

Special Specification 6083

Video Imaging and Radar Vehicle Detection System



1. DESCRIPTION

This specification sets forth the minimum requirements for a system that detects vehicles on a roadway using a multi-sensor detection system.

The multi-sensor system must utilize 2 different sensors of different technologies, video imaging and radar, to detect and track licensed and unlicensed vehicles at distances up to 600 ft. The sensor system must fuse vehicle information from the 2 sensors to provide highly accurate and precise detection for special or advanced applications.

The multi-sensor system must use a primary detector rack mounted processor to interface with the traffic control cabinet. The module must process information from both video imaging and radar sensors simultaneously in real-time.

1.1. **System Configurations.** The multi-sensor detection system (MSDS) must consist of up to 2 video cameras and radar units, detection processors (DP) capable of processing from 1 to 2 intersection approaches, output extension modules, surge suppressors, a setup tool and a pointing device.

1.2. **Available System Configurations.** The MSDS will be deployed at locations where site conditions and roadway geometry vary. The MSDS system may also be deployed at locations where existing cabinets or equipment exist. Existing site configurations will dictate the availability of cabinet space and MSDS usage.

The proposed MSDS must be available in various configurations to allow maximum deployment flexibility. Each configuration must have an identical user interface for system setup and configuration. The communications protocol to each configuration must be identical and must be hardware platform independent. The proposed MSDS must have multiple configurations available for deployment in accordance with Table 1.

Table 1
MSDS Configuration

| Description | No. of Multi-Sensor Inputs | No. Video Outputs | Mounting Configuration | Power Supply Requirements |
|-----------------------------|----------------------------|-------------------|--|---------------------------------|
| Single-Channel Rack Mounted | 1 | 1 | Rack Mount (Type 170 or NEMA TS-1, TS-2 Racks) | 12 or 24 VDC Power from Rack |
| Dual-Channel Rack Mounted | 2 | 1 | Rack Mount (Type 170 or NEMA TS-1, TS-2 Racks) | 12 or 24 VDC Power from Rack |

1.3. **System Software.** The system must include software that detects vehicles in multiple lanes. Video imaging detection zones must be defined using only an on-board video menu and a pointing device to place the zones on a video image. Up to 24 video detection zones per camera view must be available. Two additional trigger zones for the radar sensor must be available and be configurable by using the same system setup menu on the DP. A separate computer must not be required to program the detection zones. A portable setup tool must be available for sensor alignment and adjustment of camera's field of view and focus menu on the DP. A separate computer must not be required to program the detection zones. A portable setup tool must be available for sensor alignment and adjustment of camera's field of view and focus.

2. MATERIALS

2.1. **Multi-Sensor Detection System Hardware.**

The MSDS hardware must consist of the following 4 elements:

- Video imaging camera sensor
- Radar sensor
- Sensor data combiner
- Detection processor

The MSDS must be made in the U.S.A. in compliance with FTA "Buy America" regulations.

2.2.

Video Imaging Camera Sensor. To accommodate deployment flexibility, the MSDS camera sensor must be compatible with all DP platforms identified in Table 1. The MSDS camera sensor must be supplied by the MSDS manufacturer.

The advanced camera enclosure must utilize Indium Tin Oxide (ITO) technology for the heating element of the front glass. The transparent coating must not impact the visual acuity and must be optically clear.

Cable terminations at the data combiner for video and power must not require crimping or special tools.

The camera sensor must allow the user to set the focus and field of view via Wi-Fi connectivity.

The camera must produce a useable video image of the bodies of vehicles under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the camera must produce a useable video image must be the minimum range from nighttime to daytime, but not less than the range of 1.0 to 10,000 lux.

The camera electronics must include automatic gain control (AGC) to produce a satisfactory image at night.

The imager luminance signal to noise ratio (S/N) must be more than 50 dB with the automatic gain control (AGC) disabled.

