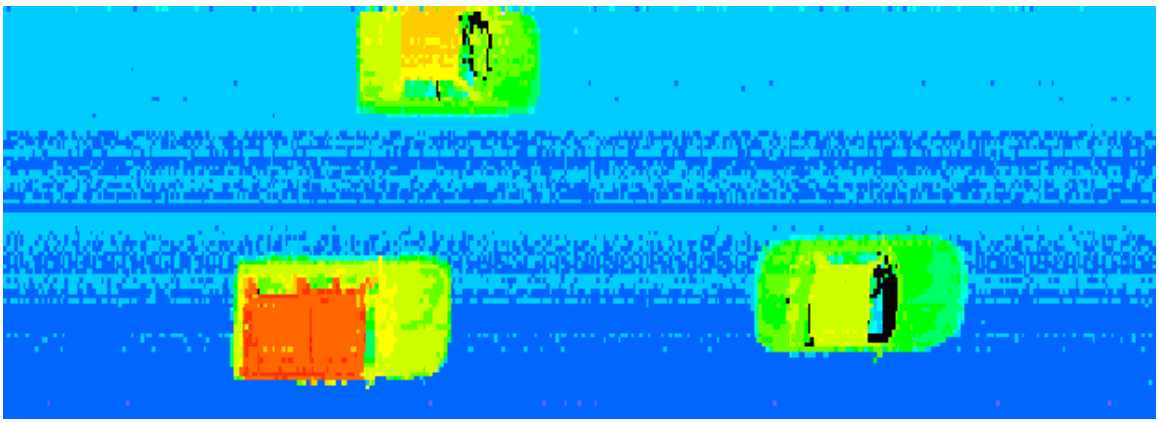


FIGURE 0. 3 False Color Range Image of Three Vehicles

As described above, the AutoSense™ employs a rotating polygon with alternating facet angles to achieve the fixed angular separation needed to line scan the diode-laser rangefinder across a lane of a highway. Alternating facet angles on the polygon allows the laser beam to trace the two lines across the road as the polygon rotates. Each range measurement for this laser beam illuminates a 3.5 mm (0.14") by 87.5 mm (3.44") spot on the pavement, as shown in Figure 0.4, that provides 7.32 meter (24 feet) total coverage when mounted 7 meters (23 feet) above the roadway. With the mounting height increased to 9.2 meters (30 feet), the same laser beam illuminates a 4.6 mm by 114 mm spot on the road.

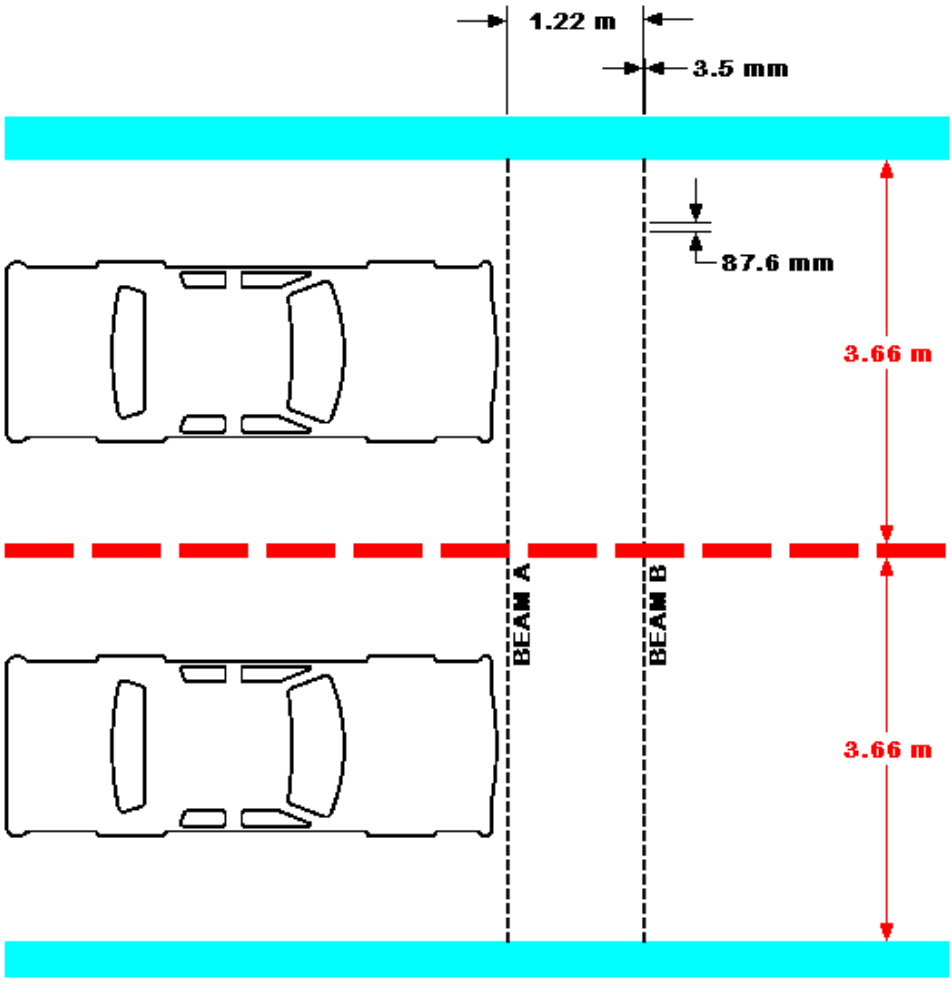


FIGURE 0. 4 Laser Beam Footprint on Road Surface at 7 meters

As described above, the AutoSense™ employs a rotating polygon with alternating facet angles to achieve the fixed angular separation needed to line scan the diode-laser rangefinder across a lane of a highway. Alternating facet angles on the polygon allows the laser beam to trace the two lines across the road as the polygon rotates. Each range measurement for this laser beam illuminates a 3.5 mm (0.14") by 87.5 mm (3.44") spot on the pavement, as shown in Figure 0.4, that provides 7.32 meter (24 feet) total coverage when mounted 7 meters (23 feet) above the roadway. With the mounting height increased to 9.2 meters (30 feet), the same laser beam illuminates a 4.6 mm by 114 mm spot on the road.

The three-dimensional profile generated for this coverage area is processed by the sensor to provide vehicle detection details and to classify the vehicle into the designated classification categories.

The AutoSense™ transmits five messages when operating in the detection mode for each vehicle detected within its field of view. In normal circumstances, each message and the order in which it is transmitted is listed below:

#1 First Beam Vehicle Detection Message
#2 Second Beam Vehicle Detection Message
#3 First Beam End of Vehicle Message
#4 Second Beam End of Vehicle Message
#5 Vehicle Classification (Axle Count) Message

An illustration of the vehicle's position for each message is shown in Figure 0.5. The first four messages uniquely identify the vehicle and its position in the lane. The fifth message is the final message for the vehicle that includes vehicle classification, classification confidence percentage, height, length, width and speed.

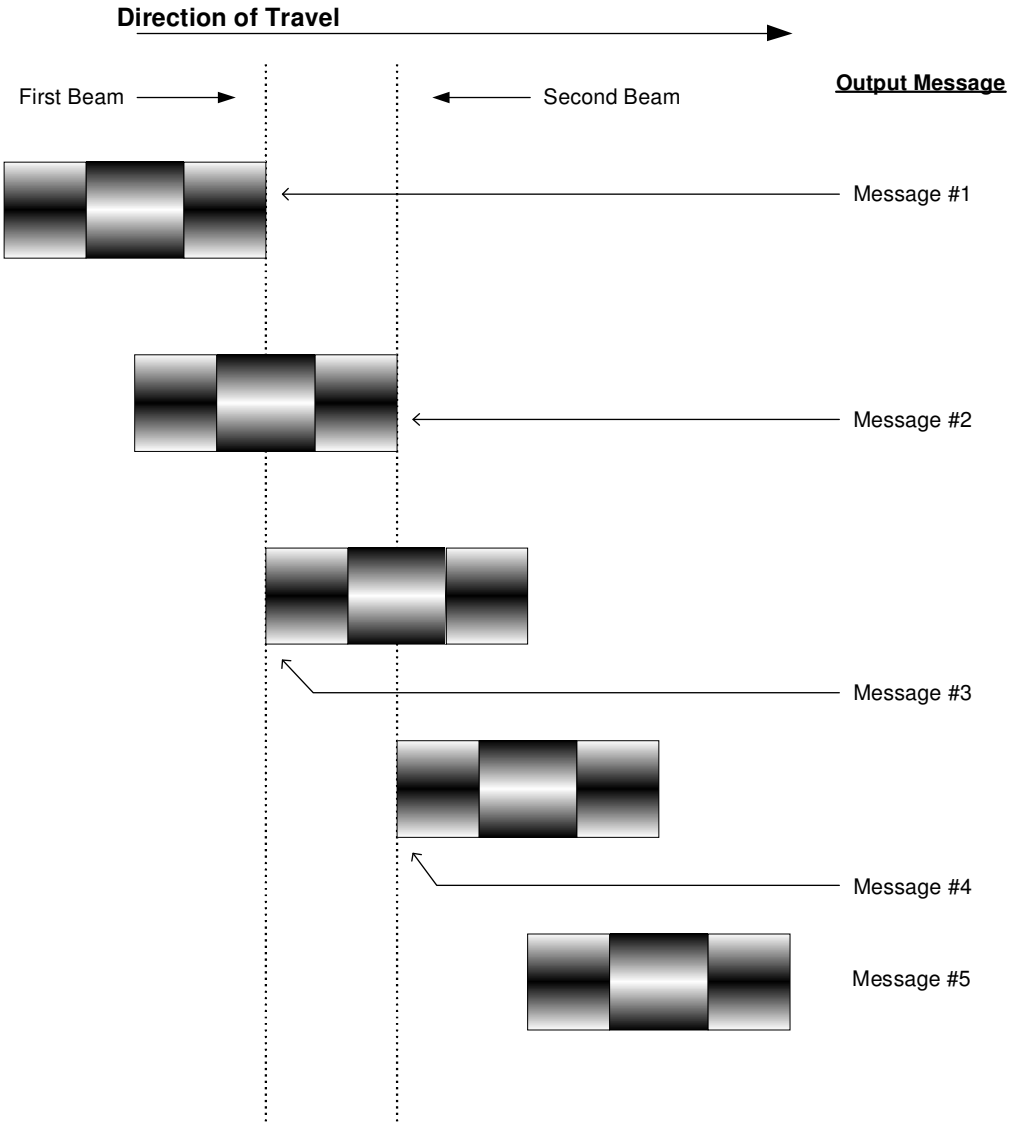


FIGURE 0. 5 AutoSense Output Message

Interfaces

Serial Data Link

The AutoSense™ provides an RS-422 (or RS-232) serial interface operating at a user selectable data rate of 19.2, 38.4 or 57.6 kilobits per second, 8 data bits, 1 start, 1 stop, no parity. The default data rate for normal operation is 57.6 Kilobits per second. An optional fiber optic interface is under development and will be available in late 2005.

Vehicle Detection Trigger

The AutoSense™ provides a real time signal to facilitate the triggering of camera's or vehicle enforcement systems. The solid state trigger can be configured for front or rear vehicle detection. In addition, the sensor also generates a trigger report as part of serial message #4.

Test

Self-Test

The AutoSense™ has continuous self-test capability. The self-test checks include the following parameters.

- Memory tests: RAM
- Motor Control
- Calibration and Threshold

Calibration and Adaptation

Automatic Calibration

The AutoSense™ performs an automatic calibration upon power up. The calibration accuracy is not compromised by vehicles passing through the AutoSense™ field of view.

Automatic Site Adaptation

The AutoSense™ has automatic calibration at varying installation sites under the following conditions.

- Slope 9%
- Grade 7%
- Road Reflectivity
- Barrier and Guard Rails

SECTION 1: INTRODUCTION

1.1. SCOPE

The AS800 Series AutoSense™ vehicle detection and classification sensor, as shown in figure 1.1, is a class I laser system that is ideally suited to providing toll and traffic management authorities with vehicle detection, presence, separation and classification information. A single sensor can be mounted overhead of travel lanes on either a Gantry, pole arm or toll plaza roof structure. Please see Section 3 and Appendix E for detailed installation information.

The AutoSense™ scans the roadway beneath the sensor, taking range measurements across the width of the road at two locations beneath the sensor. These measurements are processed to generate messages that uniquely detect and classify each vehicle, and give its speed and position in the lane. The AutoSense™ automatically initializes the vehicle detection process upon power-up, and its self-calibration process eliminates the need for any field adjustments.

This User's Guide covers safe and correct setup and operation of the AutoSense™.

1.2. PHYSICAL DESCRIPTION

The descriptions provided here are limited to support understanding of how to use and operate the AutoSense™. For a detailed description, refer to Appendix A, Specification. There is no authorized corrective maintenance of the AutoSense™ for user/operator performance. Access to the inside of the case is restricted to OSI-trained and authorized personnel. No description of the inside of the case is contained in this User's Guide. Figure 1-1 shows the AutoSense™ in the fully operational configuration.

1.2.1. Case

The AutoSense™ laser and control system are housed in a durable weather proof case.

1.2.2. Power Input Connector (3-Pin)

Located on the side of the case is the 3-pin power input connector. The connector provides for connection of the power input cable. Functional details of connector are provided in paragraph 2.6.1.

1.2.3. Communication Connector (19-Pin)

Located above the power input connector is the 19-pin communication connector. The connector provides for connection of the communication cable. Functional details of connector are provided in paragraph 2.6.2.

1.2.4. Red and Green Indicators

Located next to the connectors are a Red and two Green LED indicators. The Red and adjacent Green indicators flash when the AutoSense™ performs self-test at start up and indicate status during operation. The second Green LED indicates system power. (See section C.3.2 in Appendix C for details).

1.2.5. Laser Output Window

Located at the front of the housing, the laser output window protects the AutoSense™ components from the environment, and allows the laser to scan the traffic lane.

FIGURE 1- 1. AutoSense™

1.2.6. Carrying Handle

Located on the case, the carrying handle is used to transport the AutoSense™ and assist in the mounting procedures.