The imager must employ 3 dimensional dynamic noise reduction (3D-DNR) to remove unwanted image noise.

The camera imager must employ wide dynamic range (WDR) technology to compensate for wide dynamic outdoor lighting conditions. The dynamic range must be greater than 100 dB.

The camera must be digital signal processor (DSP) based and must use a CCD sensing element and must output color video with resolution of not less than 550 TV lines.

The camera sensor must include an electronic shutter control based upon average scene luminance and must be equipped with an auto-iris lens that operates in tandem with the electronic shutter. The electronic shutter must operate within the range of 1/1 to 1/10,000th sec.

The camera sensor must utilize automatic white balance.

The camera sensor must include a variable focal length lens with variable focus that can be adjusted, without opening up the camera housing, to suit the site geometry by means of a portable interface device designed for that purpose and manufactured by the detection system supplier.

The horizontal field of view must be adjustable from 4.6° to 53.6°. This camera configuration may be used for the majority of detection approaches in order to minimize the setup time and spares required by the user. The lens must be a 12x zoom lens with a focal length of 3.7 to 44.0 mm.

The lens must also have an auto-focus feature with a manual override to facilitate ease of setup.

The camera must incorporate the use of preset positioning that store zoom and focus positioning information. The camera must have the capability to recall the previously stored preset upon application of power.

The camera must be housed in a weather-tight sealed enclosure conforming to IP-67 specifications. The housing must allow the camera to be rotated to allow proper alignment between the camera and the traveled road surface.

The camera enclosure must be equipped with a sunshield. The sunshield must include a provision for water diversion to prevent water from flowing in the camera's field of view.

The camera enclosure must be design so that the pan, tilt and rotation of the camera assembly can be accomplished independently without affecting the other settings.

The camera enclosure must include a proportionally controlled Indium Tin Oxide heater design that maximizes heat transfer to the lens. The output power of the heater must vary with temperature, to assure proper operation of the lens functions at low temperatures and prevent moisture condensation on the optical faceplate of the enclosure.

The glass face on the front of the enclosure must have an anti-reflective coating to minimize light and image reflections.

When mounted outdoors in the enclosure, the camera must operate in a temperature range from -34°C to +74°C and a humidity range from 0 to 100% RH. Measurement of satisfactory video must be based upon DP system operation.

The camera sensor must acquire its power from the sensor data combiner.

Recommended camera placement height must be between 18 and 33 ft. (or 6 and 10 m) above the roadway, and over the traveled way on which vehicles are to be detected. For optimum detection the camera must be centered above the traveled roadway. The camera must view approaching vehicles at a distance not to exceed 350 ft. for reliable detection (height to distance ratio of 10:100). Camera placement and field of view (FOV) must be unobstructed and as noted in the installation documentation provided by the supplier.

The video signal must be fully isolated from the camera enclosure and power cabling

A weather-proof protective cover must be provided to protect all terminations at the camera.

2.3. **Radar Sensor.** The radar sensor must operate in the 24 GHz frequency band and must operate on 1 of 7 available enumerated channels that is user selectable.

The radar detection range must be 600 ft. minimum, +/- 5%.

The radar sensor must be able to track up to 20 independent objects simultaneously.

Object speed detection must be within the range of 0 and 150 mph +/- 1.0 mph.

The radar sensor must be able to detect vehicles in 1 to 4 traffic lanes.

The radar sensor must be housed in a weather-tight sealed enclosure conforming to IP-67 specifications. The housing must allow the radar to be adjusted to allow proper alignment between the sensor and the traveled road surface.

When mounted outdoors in the enclosure, the radar must operate in a temperature range of -34°C to +74°C and a humidity range from 0 to 100% RH.

The radar sensor must communicate with the sensor data combiner.

The radar sensor must acquire its power from the sensor data combiner.