1.2.7. Mounting Hardware

The mounting hardware consists of; four each, 1/4-20 bolts with lock washers and flat washers; and 2 each 1/4-20 shoulder screws. The mounting hardware is used to secure and align the case to the mounting plate. **The hardware included with the AutoSense™ is for use with the AutoSense™ Mounting Plate sold by OSI, Inc. If any other mounting arrangement is to be used, care must be taken not to break through the case by using hardware that is too long.**

1.3. OPTIONAL EQUIPMENT

The following optional equipment is available for the AutoSense™:

	Description	Part Number (as required per input voltage of unit)	
		120VAC	240VAC
A	Power Cable Assembly	9291011-xxx xxx = length in feet	9291111-xxx xxx = length in feet
B	Communications Cable Assembly	9291010-xxx xxx = length in feet	9291010-xxx xxx = length in feet
C	RS-422 to USB Converter	SeaLevel 2106	SeaLevel 2106
D	Beam Finder	9301000-9	9301000-9
E	Start-up Kit CD Rom ▪ User's Manual ▪ Software ▪ Warranty Certificate	19471024-9 ▪ 19409800 ▪ 19479601 ▪ 19479201	19471024-9 ▪ 19479200 ▪ 19479601 ▪ 19479201
F	Mounting Kit ▪ Mounting plate ▪ Mounting hardware and tools	19471022-9 ▪ 19406122-1 19471023-9	19471022-19 ▪ 19406122-1 19471023-9
G	Supplemental Communications Cable Surge Suppressor	81000143-9	81000143-9
H	RS422 Comm Board	SeaLevel 7205S-20.0000	
I	Communications Connector	PW06P-14-19S	
J	Power Connector	PW06P-12-3S	PW06P-12-3SY

SECTION 2: GETTING STARTED

2.1 SCOPE

The following procedures provide instructions for unpacking, inspection, Installation and general interface and power requirements of the AutoSense™ AS800. WARNING: Installation of the AutoSense units must be performed by qualified and trained technicians.

2.2 UNPACKING AND INSPECTION OF PARTS

The AutoSense™ is shipped in a container. Inside the container, extra protection of the equipment is provided by foamed inserts. The items used with the AutoSense™ are imbedded in the foam inserts. Unpack the AutoSense™, as follows:

a. Place the shipping container down on a flat surface.
b. Open the lid.
c. Ensure the following components are in the shipping container; check Packing List against components:
    1. AutoSense™, Unit
    2. Two Shoulder Screws
    3. Four 1/4-20 Bolts, four Lock Washers, four Flat Washers
    4. AutoSense™ User's Guide
    5. Optional Items, as shown on the Packing List
    6. Packing List.
d. Remove the items from the shipping container; place on a flat work surface (table or bench), and inspect for damage.

2.3 POWER REQUIREMENTS

The AutoSense™ is configured for one of two power requirements, as follows:

a. 120 V, 50/60 Hz, 2.0 A
b. 240 V, 50/60 Hz, 3.5 A.

CAUTION

Check the AutoSense™ power requirements label on the case, prior to applying power.

AVERTIR

le Contrôle l'AutoSense™ les conditions de pouvoir étiquètent sur le cas, avant appliquer de pouvoir.

2.4 INTERFACE SIGNALS

The AutoSense™ default serial interface is RS-422. Signals for the interface is presented in Table 2-1.

	Description	Specification
STANDARD CONFIGURATION	**RS-422 ***	
	Function	Serial data communication
	Mode of Operation	Differential
	Configuration	No Parity, 8 data bits, 1 stop bit
	Baud Rate	19.2, 38.4, 57.6 Kbaud
	Maximum Cable Length	Dependent upon data rate, ≅ 3300 feet @ 57.6 Kbaud
* **NOTE: These are factory settings only**		

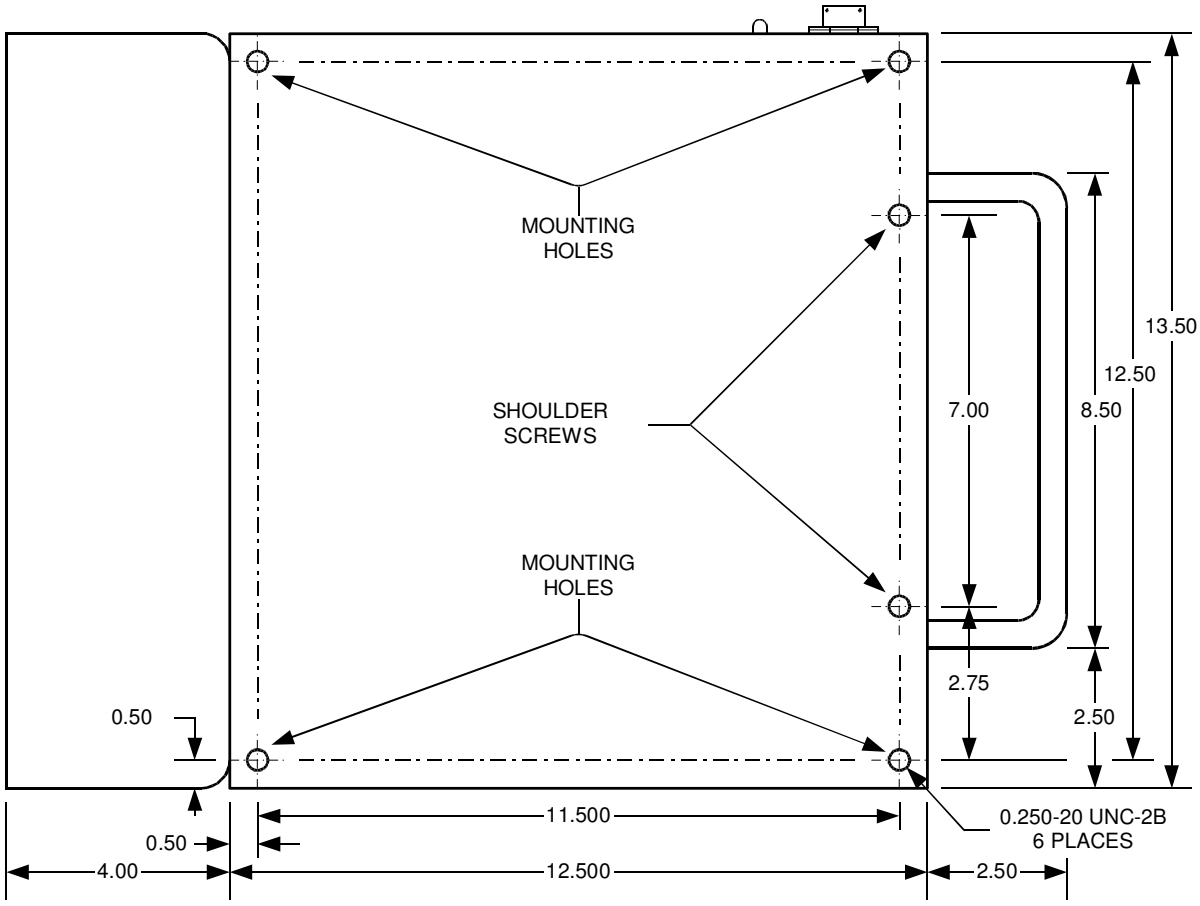
Table 2- 1. AutoSense™ Interface Signals

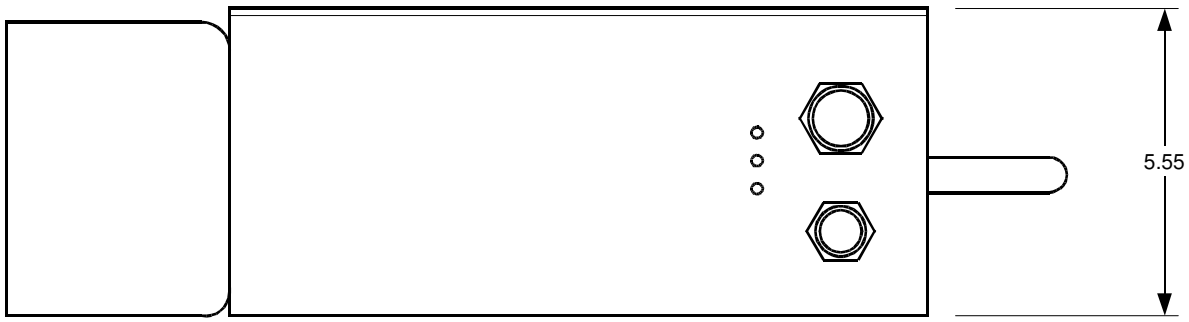
2.5 DIMENSIONS

The dimensions of the AutoSense™ are listed below. Figure 2-1 shows the mounting holes on the base of the case.

a. Height: 6.1 inches (15.5 cm)
b. Width: 13.5 inches (34.3 cm)
c. Depth: 17.9 inches (45.5 cm)
d. Weight 30 pounds (14 kg).

Figure 2- 1. AS800 Housing Dimensions (In Inches)





2.6 CABLE REQUIREMENTS

2.6.1 Power Cable

Input Power Connector pin functions are described in Table 2-2. The three-conductor power cable should be shielded and have a minimum wire size of 18 AWG. Alpha 5163/1C is an acceptable, recommended cable. OSI provides an environmentally sealed cable as an accessory. See page 10.

Pin	Function
A	AC
B	Neutral TN Style
C	Earth Ground

Table 2- 2. Input Power Connector Pin Functions

For proper installation, the AutoSense unit power must be permanently connected to a Breaker Box or Fuse Panel with all three conductors connected to the specified power and ground connections. DO NOT use any type of quick connect or temporary plugs or receptacles. A fuse or circuit breaker MUST be placed between the AutoSense™ unit and the source of power. Make sure that the Earth Ground conductor is properly terminated to provide stated IP Ratings.

The cable shield is to be grounded on the connector end of the cable ONLY and should NOT be connected to the earth ground in the breaker box.

CAUTION

For proper installation, it is necessary to connect all three conductors to the specified power and ground connections. A fuse or circuit breaker must be used between the AutoSense™ unit and the source of power. DO NOT USE A FUSE OR CIRCUIT BREAKER IN THE EARTH GROUND LINE.

LA PRUDENCE

Pour l'installation correcte, c'est nécessaire de connecter tous les trois conducteurs au pouvoir spécifié et les connexions de sol. Un fusible ou le disjoncteur doit être utilisé entre l'AutoSense™ l'unité et la source de pouvoir. Ne PAS UTILISER UN FUSIBLE OU DISJONCTEUR DANS LA LIGNE DE SOL DE TERRE.

Connect the power cable plug to the AutoSense™ power input connector, as shown in Figure 2-2.

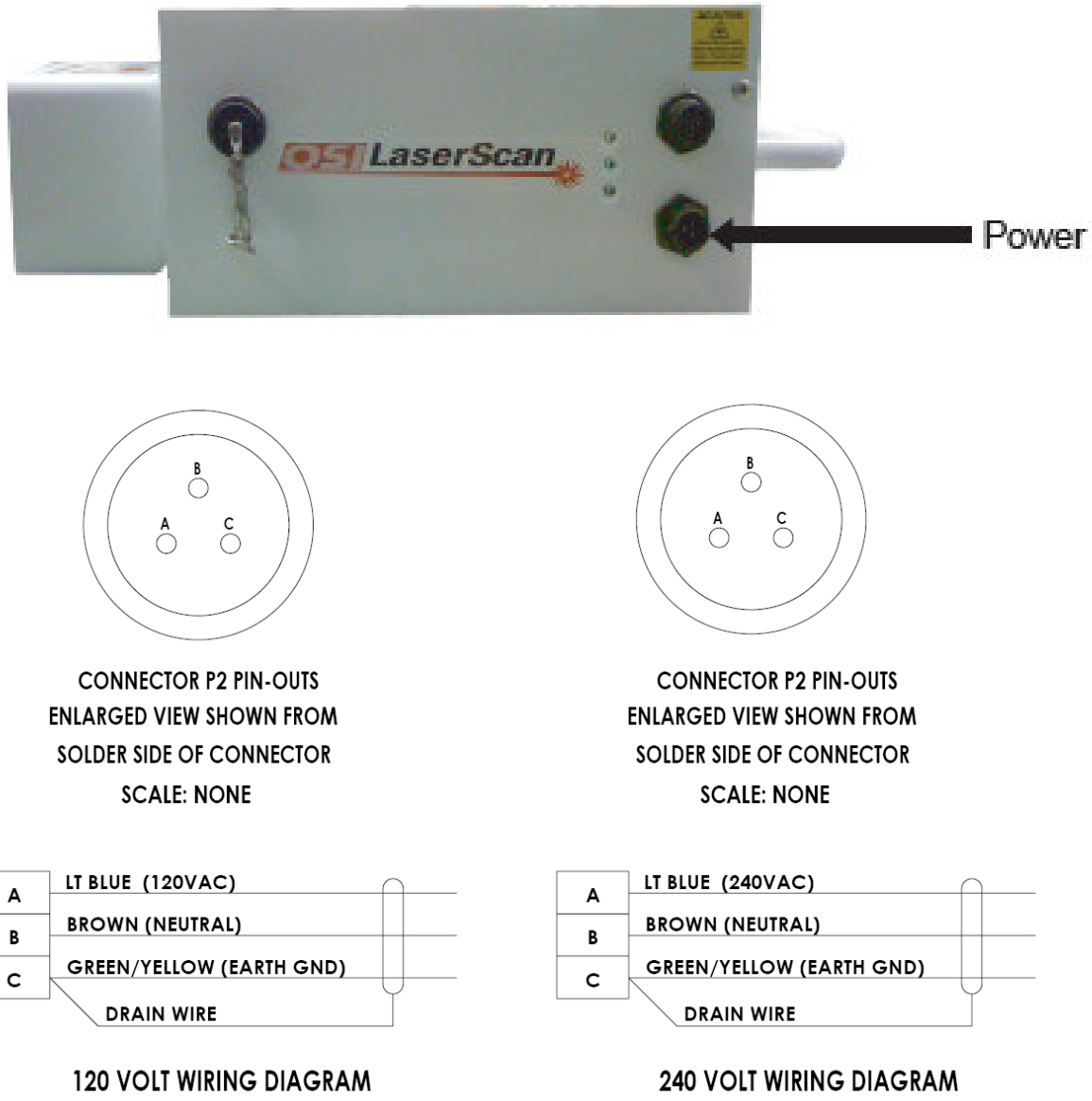


Figure 2- 2. Power Cable Connection

2.6.2 Communication Cable

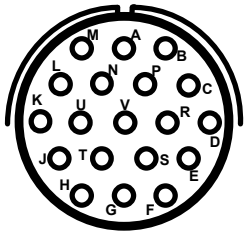
Communication Data Connector pin functions for the AutoSense™ are described in Table 2.6.2. The cable used should be a shielded, low-capacitance, polyethylene type, such as BELDEN 9807. For RS-422 operation, maximum cable length for reliable operation is determined by data rate. For RS-232 total cable capacitance will determine the maximum cable length, and should not exceed 2500 pF. For BELDEN 9807, which has a capacitance of 50.4 pF/meter, the maximum length is 165 feet (50 M). OSI provides an environmentally sealed cable as an accessory. See page 10.

AutoSense also has a high-speed (1.25 Mbps) RS-422 interface capability. The high-speed interface is used in applications requiring transmission of the sensor's raw range and intensity data. A connection diagram for a high-speed RS-422 interface is presented in Appendix B.

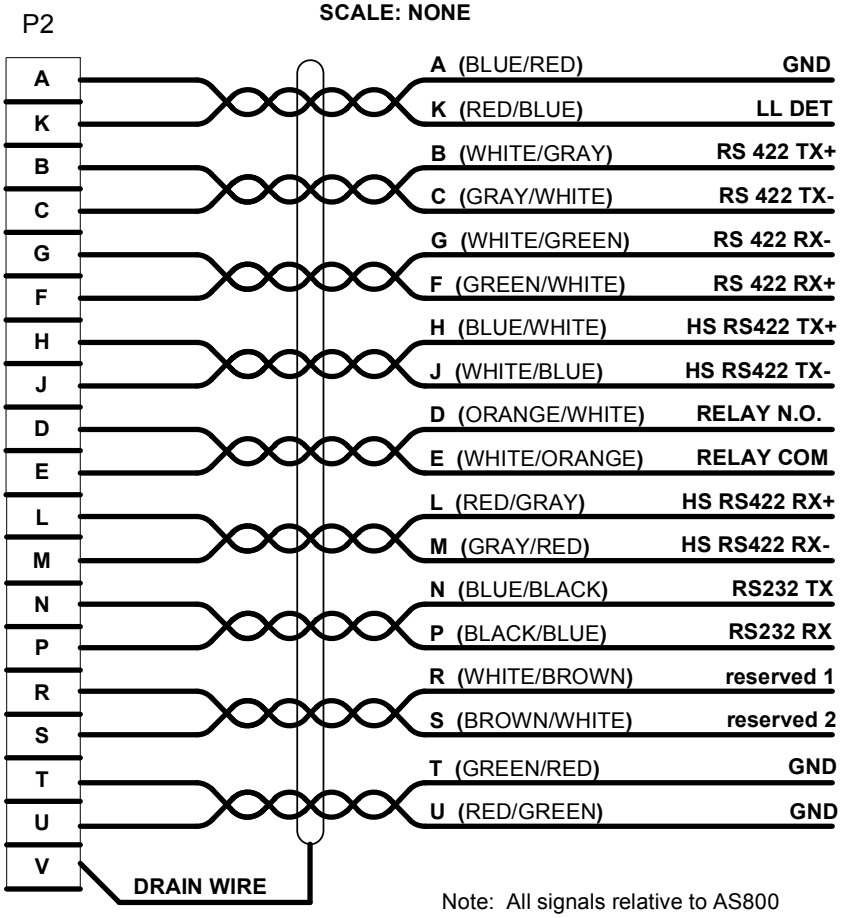
Pin	Function	Note
A	Ground	Twisted Pair
K	Camera Trigger	
B	RS-422 TX +	Twisted Pair
C	RS-422 TX -	
F	RS-422 RX +	Twisted Pair
G	RS-422 RX -	
H	High Speed RS-422 TX+	Twisted Pair
J	High Speed RS-422 TX-	
D	Relay N.O.	Twisted Pair
E	Relay COM / Aux Trigger	
L	High Speed RS-422 RX+	Twisted Pair
M	High Speed RS-422 RX-	
N	RS-232 TX	
P	RS-232 RX	
R	Reserved 1	
S	Reserved 2	
T	GND	
U	GND	
V	Cable Shield	

Table 2- 3. Communication Data Connector Pin Functions

Connect the communication cable to the AutoSense™ communication connector, as shown in Figure 2.3.



CONNECTOR P2 PIN-OUTS
ENLARGED VIEW SHOWN FROM
WIRING SIDE of CONNECTOR
SCALE: NONE

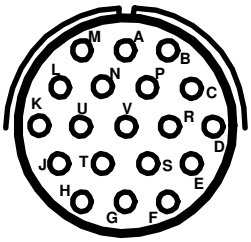


Note: All signals relative to AS800
(i.e. TX = transmit from sensor)

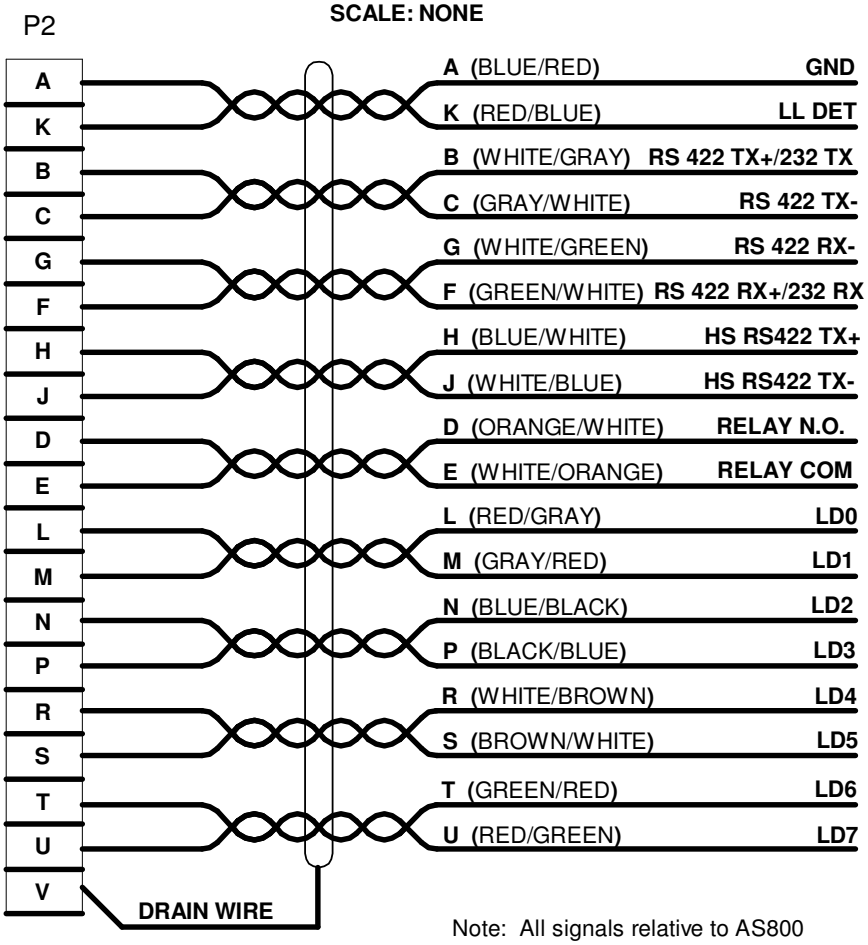
WIRING DIAGRAM

COMMUNICATION CABLE

Figure 2-3. AS800 Communication Cable



CONNECTOR P2 PIN-OUTS
ENLARGED VIEW SHOWN FROM
WIRING SIDE of CONNECTOR
SCALE: NONE



Note: All signals relative to AS800
(i.e. TX = transmit from sensor)

WIRING DIAGRAM

COMMUNICATION CABLE - Multi-Zone

Figure 2-4. Communication Cable Connection

SECTION 3: OPERATION OF THE AUTOSENSE™

3.1 FUNCTIONAL DESCRIPTION

The AS800 Series AutoSense™ provides timing, position, speed, length, and dimensional classification of vehicles passing through its field-of-view. The AS800 Series AutoSense™ is designed to be installed on a gantry, pole arm or roof structure in a toll plaza scanning across the traffic lane. The AutoSense™ is designed to communicate with a roadside computer through its serial data connector, using either RS-422 or RS-232. It also provides a camera trigger signal as a discrete through the same connector. An optional fiber optic communications interface is also available as an option. For each vehicle passing through its field-of-view, the AutoSense™ will output five serial data messages and a camera trigger, as shown and described in Figure 3-1 and Table 3-1. A Vehicle ID number assigned by the unit will be used to identify the passing vehicle for all five messages.

Regardless of the installation location (i.e., open road or toll plaza) the AutoSense™ will provide vehicle detection, separation and camera trigger information. However, accurate classification information is best obtained in an environment where vehicle speeds are maintained above 20 mph (32kph). Below 20 mph (32kph) the confidence factor associated with the vehicle classification will be degraded.

When enough pixels per scan find an object for enough consecutive scans of the first beam of the AutoSense™, the unit will detect the presence of the vehicle, assign a Vehicle ID number, and send a "1st Beam Vehicle Detection" message to the roadside computer.

When enough pixels per scan find an object for enough consecutive scans of the second beam, the AutoSense™ will send a "2nd Beam Vehicle Detection" message to the roadside computer. This message contains the Vehicle ID number, the vehicle speed and the vehicle's left-edge and right-edge positions in the 1st beam.

When no object has been found for enough consecutive scans under the first beam, the unit will send a "1st Beam End of Vehicle" message to the roadside computer. This message contains the Vehicle ID number, left-edge and right-edge positions in the 2nd beam.

When no object has been found for enough consecutive scans under the second beam, the AutoSense™ outputs a camera-trigger signal and sends a "2nd Beam End of Vehicle" message to the roadside computer. This message contains only the Vehicle ID number. The camera trigger is generated as a discrete output on pin K of the Communications Data Connector. It is a complementary 5 Volt digital signal, 1 µsec in length.

The AutoSense™ compiles the accumulated data for the vehicle, generates a classification for this vehicle and sends this data along with the Vehicle ID number, vehicle length, vehicle-on-road distance and speed to the roadside computer. This is the "Classification Message" and is the last message the AutoSense™ will send regarding the vehicle.

In addition, the AutoSense™ runs self-tests on a periodic basis and will report any detected failures by sending a Self-Test Message to the roadside computer.

NOTE: Refer to Section 4, Message Protocol, for a complete list of output messages.

In addition, the AutoSense™ runs self-tests on a periodic basis and will report any detected failures by sending a Self-Test Message to the roadside computer.

NOTE: Refer to Section 4, Message Protocol, for a complete list of output messages.

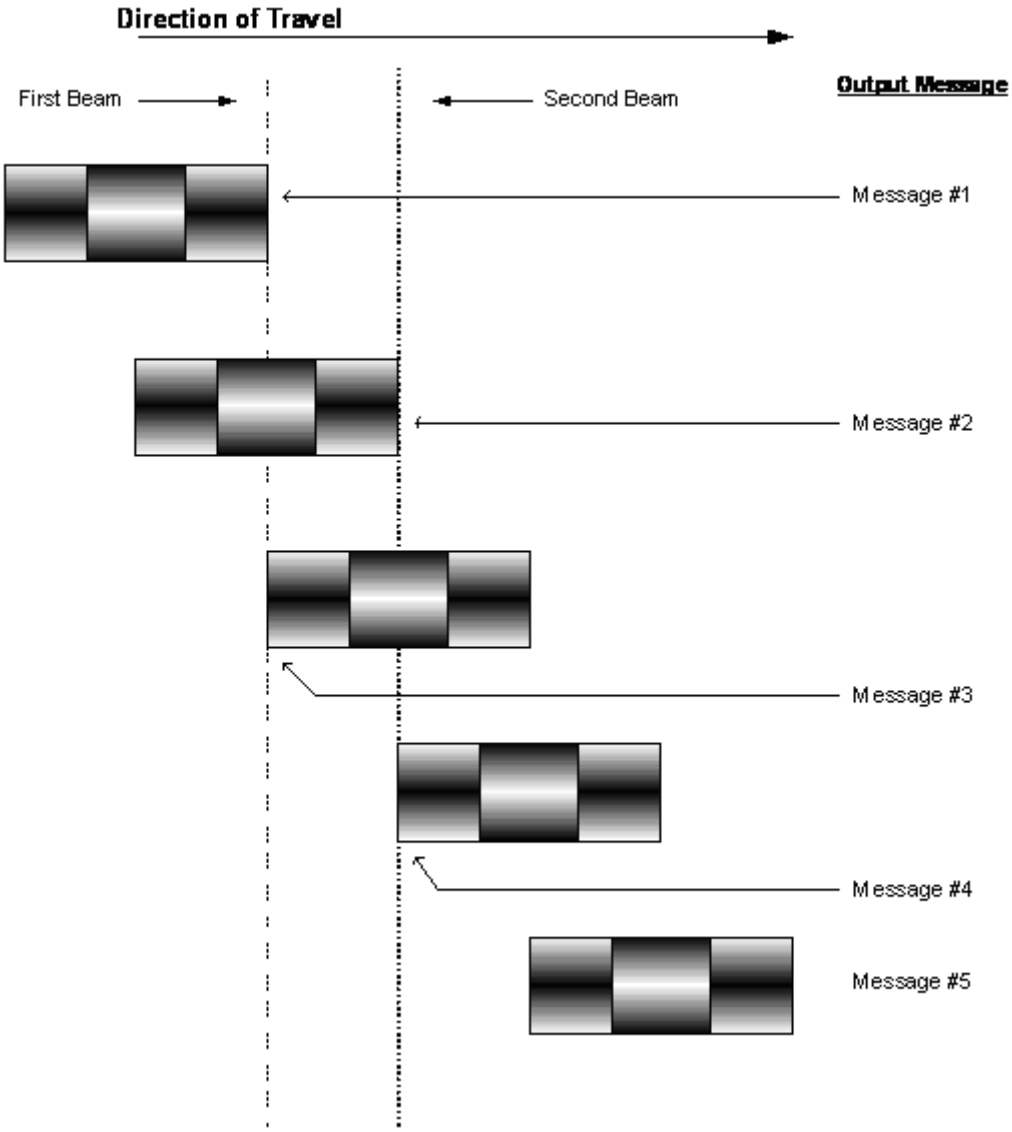


FIGURE 3-1: AutoSense™ Output Messages Versus Vehicle Location.

Number	Message
1 of 5	1st Beam Vehicle Detection ID = 49
2 of 5	2nd Beam Vehicle Detection ID = 49 Speed (mph): 6
3 of 5	1st Beam End of Vehicle ID = 49
4 of 5	2nd Beam End of Vehicle ID = 49 Trigger on Pin K
5 of 5	Classification Message ID = 49 Passenger car: 95% Height: 5.45 ft Length: 18.25 ft Width: 9 Degrees
	Speed (mph): 6

TABLE 3-1. AutoSense™ Sample Output Messages.

As described in Table 3-1, The AutoSense™ will transmit 5 messages for each vehicle that is detected within its field of view. In normal circumstances, each message and the order in which it is transmitted is listed below.

#1 First Beam Vehicle Detection Message

#2 Second Beam Vehicle Detection Message

#3 First Beam End of Vehicle Message

#4 Second Beam End of Vehicle Message

#5 Vehicle Classification Message

Each message will include a corresponding vehicle ID. For a vehicle to be validated, messages #1 through #5 must be received when the same vehicle ID. If any message is not received, or if all of the messages do not have the same vehicle ID, then the vehicle is not valid and should not be counted.

Normal Vehicle Message Sequence:

[Msg#1, ID=1] [Msg#2, ID=1] [Msg#3, ID=1] [Msg#4, ID=1] [Msg#5, ID=1]

However, if the AutoSense™ unit is installed incorrectly and the 10 degree laser beam is not pointing into the oncoming flow of traffic, the AutoSense™ will transmit messages out of the normal sequence. Likewise, if a vehicle were to back-up through the detection zone (i.e., travel in the opposite direction of traffic, the AutoSense™ will also transmit the messages out of sequence. This will allow the off-board computer system to identify and filter this detection as an invalid detection.

Reverse Vehicle Message Sequence:

[Msg#2, ID=1] [Msg#1, ID=2] [Msg#4, ID=2] [Msg#5, ID=2] [Msg#3, ID=1]

3.2 TYPICAL INSTALLATION

Typically, the AutoSense™ is mounted between 6 and 10 meters (19.5 and 32.7 feet), centered above the traffic lanes, as shown in Figure 3-2. The AutoSense™ has mounting holes located at each corner of the base. Mounting bolts are supplied with each unit. A mounting plate is also available that allows the sensor to be mounted to horizontal poles with a diameter from 2 to 3.5 inches (50 to 90 mm). The maximum mounting height is 10 meters (32.7 feet). Please reference APPENDIX E for nominal installation information.

3.2.1 Look Down Angle

The *AutoSense* will meet the specifications as defined herein when mounted with the correct look down angle. The recommended look down angle is 10 degrees for the first beam and 0 degrees for the second beam. These beam angles are achieved by mounting the sensor with a 5-degree forward tilt as shown in Figure 3-2.

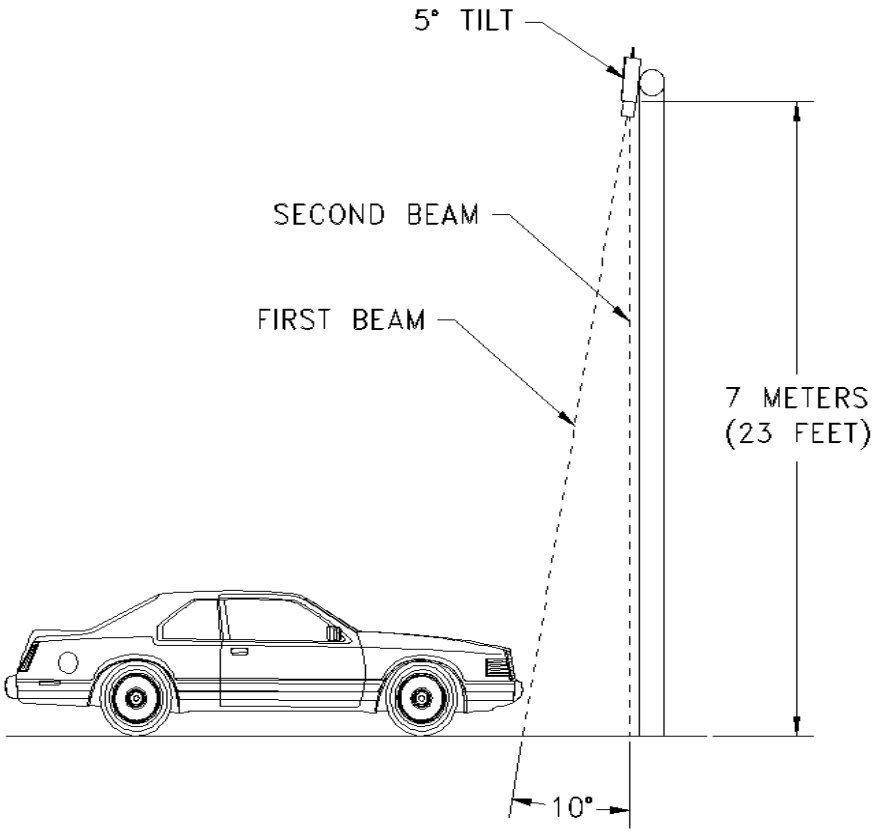


FIGURE 3-2. Typical AutoSense™ Mounting.

SECTION 4: MESSAGE PROTOCOL OF THE AUTOSENSE™

4.1 DATA FRAME FORMAT

For normal operation, the AutoSense™ is configured for 57.6 Kbps, no parity, 8 data bits, and 1 stop bit. No hardware or software handshaking is used. The AutoSense™ will send messages as it detects vehicles. Each data frame will consist of a 2 byte synchronization header, followed by the message/command, and ending with a 1 byte checksum, as shown in the following table. The sections that follow describe the message blocks for each of the AutoSense™ messages. All multi-byte data is transferred low byte first.

Name	Descriptions	Size	Value
Frame Sync	First byte of a two byte synchronization header.	1 Byte	A5 hex
Frame Start	Second byte of a two byte synchronization header.	1 Byte	5A hex
Message Block	The message/command data will be inserted into this location.	1 – N bytes	See 4.2 through 4.13
Checksum	Byte-wise exclusive-OR of Message block	1 Byte	0 to FF hex

4.2 MESSAGE SUMMARY

Command	Message ID	Response	Description
Power-On Message	6	N/A	Power-up Report
1st Beam Detection	1	N/A	1st beam vehicle detect
2nd Beam Detection	2	N/A	2nd beam vehicle detect
1st Beam End of Vehicle	3	N/A	1st beam end vehicle detect
2nd Beam End of Vehicle	4	N/A	2nd beam end vehicle detect
Vehicle Classify	5	N/A	Vehicle Classify
Command Acknowledge	8	N/A	
Test Data Output Message	9	N/A	Test Data Output Message
Self Test Message Block	7	N/A	Self Test Status Message
Heartbeat Message	12	N/A	Periodic communication.
Detection Clear Message	13	N/A	No Vehicle Present
Version Report	29	N/A	Version Report

4.2.1 Power-On Message Block

This message will be sent after the AutoSense™ unit has powered up and completed initial calibration.

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Message ID	Defines the start of a message	Byte	1	6	N/A	N/A
Self-Test Results	Any faults detected by the internal self-test routines. A set bit indicates a failure. All bits are defined in the Self-Test Message Description	Word	1	0-7FFh	N/A	N/A
Firmware Major Revision	The primary version level of sensor's Firmware	Byte	1	0-99	1	N/A
Firmware Minor Revision	The secondary version level of the sensor's Firmware	Byte	1	0-99	1	N/A
Firmware Patch Revision	The patch version level of the sensor's Firmware	Byte	1	0-99	1	N/A
Range to Road Beam #1	The range from the sensor to the road for 30 samples of the scan for Beam #2	Byte	30	0-255	0.25	¼ Feet
Range to Road Beam #2	The range from the sensor to the road for 30 samples of the scan for Beam #1	Byte	30	0-255	0.25	¼ Feet

4.2.2 First Beam Vehicle Detection Message Block: (Message #1)

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Message ID	Defines this as a First Beam Vehicle Detection Message	Byte	1	1	N/A	N/A
Vehicle ID	Unique number assigned by the sensor upon detection of a new vehicle	Byte	1	0-255	1	N/A
** Vehicle Left Edge Position*	*Defines where the left edge (with respect to the sensor) of the vehicle is positioned within the lane.*	*Byte*	*1*	*0-89*	*0.67*	*Degree*
** Vehicle Right Edge Position*	*Defines where the right edge (with respect to the sensor) of the vehicle is positioned within the lane.*	*Byte*	*1*	*0-89*	*0.67*	*Degree*

** Optional data: these bytes are sent only if the "Extra Message Bytes Enable" option is set in FLASH Parameters.* ***This adds 2 bytes to the length of the message.***

4.2.3 Second Beam Vehicle Detection Message Block: (Message #2)

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Message ID	Defines this as a Second Beam Vehicle Detection Message	Byte	1	2	N/A	N/A
Vehicle ID	Unique number assigned by the sensor corresponding to Message #1 for the same vehicle.	Byte	1	0-255	1	N/A
Vehicle Left Edge Position	Defines where the left edge (with respect to the sensor) of the vehicle is positioned within the lane	Byte	1	0-89	0.67	Degrees
Vehicle Right Edge Position	Defines where the right edge (with respect to the sensor) of the vehicle is positioned within the lane	Byte	1	0-89	0.67	Degrees
Vehicle Speed	Speed at the leading edge of the vehicle	Byte	1	0-255	1	MPH
* Vehicle Left Edge Range	Defines the range at the left edge (with respect to the sensor) of the vehicle (¼ feet).	Byte	1	0-255	1	¼ feet
* Vehicle Right Edge Range	Defines the range at the right edge (with respect to the sensor) of the vehicle (¼ feet).	Byte	1	0-255	1	¼ feet
Vehicle Speed	Speed at the leading edge of the Vehicle, MPH.	Byte	1	0-120	1	MPH

* *Optional data: these bytes are sent only if the "Extra Message Bytes Enable" option is set in FLASH Parameters**. This adds 2 bytes to the length of the message***.

4.2.4 First Beam End of Vehicle Detection Message Block: (Message #3)

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Message ID	Defines this as a First Beam End of Vehicle Detection Message	Byte	1	3	N/A	N/A
Vehicle ID	Unique number assigned by the sensor corresponding to Messages #1 and #2 for the same vehicle	Byte	1	0-255	1	N/A
Vehicle Left Edge Position	Defines where the left edge (with respect to the sensor) of the vehicle is positioned within the lane	Byte	1	0-89	0.67	Degrees
Vehicle Right	Defines where the right edge (with	Byte	1	0-89	0.67	Degrees

Edge Position	respect to the sensor) of the vehicle is positioned within the lane					
** Vehicle Left Edge Range*	*Defines the range at the left edge (with respect to the sensor) of the vehicle (¼ feet).*	*Byte*	*1*	*0-255*	*1*	*¼ feet*
** Vehicle Right Edge Range*	*Defines the range at the right edge (with respect to the sensor) of the vehicle (¼ feet).*	*Byte*	*1*	*0-255*	*1*	*¼ feet*
** Optional data: these bytes are sent only if the "Extra Message Bytes Enable" option is set in FLASH Parameters.* ***This adds 2 bytes to the length of the message****.*						

4.2.5 Second Beam End of Vehicle Detection Message Block: (Message #4)

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Message ID	Defines this as a Second Beam End of Vehicle Message	Byte	1	4	N/A	N/A
Vehicle ID	Unique number assigned by the sensor corresponding to Messages #1, #2, and #3 for the same vehicle	Byte	1	0-255	1	N/A

4.2.6 Vehicle Classification Message Block: (Message #5)

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Message ID	Defines this as a Vehicle Classification Message	Byte	1	5	N/A	N/A
Vehicle ID	Unique number assigned by the sensor corresponding to previous messages for the same vehicle	Byte	1	0-255	1	N/A
Vehicle Classification	A number which represents the class of a vehicle	Byte	1	0-11	1	N/A
	0 = Unknown 1 = Motorcycle 2 = Motorcycle with trailer 3 = Passenger Car 4 = Passenger Car w/trailer 5 = Pickup/Van/Sport Utility 6 = Class 5 w/trailer 7 = Single Unit Truck/Bus 8 = Class 7 w/trailer 9 = Tractor w/ 1 trailer 10 = Tractor w/2 trailers 11 = Tractor w/3 trailers					
Classification Confidence	A number which represents the probability that the Vehicle Classification is accurate	Byte	1	0-100	1	Percentage
Feature Data	Vehicle Height	Byte	1	0-255	0.25	Feet
Feature Data	Vehicle Length	Byte	1	0-255	0.25	Feet
Feature Data	Vehicle Width	Byte	1	0-89	0.67	Degree
Feature Data	Spare	Byte	5	0	N/A	N/A
Vehicle Speed	Speed at leading edge	Byte	1	0-255	1	MPH

4.2.7 Command Acknowledged Block

This message will be sent in response to the AutoSense™ unit receiving a Reset Command (4.2.17) or any command requiring an Acknowledge response.

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Message ID	Defines the start of a message	Byte	1	8	N/A	N/A

4.2.8 Test Data Output Command Block

This command can be sent by the roadside computer to receive range and intensity data from the AutoSense™ unit. The Test Data Output Message (4.2.9) will be sent in response to this command.

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Command ID	Defines this as a Test Data Output Command	Byte	1	17	N/A	N/A

4.2.9 Test Data Output Message Block

This message will be sent after the AutoSense™ unit has received the Test Data Output Command (4.2.8).

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Message ID	Defines the start of a message	Byte	1	9	N/A	N/A
Range to Road Beam #2	The range to the road for 30 samples of the scan for Beam #2	Byte	30	0-255	0.25	Feet
Intensity of Road Beam #2	The intensity (signal strength) for every degree of the scan for Beam #2	Byte	30	0-127	1	N/A
Range to Road Beam #1	The range to the road for 30 samples of the scan for Beam #1	Byte	30	0.255	0.25	Feet
Intensity of Road Beam #1	The intensity (signal strength) for 30 samples of the scan for Beam #1	Byte	30	0-127	1	N/A

4.2.10 Self-Test Command Block

This command can be sent by the roadside computer to initiate a self-test by the AutoSense™. The Self-Test Message (4.2.11) will be sent in response to this command.

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Command ID	Defines this as a Self-Test Command	Byte	1	7	N/A	N/A

4.2.11 Self-Test Message Block

This message will be sent in response to receiving a Self-Test Command (4.2.10) or when the AutoSense™ detects a failure.

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Message ID	Defines the start of a message	Byte	1	7	N/A	N/A
Faults	Any faults detected by the internal self-test routines. A set bit indicates a failure. See SELF-TEST RESULTS FLAGS (section 4.2.12.1) for a description of each item.	Word	1	0-7FFh	N/A	N/A
	Bit 0 = EPROM Checksum Bit 1 = EEPROM Checksum Bit 2 = Internal RAM Bit 3 = External RAM Bit 4 = Motor Control Bit 5 = 5-Volt Supply Bit 6 = APD Temperature Bit 7 = Air Temperature Bit 8 = Calibration Bit 9 = Threshold Bit 10 = High Voltage Bit 11 = T0 Warn Bit 12 = N/A Bit 13 = N/A Bit 14 = N/A Bit 15 = N/A					

4.2.11.1 SELF TEST RESULT FLAGS

Bit	Name	Description
0	Application Image	This test checks the CRC checksum of the application image in FLASH. A failure of this test will prevent the application code from running. (Only the Bootloader will operate if this test fails).
1	Parameters Image	Parameter Settings FLASH image Checksum. This test will fail if the parameters in FLASH are corrupted. This failure requires reloading of the parameter image for the unit from an archive. . (Only the Bootloader will operate if this test fails)
2	Internal RAM	Microprocessor Internal RAM Read/Write test.
3	External RAM	External SRAM Read/Write test.
4	Motor Control	Indicates the motor speed is out of tolerance.
5	-	Not used.
6	APD Temperature	Laser receiver APD temperature reading out of acceptable limits. Possibly defective temperature sensor.
7	Air Temperature	The window temperature sensor value is not within the acceptable limits (0.02 to 3.00 volts.)

Bit	Name	Description
8	Calibration	Indicates the laser range calibration numbers are out of acceptable limits.
9	THRESHOLD	Laser receiver threshold setting test. A failure indicates a problem in the HVC controller electronics.
10	High Voltage	Laser receiver APD High voltage gain setting out of range. A failure indicates a problem in the HVC controller electronics.
11	T0 warning	Indicates that ten percent or more range readings were less than the minimum range threshold during a three hour period..
12	-	Not used.
13	-	Not used.
14	-	Not used.
15	-	Not used.

4.2.12 Heartbeat Message

This message will be sent periodically to indicate that the system is operating nominally. The message will be sent only if no other message has been sent during the defined time interval.

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Heartbeat	Indicates Status of Sensor	Byte	1	12	N/A	N/A
Beam #0 Detection	Indicates Detection Active on Beam #2	Byte	1	0-255	N/A	N/A
Beam #1 Detection	Indicates Detection Active on Beam #1	Byte	1	0-255	N/A	N/A

4.2.13 Detection Cleared Message

This message will be sent to indicate that there currently is no vehicle currently in detection.

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Field of View Clear	Indicates all vehicles have cleared the sensor.	Byte	1	13	N/A	N/A

4.2.14 Version Report

This message is sent in response to receiving a Version Report Request message (4.2.15).

Name	Description	Type	Size	Range/ Value	Precision	Unit of Measure
Command ID	Defines this as a Version Report message.	Byte	1	29	N/A	N/A
Operating mode	Non-zero indicates the application firmware is running.	Byte	1	0-FFh	N/A	N/A
Boot Loader Firmware Major Revision	The primary version level of Boot Loader Firmware.	Byte	1	0-99	1	N/A
Boot-Loader Firmware Minor Revision	The secondary version level of the Boot Loader Firmware.	Byte	1	0-99	1	N/A
Boot-Loader Firmware Patch Revision	The patch version level of the Boot Loader Firmware.	Byte	1	0-99	1	N/A
Reserved	Boot loader development number.	Byte	1	0-255	1	N/A
Application Firmware Major Revision	The primary version level of Application Firmware.	Byte	1	0-99	1	N/A
Application Firmware Minor Revision	The secondary version level of the Application Firmware.	Byte	1	0-99	1	N/A
Application Firmware Patch Revision	The patch version level of the Application Firmware.	Byte	1	0-99	1	N/A
Reserved	Application Firmware development number.	Byte	1	0-255	1	N/A
Serial Number	The sensor serial number.	32-bit Word	1	0-FFFFFFFFh	1	N/A

4.2.15 Sensor Input Message (Commands)

The sensor accepts the following messages from the Controller via the 57.6 kbps RS-422 Interface.

Command	Message ID	Response	Description
Heart-Beat Configure/Request	12	Heart-beat message (5.1.10).	Time, in seconds, allowed to elapse with no message before a Heart-Beat report will be sent. 255 = disable. This value will only be retained until the sensor is reset. To permanently change the value, Change the setting in the FLASH Parameters.
Reset Command Block	16	Command Acknowledge (5.1.7)	Resets the unit.
Test Data Output Command	17	Test Data output (5.1.8)	Test Data Output Command
Self Test Command Block	7	Self Test Message (5.1.9)	Self Test Status Request Command
Version Request	29	Version Report (5.1.12)	Defines this as a Version Request Command.
Soft Reset Command	15	Command Acknowledge (5.1.7)	Restarts the application without running the boot-loader.

4.2.16 Heart-Beat Configure/Request

Request a heart-beat report from the sensor. Optionally enables / disables the heart-beat report until the next power or RESET event.

Name	Description	Type	Size	Range/ Value	Precision	Unit of Measure
Command ID	Defines this as a Heart – beat request Command.	Byte	1	12	N/A	N/A
Heart-beat period	Time, in seconds, allowed to elapse with no message before a Heart-Beat report will be sent. 255 = disable. This value will only be retained until the sensor is reset. To permanently change the value, Change the setting in the FLASH Parameters.	Byte	1	10 – 254, 255 = disable	1	seconds

4.2.17 Reset Command Block

This command can be sent by the off-board computer to reset the unit.

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Command ID	Defines this as a Reset command	Byte	1	16	N/A	N/A

4.2.18 Test Data Output Command Block

This command can be sent by the roadside computer to receive range and intensity data from the unit. The Test Data Output Message (4.2.9) will be sent in response to this command.

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Command ID	Defines this as a Test Data Output Command	Byte	1	17	N/A	N/A

4.2.19 Self-Test Status Command Block

This command can be sent by the roadside computer to request a self-test status from the unit. The Self-Test Message (4.2.11) will be sent in response to this command.

Name	Descriptions	Type	Size	Range/ Value	Precision	Unit of Measure
Command ID	Defines this as a Self-Test Command	Byte	1	7	N/A	N/A

4.2.20 Version Request

This message is sent to the sensor to request a Version Report message (4.2.14).

Name	Description	Type	Size	Range/ Value	Precision	Unit of Measure
Command ID	Defines this as a Version Request Command.	Byte	1	13	N/A	N/A

4.2.21 Soft Reset

The Soft Reset command causes the sensor to reload and initialize the Application. This differs from the Reset command (0x10) by bypassing the Boot Loader mode. The sensor responds with the Command Acknowledge Response message.

Name	Description	Type	Size	Range/ Value	Precision	Unit of Measure
Command ID	Defines this as a Soft Reset Command message.	Byte	1	15	N/A	N/A

4.2.22 Communications Check

This command used to test communication with sensor. It requests a simulated detection event sequence from the sensor. The sensor responds with a 5 message sequence (msg 1,2,3,4 & 5) simulating a vehicle detection. Also the trigger outputs are inverted for 0.5 seconds.

Name	Description	Type	Size	Range/ Value	Precision	Unit of Measure
Command ID	Defines this as a Communications Check Command message.	Byte	1	21	N/A	N/A

SECTION 5: TROUBLESHOOTING THE AUTOSENSE™

a. **PROBLEM:** AutoSense™ does not power-up.

CORRECTIVE ACTIONS

1. Ensure the main power cable is properly plugged into the power in receptacle and into the facility outlet with appropriate power available. Refer to paragraph 2.3 for input power requirements.
2. Ensure the main power supply is on.
3. Should the problem still exist, go to paragraph 6.2.

b. **PROBLEM:** AutoSense™ does not function.

CORRECTIVE ACTIONS

1. Check the power to the sensor and ensure that normal current is drawn. Refer to paragraph 2.3 for input power requirements.
2. Confirm that the sensor is mounted at least 4.00 Feet (1.2 Meters) from any surface.
4. Refer to Software User's Manual to run the Communication Self-check and view the range and signal strength.
5. In the event that these tests fail to remedy the fault, it is recommended that the unit be returned to the supplier or OSI LaserScan. (Go to paragraph 6.2.)

c. **PROBLEM:** AutoSense™ messages indicate that vehicle speed and length are always "0".

CORRECTIVE ACTIONS

1. Confirm that AutoSense™ is mounted so that the 1st beam intercepts the vehicle before the 2nd beam.

SECTION 6: MAINTENANCE OF THE AUTOSENSE™

CAUTION

DO NOT ATTEMPT TO OPEN THE AUTOSENSE™ HOUSING! The AutoSense™ housing is nitrogen purged and hermetically sealed prior to shipping, and should only be opened in a laboratory environment by OSI personnel. All of the screws in the main housing are seal screws and should not be loosened. All calibration and internal alignment adjustments are set during final test, and no field adjustments are required. Opening the housing could damage the unit and will void the warranty. Exposure to Class III Laser Radiation is possible when enclosure cover is removed.

6.1 PREVENTIVE MAINTENANCE

The AutoSense™ is designed to require very little maintenance. The only maintenance requirement for the AutoSense™ is keeping the window clean. When the window becomes dirty, range errors may occur. The window should be cleaned with optical lens tissue to avoid possible scratches and damaging the window. This should be done at intervals of approximately six months, or as conditions require.

6.2 CORRECTIVE MAINTENANCE

There is no authorized repair or service of the AutoSense™ by the user/operator. Should the AutoSense™ need service or repair, contact OSI per the contact information provided on page ii of this User's Guide. Any unauthorized repairs performed on the AutoSense™ will void the equipment warranty.

For all repairs and services, contact OSI per the contact information provided on page i of this User's Guide. Obtain a Return Material Authorization (RMA) number and directions for shipping the AutoSense™.

6.2.1 Packing the AutoSense™ for Shipment.

Pack the AutoSense™ in a suitable shipping container along with a brief description of the problem and the RMA number. DO NOT pack any accessories unless instructed to do so by your OSI service representative.

Be sure the AutoSense™ is surrounded on all sides by 2 to 3 inches (50 to 75 mm) of packing material and is restrained from movement. The unit contains sensitive optical and electrical components which may be damaged by rough handling.

Label and ship the unit per the instructions of your OSI representative. Be sure the RMA number is displayed on the outside.

6.3 PERIODIC OVERHAUL MAINTENANCE

After significant use, the AutoSense™ will require overhaul maintenance by qualified OSI-authorized maintenance technicians. Recommended time between overhauls is tied to the Mean Time Between Failures and is currently 4 years. To schedule overhaul maintenance of the AutoSense™, contact OSI per the contact information provided on page iii of this User's Guide. The *AutoSense* and its associated parts and accessories are listed in Table 6.1 below.

	Description	Part Number (as required per input voltage of unit)	
		120VAC	**240VAC**
1.	AutoSense, 120VAC	AS825-120-422	
2.	AutoSense, 240VAC		AS825-240-422
3.	Power Cable Assembly	9291011-xxx xxx = length in feet	9291111-xxx xxx = length in feet
4.	Communications Cable Assembly	9291110-xxx xxx = length in feet	9291110-xxx xxx = length in feet
5.	RS-422 to USB Converter	Sealevel 2106	Sealevel 2106
6.	Beam Finder	9301000-9	9301000-9
7.	Start-up Kit CD Rom ▪ User's Manual ▪ Software ▪ Warranty Certificate	19471024-9 ▪ 19479200 ▪ 19479601 ▪ 19479201	19471024-9 ▪ 19479200 ▪ 19479601 ▪ 19479201
8.	Mounting Kit ▪ Mounting plate ▪ Mounting hardware and tools	194xxxxx ▪ 19406122-1 19471023-9	194xxxxx ▪ 19406122-1 19471023-9
9.	Power Connector	PW06P-12-3S	PW06P-12-3SY
10.	Communications Connector	PW06P-14-19S	PW06P-14-19S
11.	RS422 High Speed Comm Board	Sealevel 7205S-20.0000	

TABLE 6-1: *AutoSense™* Parts List

APPENDIX A - SPECIFICATIONS

The following specifications are subject to change without notice:

A.1 Performance

Vehicle Detection Accuracy	>99.9% (one vehicle in field-of-view)
Vehicle Classification Categories	Motorcycle, Motorcycle + trailer, Car, Car + trailer, Pickup/Van/Sport Utility, Pickup + trailer, Single Unit Truck/Bus, Single Unit Truck/Bus + trailer, Tractor + 1 trailer, Tractor + 2 trailers, Tractor + 3 trailers
Vehicle Classification Accuracy	>95% (into 6 vehicle classes)
Vehicle Spacing Resolution	4 feet at 125 mph (1.2 m at 200 kph) 2 feet at 62 mph (0.6 m at 100 kph) 1.5 feet at 10 mph (.35m @ 18.2 kph)
Trailer Tow Bar Detection	>2 inches wide, >2 feet long up to 125 mph (>5 cm wide, >60 cm long up to 200 kph)
Side-by-Side Vehicle Spacing	3 degrees minimum between vehicles
End-of-Vehicle Detection Signal	~1 foot (0.3 M) after vehicle exits 2nd beam
Minimum Height Detection	2 feet (0.6 m)
Lane Width Coverage	24 feet at 23 feet mounting height (7.3 m at 7 m)
Maximum Mounting Height	32.8 feet (10 meters)
Minimum Mounting Height	19.7 feet (6 meters)
Vehicle Height Accuracy	± 3 inches (± 76 mm)
Vehicle Speed Accuracy	± 10%

A.2 Physical

Power Input	240V, 50-60 Hz, 3.5A or 120V, 50-60 Hz, 2.0A
Power Consumption	40 watts nominal, 160 watts maximum (motor startup and heaters on)
Dimensions	17.9 x 13.5 x 6.1 inches (Length x Width x Height) (45.5 x 34.3 x 15.5 cm)
Weight	30 pounds (13.6 Kg)

A.3 Laser Output

Wavelength	904 nm

Pulse Width (MAX)	9 nanoseconds
Energy per pulse (MAX)	60 nanojoules

A.4 Data Interface

RS-422 or RS-232 Serial	19.2, 38.4, 57.6 Kbps (User selectable) 8 data bits, 1 start, 1 stop, no parity

A.5 Environmental

Temperature	-40 to +160 degrees F (with sun loading)
Thermal Shock	60 degrees F/minute
Humidity	0 to 100% condensing
Rain	0.8 inches/hour (20 mm/hour) operating 4 inches/hour (100 mm/hour) maximum
Snow Loading	20 lb./ft2 (98 Kg/m2)
Ice Loading	Accumulation to 0.6 inches (15 mm)
Wind Loading	43 knots steady, 73 knots gusts
Dust	1g/m3 with particles 10-100 micrometer diameter
Vibration	5 to 30 Hz, 0.5 G for 3 minutes in each axis
Shock	10 G in each axis
Electrostatic Discharge	2,000 volts
Reliability	>26,000 hours (Mean Time Between Failures)
Maintainability	15 minutes (Mean Time To Replace)
IP Rating	IPx4 Per IEC60950-22 2005 Version
Certifications	CE Mark, UL, CSA, CB Scheme

APPENDIX B

B.1 High-Speed RS422 Interface

This table shows cable wiring from the sensor to a 1.25 Mbps high-speed communications card using a DB25 connector.

P1 (JST PHR-10)	**Function**	**Wire Color** (Belden 9807)	**Sensor Data Plug** (PW06P12-10S)	RS530 (DB25 Female)
1	RS232 Gnd	Black	A	
2	Unused	Red	K	
3	**RS422 TX+**	**White**	**B**	**16**
4	**RS422 TX-**	**Black**	**C**	**3**
5	**RS422 RX-**	**Black**	**G**	**2**
6	**RS422 RX+**	**Green**	**F**	**14**
7	Unused	Blue	H	
8	Unused	Black	J	
9	Unused	Black	E	
10	Cable Shield	Yellow	D	

Notes

(1) The data cable is paired and has twisted conductors (1 and 2, 3 and 4, etc. per P1)
(2) Only two pairs (RS422 TX and RX) are used.

APPENDIX C – AUTOSENSE™ QUICK START GUIDE TO OPERATION

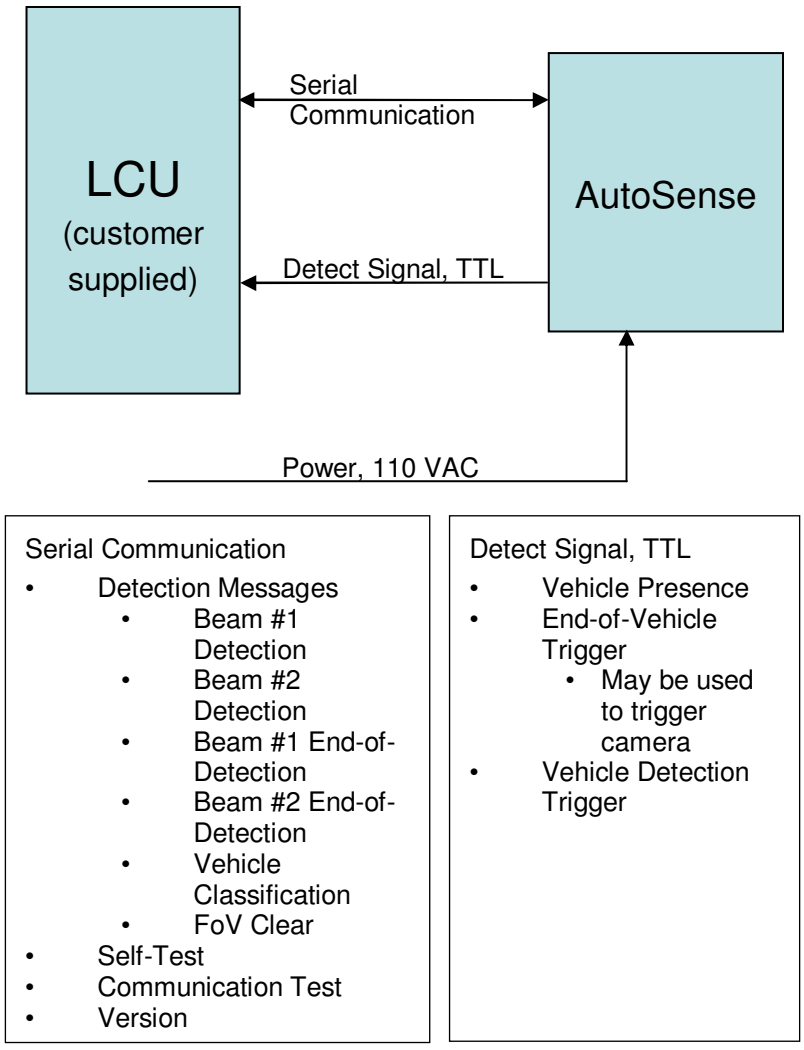


Figure C.1 AutoSense™ Interface

C.0 AutoSense Test Software

The AsMgr2.exe program, supplied with each sensor via "AsMgr2 Installer.msi", is used to verify the operation of the AutoSense™. This software, which runs on a computer running Windows 2000 or XP Pro, is used to control AutoSense™ and to display message data in the standard operating mode. The standard operating mode outputs a series of 5 messages for each vehicle detected. The messages are sent via RS-422 or RS-232 serial interface at a rate of 57.6 Kbps.

C.1 Getting Started

Mount the AutoSense™ as shown in Figure 2.1 such that the distance from the front of the sensor to any other objects within the 60 degree field of view, is at least 1.3 meters (~4 feet).

Now apply power to the AutoSense™. The Green will flash while the Boot-loader checks the application image and parameters. After 15 seconds the boot-loader will load and start the application software.

While the application software initializes the system and waits for the motor to spin up, the RED and GREEN LED's will flash alternately. This may take up to 120 seconds at cold temperatures.

At the end of the initialization period the Green LED will remain on and the RED LED will remain off indicating road calibration.

Once road calibration is complete the RED LED will turn ON and remain ON unless a system fault is detected. The GREEN LED will turn OFF when a vehicle is detected.

In cold environments, heaters are turned on prior to initialization. In these circumstances, initialization can take up to 30 minutes. The following sequence of events will occur within this time period. After power is applied to the unit, if the temperature is below 15 degree C, the onboard heaters will be activated. Power to the processor is removed if the ambient temperature is below 0 degrees C. Once the temperature reaches 0 degrees C and the processor is active, the heated window is turned on and the system waits until the ambient temperature reaches 10 degrees C or 10 minutes has passed, whichever comes first. This allows for the window to clear before the unit begins scanning. Once the system is active the normal startup sequence is followed.

Now run the AsMgr2.EXE. (For extended information on AsMgr2, see "AsMgr2_User Guide.doc".) Select the Configure Software option from the Setup Menu. Select the serial communication port that the AutoSense is connected to on the PC. Select the device model (AS815 or AS825).

After the correct serial port and device model are selected, press the **Save &Exit** button so that the software will always default to the correct serial port where the AutoSense™ is connected.

The default data rate is fixed at 57.6 Kbps. However, other data rates are supported.

The **Configure Software** menu also provides the user with the option of saving all of the data to an ASCII text file. The file name field is large enough to allow the data to be redirected to another drive. For automatically opening a new log file each day, enter the directory path for the data file in the "**Data Path:**" entry. In this case the filename will be **ACyyyymmdd.txt**, where "yyyymmdd" is the current date.

After making changes, press the **Save & Exit** button so that the software will always use the selected settings.

C.1.1 What You Should See

The AutoSense™ will send a power-on message approximately 45 - 60 seconds after the unit is powered on. The power-on message will contain the self test results, firmware version number, and the measured range to the road for each sample in both beams. If the road reference point for the AutoSense™ is not found initially, the power-on message may be delayed up to 2 minutes as the unit continually self calibrates.

At the bottom of the screen there are function buttons. The operation of these buttons is described below.

C.1.2 Reset

Sends a Reset command to the AutoSense™. The AutoSense™ should respond with a Command Accepted message. After 45 - 60 seconds, the unit will send a Power-On message.

C.1.3 Test Data

Sends a Test Data Output command. The response will include the range and intensity data for 30 samples in both beams. The top section of the response will show the range data (displayed in feet) for the second beam. The next section shows the corresponding intensity data for the second beam. The numbers will be in the range of 0 to 127. The next two sections are the range and intensity for the first beam.

C.1.4 Self Test

Sends a Self Test Status Command to the AutoSense™. The response will include a pass / fail status for each test.

C.1.5 Comm Check

Runs a communication self check to test that the serial port, cables, 422-232 Converter, and the AutoSense™ are all configured properly. When the button is pressed, the following message will be displayed in yellow “Send Communication Check Command”. If everything is working correctly, the AutoSense™ will respond with a sample set of the 5 vehicle detection messages that it sends for each vehicle. These detection messages will immediately be displayed on the screen. If no messages are displayed, then all components of the communication interface will have to be verified before proceeding any further.

C.1.6 Version Info

Sends a Version Info command to the Sensor. The response will include the Boot Loader Version, the Application Version, and the Sensor’s Serial Number from the Sensor.

C.1.7 Diagnostics

Sends a System Status command to the Sensor. The Response will include the Application Version, the Sensor’s Serial Number and diagnostic configuration settings.

C.2 Testing with Vehicles

The AutoSense™ will transmit as many as 5 messages for each vehicle that is detected within its field of view. In normal circumstances, each message and the order in which it is transmitted is listed below.

#1 First Beam Vehicle Detection Message
#2 Second Beam Vehicle Detection Message
#3 First Beam End of Vehicle Message
#4 Second Beam End of Vehicle Message
#5 Vehicle Classification (Axle Count) Message

Please refer to Section 4.0 for details on the information contained within each message.

C.3 AutoSense LED Indicators

C.3.1 Message Mode

C.3.1.1 Power Up

On initial power-up the RED and GREEN LEDs are both turned off.

C.3.1.1.1 Boot-loader

The boot-loader indicates that a valid application image and parameters were found by flashing the GREEN LED continuously.

C.3.1.1.2 System Initialization and Motor spin-up

After a 15 second delay for boot-loading the RED and GREEN indicators blink alternately for up to 120 seconds to indicate application initialization and motor spin-up.

C.3.1.1.3 Initial Road Calibration

During initial road calibration the GREEN LED is turned ON and the RED LED is turned OFF. The RED LED is turned on when calibration is completed. This can be from a couple of seconds up to a couple of minutes.

C.3.1.2 Normal Operation

The RED LED remains ON during normal operation.

The GREEN LED indicates vehicle presence, as defined below.

C.3.1.3 Detection Idle

Used when no vehicle is detected in beam 2. Both LEDs remain ON.

C.3.1.3.1 Vehicle Present

GREEN LED turns OFF when a vehicle is detected in beam 2.

C.3.1.3.2 End-of-Vehicle

GREEN LED turns ON when an end-of-vehicle is detected in beam 2.

C.3.1.4 System Check

When the "Comm Check" command is processed the GREEN LED is inverted for ½ second.

C.3.1.5 Error Conditions

A flashing RED LED indicates error conditions.

C.3.1.5.1 Power-up (Boot Mode)

C.3.1.5.1.1 Invalid application or parameters

Red LED flashes steadily.

C.3.1.5.2 Operating (Application running)

C.3.1.5.2.1 Non-critical System failure

A non-critical failure condition may affect the performance of the system. It is indicated by the RED LED flashing once every 2 seconds

C.3.1.5.2.2 Critical System Failure

If a critical system failure occurs, which prevents the system from operating properly, the RED LED will flash 4 times every 2 seconds.

C.3.2 LED Indications Tables

Mode	Step	LED			Indication	Description
		POWER	GREEN	RED		
Power Up		ON	OFF	OFF		Initial power-up
Boot Loader	Running Self-Test	ON	FLASH	OFF	Self-Test OK	Self-test is running and passed so far.
			OFF	FLASH	Self-Test Failure	A failure has been detected during Self-Test. System will not be initialized (remains in boot loader interface).
	Boot loader Interface mode.	ON			System OK	
				FLASH	Self-Test Failure	The system failed the boot-loader Self-Test.
System Initialization	Init	ON	ALTERNATING			System is initializing. Waiting for system to stabilize and motor to spin-up.
	Road Calibration		ON	OFF	Road Cal Active	The initial road calibration is being performed.
Normal Operation	Detection Idle	ON	ON	ON		No vehicle detected in 0º beam.
	0º Detect	ON	OFF		Vehicle Detection	Vehicle detected in 0º beam.
	0º End-of-Detect	ON	ON		End-of-Vehicle	Vehicle exited 0º beam.
System Test	Comm-Check	ON	OFF ½ second	ON	Comm check	When a "Comm Check" command is received the GREEN indicator switches for ½ second. The Logic-Level Detect signal is also switched at the same time.

Error Conditions	Non-Critical	ON	No change	1 FLASH every 2 seconds	Non-Critical Failure	A non-critical failure has been detected. The condition may affect performance of the system but does not prevent it from running.
	Critical	ON	TBD	4 FLASHES every 2 seconds.	Critical Failure	A critical failure has been detected. The condition prevents the system from functioning properly.

C.4 AutoSense – Message Mode LL_DET Signal

C.4.1 Purpose

This section explains the function of the LL_DET (Trigger) signal of the AutoSense™ (AC).

C.4.2 Application

The LL_DET mode selected has no effect on the vehicle detection and classification operation of the AutoSense.

C.4.3 Interface

The LL_DET signal is an active low TTL level signal located on pin K of the communications interface connector of the AutoSense. This signal is referenced to the ground pin (pin A) of the communications interface connector.

C.4.4 Function

The LL_DET signal activates to indicate a detection event. The event which activates the signal is selected by configuration parameters contained within the system EEPROM parameters. The event can be End-of-Vehicle Trigger, Vehicle Detection Trigger or Vehicle Presence.

The LL_DET mode selected has no effect on the vehicle detection and classification operation of the AutoSense.

C.4.4.1 Trigger Mode

In Trigger Mode the LL_DET signal pulses low for one microsecond. The trigger can be configured to occur either at the end-of-vehicle (trailing) or at vehicle detection (leading).

C.4.4.1.1 End-of-Vehicle Trigger

For End-of-Vehicle Trigger mode the LL_DET pulse occurs when the end-of-vehicle is detected on the second beam. This pulse occurs just prior to message 4 being sent. The end-of-vehicle occurs approximately one foot after the vehicle exits the second beam.

C.4.4.1.2 Detection Trigger

For Detection Trigger mode the LL_DET pulse occurs when a vehicle is detected on the first beam. This pulse occurs just prior to message 1 being sent. The vehicle detection occurs when a vehicle is detected in the first beam for 8 consecutive scans.

When Detection Trigger mode is selected the first beam detection message (message 1), second beam detection message (message 2) and end-of-vehicle message (message 3)

contain two extra bytes. Message 1 defines the left and right edges of the vehicle at detection. Messages 2 and 3 define the range to the left and right edges of the vehicle.

C.4.4.2 Presence Mode

For Presence mode the LL_DET signal goes active (low) when a vehicle is detected in the second beam. It goes inactive (high) when the vehicle is no longer detected in the second beam. The active edge corresponds with message 2, while the inactive edge corresponds to message 4.

C.4.4.3 Summary

Mode	Signal Type	Signal Activation	Signal De-Activation	Multi-Vehicle Behavior
End-of-Vehicle (Trialing)	1µs Pulse	2nd beam end-of-detection.	N/A	A pulse for each vehicle.
Detection (Leading Edge)	1µs Pulse	1st beam vehicle detection	N/A	A pulse for each vehicle.
Presence	Active low	2nd beam vehicle detection	2nd beam end-of-detection.	The presence signal tracks the first vehicle.

C.4.5 Vehicle Detection Criteria

The vehicle detection criteria explain the thresholds used by the AutoSense™ to determine vehicle detection and end-of-vehicle detection. **These criteria are completely independent of the LL_DET mode of operation.** This information is included in this document for completeness only.

C.4.5.1 Vehicle Detection

Vehicle detection occurs for a beam (1st or 2nd) if an object is detected for 8 consecutive scan lines. Scan lines occur at a rate of 180 per second for each beam. The table below shows the distance the vehicle travels from when it breaks a beam until it is detected.

Speed (mph)	Speed (fps)	Detection Distance (feet)	Detection Time (ms)
20	29.3	0.64	22.2
30	44.0	0.98	22.2
45	66.0	1.47	22.2
60	88.0	1.95	22.2
80	117.3	2.60	22.2
120	176.0	3.91	22.2

C.4.5.2 End-of-Vehicle

End-of-Vehicle detection for each beam (1st of 2nd) is speed dependent and is calculated to occur one foot beyond the last detection. The table below shows the number of scans and time for end-of-vehicle determination at different speeds.

Speed (mph)	EoV Scans == 1 foot	Time (ms)
Minimum	120	333
20	12	33
30	8	22
45	5	14
60	4	11
80	3	8
120	2	6
Maximum	2	6

C.4.6 Trigger Mode Configuration

The Selection of Trigger mode between Detection (Leading Edge) or End-of-Vehicle (Trailing Edge) is performed at the factory at production time. It is currently not field changeable.

C.4.7 Troubleshooting

C.4.7.1 Weather Related

In inclement weather conditions (heavy rain, fog or snow) or when the road surface under the sensor is very wet (pooling water) the LL_DET signal may fail to pulse at the end of the vehicle. In Detection mode the signal may remain active (low). This can be verified by observing the message data and observing whether or not the corresponding message (message 4) is occurring.

C.4.7.2 Slow Vehicles (Barrier Lane)

When a vehicle is moving very slowly (less than 20mph) under the sensor, multiple detection messages may occur as the vehicle passes through the beams. This may result in additional trigger pulses in Trigger mode or early deactivation of the presence signal in Presence mode.

C.5 Software Application Installation Procedure (Using AsMgr2)

C.5.1 Equipment Required

1. Windows Computer with a USB interface or one available Serial Communications port (COM1 thru COM9).
2. AutoSense Manager 2 application (AsMgr2).
3. AutoSense application (supplied by OSI LaserScan).
4. RS422 to USB converter, Sealevel 2106. (May use other equivalent 422 to USB or 422 to 232 converter capable of 57,600 bit-per-second data rate).
5. AutoSense™ Communications Cable (P/N 9291010-xxx).
6. AutoSense™ Power Cable (P/N 9291011-xxx).

7. PC Serial Interface Cable, DB25M to DB25F (or DB9F).

C.5.2 Setup

1. Connect the Sealevel 2106 converter to the AS8xx device (AS815 or AS825) comm cable as shown below.
2. Connect a 25-pin Serial communications cable from the Sealevel 2106 to a USB port on the PC or from the 422 to 232 converter to the COM port on the PC. (A 25-pin to 9-pin adapter may be required depending upon the adapter.)
3. Power up the computer.
4. Power up the AutoSense™ unit.
5. Start AsMgr2.exe.
6. Select the Setup->"Configure Software" menu item.
7. Select the device model.
8. Select the COM port to which the AS8xx device is connected.
9. Select the "Baud Rate" menu item. Select the baud rate the AS8xx device is configured for (default is **57.6**).
10. Press the "Save and Exit" to save the configuration.

C.5.3 Application Installation

1. Create a directory and copy the AS8xx (.ldr) file supplied by OSI LaserScan to the directory.
2. Select the **Boot Loader -> Write App** menu item. Select the application from the location from step 1.
3. When the application has been written, select the **Boot Loader-> Valid Prog Test** menu item. The response should be **"Valid Program Test: OK"**.
4. Press the **"Self Test"** button and verify that the **"Application"** test is **"OK"**.
5. Select the **Boot Loader -> Run Application** menu item. Wait for the Power up message to be displayed and the version number is correct.
6. The new Application is now installed.

APPENDIX D - INSTRUCTIONS FOR HIGH SPEED DATA COLLECTION

The AutoSense 800 Series sensor is capable of transmitting both low speed and high speed data simultaneously. The low speed data interface is typically transmitted via the RS422 or RS232 interface. The high speed data is transmitted at 1.25Mbs over a dedicated RS422 interface using a 20 MHz crystal. In order to access this information, the AutoSense unit must be connected to a computer running the AutoSense Manager high speed capture software. This appendix provides an overview of setting up the high speed data capture system.

D.1 Overview

In order to establish the high speed data capture, the AutoSense 800 will need to be interfaced to a Windows based PC running the AutoSense Manager software program. In addition, there is several required hardware elements listed in Table D-1 below.

Manufacturer	Part Number	Quantity	Description	Comments
Any	-	1	≥1GHz Windows 2000 or XP Pro machine with 128MB (256MB for XP) ram.	≥ 2.6 GHz Pentium 4 for connection to 2 sensors.
Iomega www.iomega.com	REV 35GB/90GB ATAPI drive	1	Iomega REV drive, Internal, ATAPI.	Uses removable cartridges for data collection
SeaLevel Systems www.sealevel.com	7205S-20.0000	1	Dual channel high speed RS422 serial communications card with 20.0 MHz oscillator.	One channel for message data. One channel high-speed data.
SeaLevel Systems	KT106	1	Dual DB9 to 18 Screw Terminal and 2 – 72inch DB9 cable.	Use if AutoSense data cables are not terminated.
SeaLevel Systems	CA176	2	DB9 to RS530 Adapter cable, 12inch	Use if AutoSense data cables are terminated with 25-pin D connector
OSI LaserScan	19471010 – XX	1	AutoSense Communications Cable (XX – denotes length)	

Table D- 1. Hardware required for setup High Speed Data Capture

D.2 Setup and Configuration

D.2.1 Installation and setup of SeaLevel RS-422 Multi-Port high-speed serial card

1. Install the SeaCom Software **BEFORE installing the card!**
2. Set Switches J1A & J2A as follows:

P	P	T	L	L
Connect	Connect	Connect	No Connect	No Connect

3. Set Switches J1B & J2B as follows:

AT	RT	NE
No Connect	No Connect	No Connect

4. Install the card in a PCI slot.
5. Connect the 25-pin to dual 9-pin adapter cable (P/N CA-203) to the back of the card.
6. Start computer.
7. Install the driver:
   a. When Found New Hardware Wizard appears select “Next”.
   b. Select “Search for a suitable driver” and press “Next”.
   c. Deselect all options and press “Next”. Press “Next” again.
   d. Respond “Yes” to the “Digital Signature not found” message.
   e. Several “new device found” messages will be displayed.
8. Configure the ports:
   a. Start “Device Manager” and click on “Ports (COM & LPT)”
   b. Right-click on “ULTRA COMM+2.LPCI: PCI 2 port RS-232/422/485 (Port1) (COMn)” and select “Properties”.
   c. Select “Port Settings” tab, select the “Advanced” button. Set the “COM Port Number” to “COM5”.
   d. Select the “Advanced” tab:
   e. Make sure “FIFO Enabled” is selected.
   f. Select “Suppress Modem Control”.
   g. Set “Trigger Level” 64 Receive FIFO and 64 Transmit FIFO.
   h. Set “Oscillator Options” to “20000000”. (20Mhz).
   i. Press the “OK” button.
   j. Repeat steps b through i for Port 2, selecting “COM6” at step c.
   k. Exit Device manager.

D.2.2 Installation and Setup of AutoSense Manager high-speed capture application

1. Use Control Panel->Add/Remove Programs to remove AutoSense Manager application.
2. Install the new Autosense Manager application (dated 8/11/2004 or later).
3. Start “AutoSense Manager” and select the proper device (AS615).
4. From the main menu select “Configuration”->”High-Speed Comm” and select the COM port for the first system (default would be COM5) then close the dialog.
5. Select the “View or Record High Speed Data” menu item.
6. Select the “Advanced” button in the “HighSpeedData” window.

7. In the “Saved File Directory” box enter a unique path for this channel (i.e. “d:\as2dat\leftlane\”). Then press the “Accept” button.
8. Repeat steps 3 through 7 for the other com port (COM6). In step 7, use a different path than for the other COM port (i.e. “d:\as2dat\rightlane\”).
9. Each high speed application will now save to the directory associated with that COM port.

D.2.3 Communication Port pin assignment cross reference

AutoSense™ RS422 to Communications Adapter pin assignments.

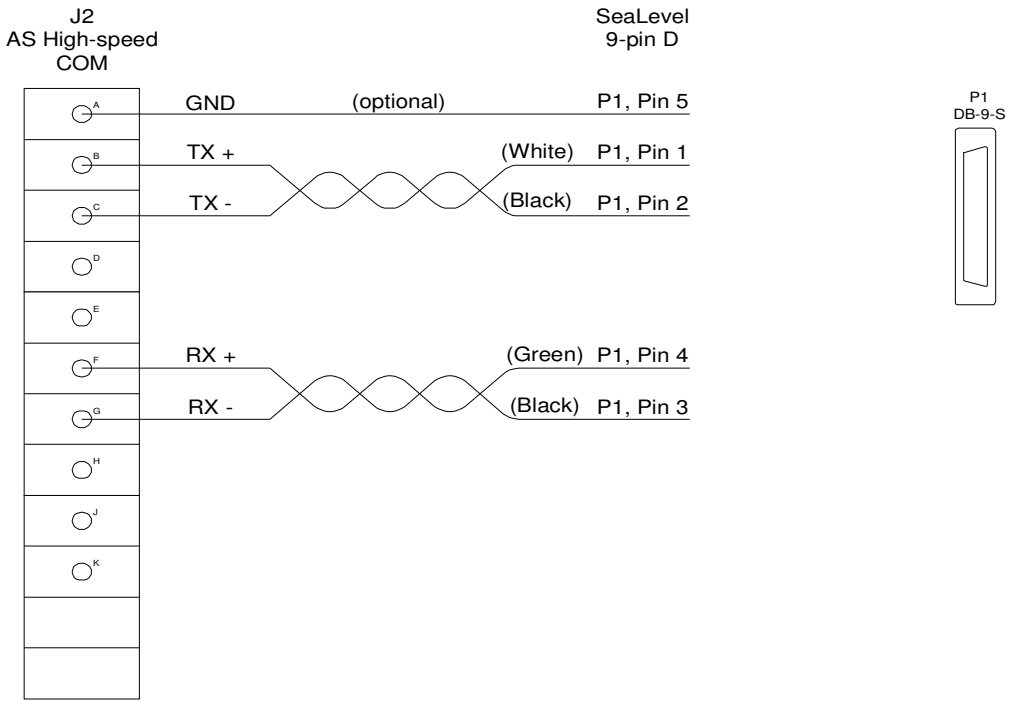
(Signal names are from AutoSense™)

Signal	**AutoSense Connector** (PW06P12-10S)	**RS530 / SeaLevel 25-pin D**	**SeaLevel 9-pin D**	**FastCom 9-pin D**
TX+	B (white)	16	1	8
TX-	C (black)	3	2	9
RX+	F (green)	14	4	4
RX-	G (black)	2	3	5
GND	A	7	5	1

NOTES

- B and C is a twisted pair.
- F and G is a twisted pair.
- GND is optional.

AS6xx, AS7xx Communications interface Test Cable, Rs422 mode, SeaLevel 9-pin



APPENDIX E - NOMINAL INSTALLATION INFORMATION

As was previously described in Section 3.0, the AutoSense™ 800 is intended to be mounted between 6 and 10 meters (19.5 and 32.8 feet), centered above the traffic lane. The maximum recommended mounting height is 10 meters (32.8 feet). If the recommended minimum mounting height cannot be achieved, please contact OSI for additional information on mounting options.

To ensure optimal performance of the unit, it is imperative that when determining the overhead mounting location, the respective field of view for the AutoSense™ 800 unit is free of any non-stationary objects, such as cables, flags, banners, moving gate arms, etc.. This is imperative because the AutoSense™ 800 unit will detect the movement of the objects if the movement occurs within the detection zone beneath the unit and generate associated detection messages.

E.1 Overhead Mounting and Look Down Angle

When installing the AutoSense™ 800 it is recommended that the Mounting Plate, when affixed to the appropriate support element, be canted with a 5 degree forward tilt as shown in FIGURE E-1. This will ensure that the two laser beams emitted by the AutoSense™ 800 unit are at the specified angle to the road, 10 degrees and 0 degrees respectively.

E.2 Beam Separation and Lane Coverage versus Mounting Height.

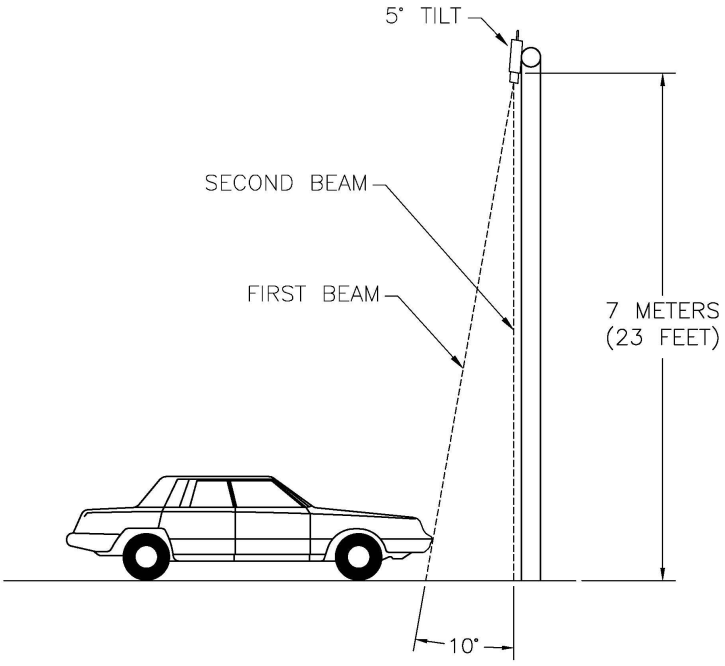
The AutoSense™ 800 will meet coverage specifications when mounting height is as shown on Table E-1.

E.3 Vehicle Separation versus Speed

The AutoSense™ 800 is designed to detect, separate and classify vehicles that pass within the detection zone beneath the sensor. Detection and subsequent separation of the successive vehicles is dependent on the speed with which the vehicles are traveling. Graph E-1 below defines the required separation distance between vehicles at various speeds.

E.4 Typical AutoSense™ 800 Installation

To facilitate the initial design and installation of the AutoSense™ 800 units, please refer to Figures E-2 and E-3. These figures are intended to serve as a reference only, as variability's in toll plaza designs exist.



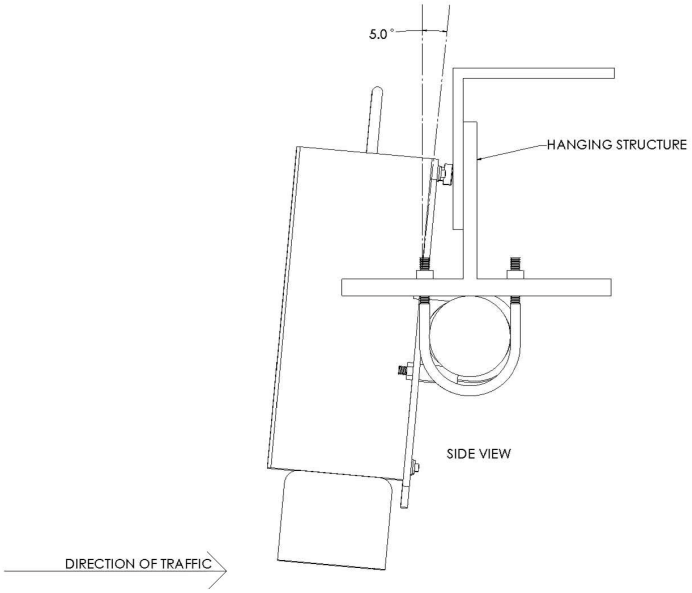
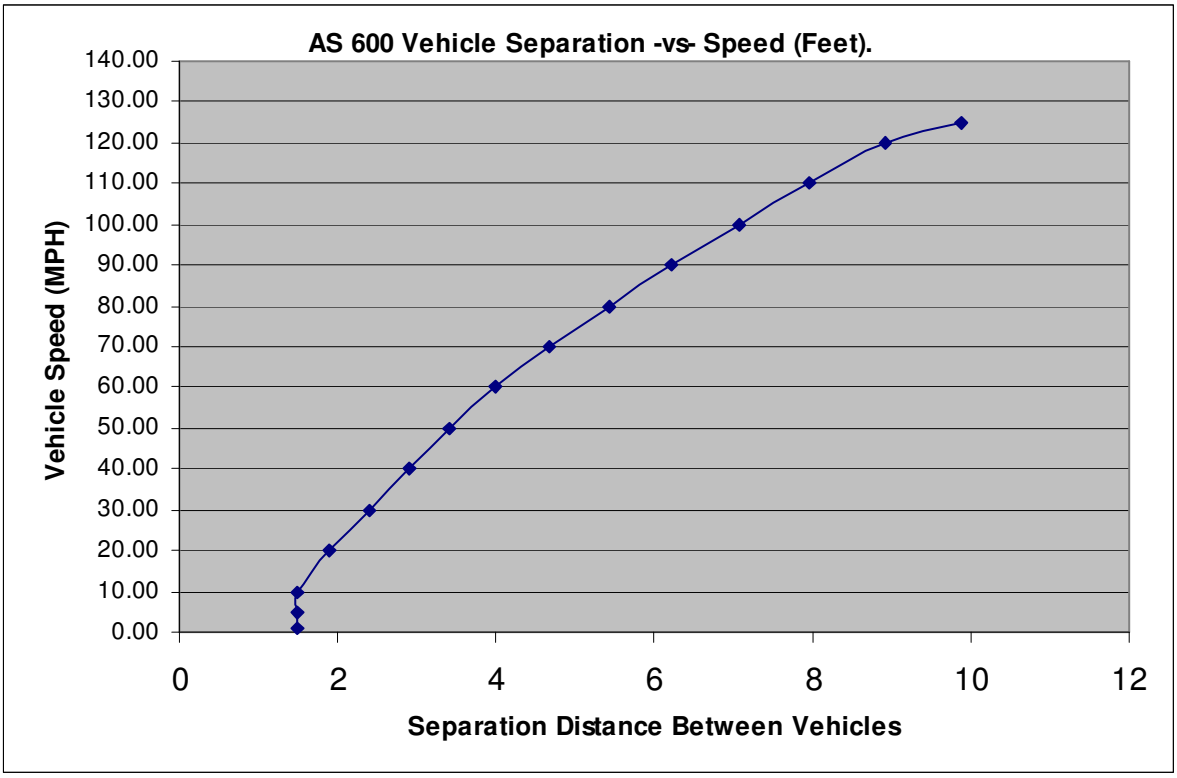


Figure E-1. Overhead Mounting and Look Down Angle

AutoSense 800 - 0 & 10 deg. Beam separation, Lane coverage and Beam coverage area: Unit angled 5° Into traffic				
Mount Height (m)	**Mount Height (ft)**	**0 & 10 deg. beam seperation distance (ft)**	**Horizontal beam width (ft.)**	**Beam coverage area (Sq. ft.)**
7.01	23.00	4.06	26.56	107.71
7.09	23.25	4.10	26.85	110.06
7.16	23.50	4.14	27.14	112.44
7.24	23.75	4.19	27.42	114.85
7.32	24.00	4.23	27.71	117.28
7.39	24.25	4.28	28.00	119.73
7.47	24.50	4.32	28.29	122.21
7.54	24.75	4.36	28.58	124.72
7.62	25.00	4.41	28.87	127.25
7.70	25.25	4.45	29.16	129.81
7.77	25.50	4.50	29.44	132.39
7.85	25.75	4.54	29.73	135.00
7.92	26.00	4.58	30.02	137.64
8.00	26.25	4.63	30.31	140.30
8.08	26.50	4.67	30.60	142.98
8.15	26.75	4.72	30.89	145.69
8.23	27.00	4.76	31.18	148.43
8.31	27.25	4.80	31.47	151.19
8.38	27.50	4.85	31.75	153.98
8.46	27.75	4.89	32.04	156.79
8.53	28.00	4.94	32.33	159.63
8.61	28.25	4.98	32.62	162.49
8.69	28.50	5.03	32.91	165.38
8.76	28.75	5.07	33.20	168.29
8.84	29.00	5.11	33.49	171.23
8.92	29.25	5.16	33.77	174.20
8.99	29.50	5.20	34.06	177.19
9.07	29.75	5.25	34.35	180.20
9.14	30.00	5.29	34.64	183.24
9.22	30.25	5.33	34.93	186.31
9.30	30.50	5.38	35.22	189.40
9.37	30.75	5.42	35.51	192.52
9.45	31.00	5.47	35.80	195.66
9.53	31.25	5.51	36.08	198.83
9.60	31.50	5.55	36.37	202.03

Table E-1. AS8xx 0° to 10° Beam Separation & Lane Coverage: Unit Angled 5° into Traffic

To achieve vehicle separation, the AutoSense unit needs a maximum of 48 laser scans (at 5 MPH) and a minimum of 2 laser scans (at 120mph) on the road surface to separate vehicles. Graph E-1 below presents the intervehicle spacing required for vehicles traveling between 5 MPH and 125 MPH.



Graph E-1. Vehicle Separation Versus Speed

APPENDIX F - ROAD AUGMENTATION FOR REFLECTIVITY

F.1 Purpose

The AutoSense™ products utilize an eye-safe laser to detect and classify vehicles. In order for the AutoSense™ unit to function properly, the unit must be able to detect a "receive" laser pulse from either an object (i.e., car) or the road. Since many road surfaces do not provide a consistent reflective pattern for the laser, augmentation of the surface may be required in order to ensure adequate reflectivity for the laser.

Road reflectivity is best on "clean" concrete road surfaces and worse on newly installed black asphalt. Over time, the dark non-reflective surface of black asphalt will fade, thereby improving reflectivity, however, until such time, the performance of the AutoSense™ will be impaired. To minimize the impact of poor road reflectivity, OSI LaserScan recommends that an application of either, Thermaplastic, Duraset or System 400 Cold Plastic or Hot Tape in the color specified below be applied to the road surface where the AutoSense™ laser strikes the road.

F.2 Location of Stripe(s)

One or two stripes can be used. The goal is to apply the road striping where the laser beam contacts the road.

The distance between the beams on the road is based on the mounting height and the 10 degree beam separation. At a height of 7 meters, the beams are separated by 1.23 meters. For a single stripe, we suggest a 1.5 meter stripe width. For 2 stripes, they need to be separated by 1.23 meters. The laser beam diameter is less than 5mm, so 2 stripes with a width of 100mm or 4 inches will be sufficient. For specific beam separation information, please see Appendix E, Table E-1. To locate the beams, an AutoSense™ Beamfinder should be used.

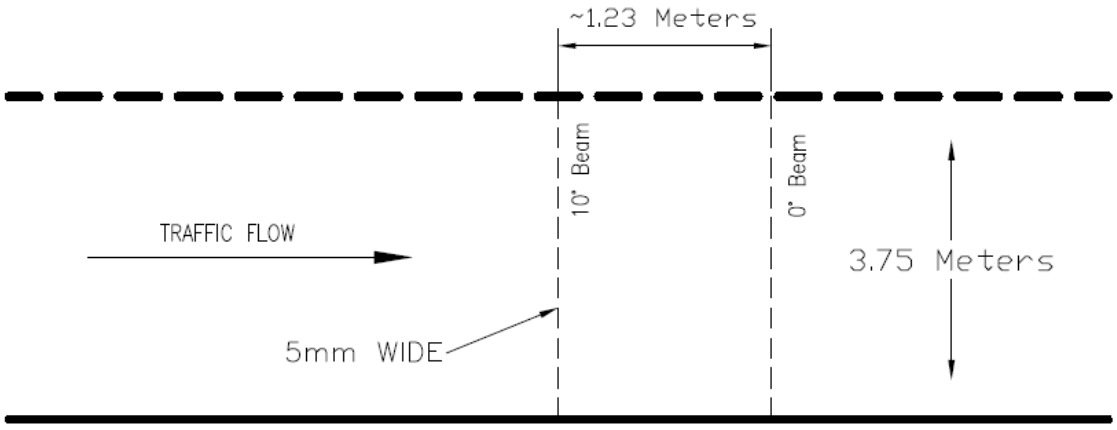


Figure F-1: Location of Stripe(s)

F.3 Paint Color

A semi-reflective surface with the following color hues has shown to provide adequate reflectivity. The specification for both color hues is given below.

	
Hue = 160 Lum = 160	Hue = 160 Lum = 181
Dark Color Specification 6% cold gray Pantone PMS-429U 3.9% black 2.3% reference blue 93.8% white Equiv: Sherwin Williams #SW1232	Light Color Specification 3% cold gray Pantone PMS-428U 1.9% black 1.1% reference blue 97.0% white Equiv: Sherwin Williams SW1234

F.4 Approved Hot Tape Product

OSI LaserScan has tested and approved the following Hot Tape product for use with the AutoSense units.

Part Number	Description	Manufacturer
894014	Hot Tape, Grey Sample Width: 4 inch (101.6 mm) Thickness: 125 mil	Zumar Industries P.O. Box 44549 Tacoma, WA 98444-0549 Phone: (253) 536-7740 Toll Free: (800) 426-7967

Note

Due to the variations in climatic conditions, traffic loads, the effects of road salt and chemical deicing agents, it is difficult to predict how often the paint stripe will need to be applied. However, empirical evidence on has indicated that using a traditional road stripe epoxy in the color hues specified above, the paint stripe provided sufficient reflectivity for a period of 2 years without maintenance.