- 2.4. **Multi-Sensor Assembly.** Both camera and radar sensors must be housed in an overall, single enclosure assembly.
- The overall size of the multi-sensor enclosure must not exceed 14 in. x 15 in. x 17 in.
- The overall weight of the multi-sensor unit must not exceed 11 lb.
- The effective projected area (EPA) must not exceed 2.0 sq. ft.
- The maximum power consumption for the multi-sensor assembly must be less than 10W typical, 20W peak.
- 2.5. **Sensor Data Combiner.** A sensor data combiner that combines sensor information from both video and radar sensors must be employed.
- The sensor data combiner must supply primary power to each sensor unit.
- The sensor data combiner must facilitate digital communications between the sensor data combiner and each of the sensor units.
- The sensor data combiner must get its primary power from an AC power source using industry standard 3-conductor cabling.
- The sensor data combiner must communicate with the detection processor using a single coax cable. Both video imaging and radar data must use the single coax cable.
- The sensor data combiner must also employ industry standard Wi-Fi connectivity for remote sensor system setup using a mobile programming device such as a netbook or tablet computer. Video camera and radar sensor must be able to be configured independently.
- The sensor data signal must be fully isolated from the mechanical enclosure and power cabling.
- Cable terminations at the sensor data combiner must not require crimping tools.
- The sensor data combiner must be housed in a weather-tight sealed enclosure conforming to IP-67 specifications.
- 2.6. **Detection Processor (DP).** Each sensor input must accept RS170 (NTSC) or CCIR (PAL) signals from an external video source. The interface connector must be BNC type and must be located on the front of the processing unit. The sensor input must have the capability to be terminated into 75 ohms or high impedance (Hi-Z) using dip switches or software control from the user menu. The sensor input must also facilitate the data from the radar sensor.
- A LED indicator must be provided to indicate the presence of the sensor signal. The LED must illuminate upon valid sensor synchronization and turn off when the presence of a valid sensor signal is removed.
- One video output must be provided. The video output must be RS170 or CCIR compliant and must pass through the input video signal.
- For multi-channel video input configurations, a momentary push-button must be provided on the front panel to cycle through each input video channel. In the absence of a valid sensor signal, the channel must be skipped and the next valid sensor signal must be switched. The real time video output must have the capability to show text and graphical overlays to aid in system setup. The overlays must display real-time actuation of detection zones upon vehicle detection or presence. Overlays must be able to be turned off by the user. Control of the overlays and sensor switching must also be provided through the serial communications port. The video output interface connector must be positive locking BNC type. Friction type (e.g. RCA type) connectors must not be allowed.

A serial communications port must be provided on the front panel. The serial port must be compliant with EIA232 electrical interfaces and must use a DB9 type connector mounted on the front panel of the DP. The serial communications interface must allow the user to remotely configure the system and to extract calculated vehicle and roadway information. The interface protocol must be documented or interface software must be provided. The interface protocol must support multi-drop or point-to-multipoint communications. Each MSDS must have the capability to be addressable. The DP must support data rates of 1200 to 230,400 bps, inclusive.

Open collector (contact closure) outputs must be provided. Four open collector outputs must be provided for the single or dual channel rack-mount configuration. Additionally, the DP must allow the use of extension modules to provide up to 24 open collector contact closures per camera input. Each open collector output must be capable of sinking 30 mA at 24 VDC. Open collector outputs will be used for vehicle detection indicators as well as discrete outputs for alarm conditions. The DP outputs must be compatible with industry standard detector racks assignments.

Logic inputs such as delay/extend or delay inhibit must be supported through the appropriate detector rack connector pin or front panel connector in the case of the I/O module. For DPs and extension modules, 4 inputs must be supported via detector rack interface. The I/O module must accommodate 8 inputs through a 15-pin "D" connector.

Detection status LEDs must be provided on the front panel. The LEDs must illuminate when a contact closure output occurs. Rack-mounted detection processors must have a minimum of 4 LEDs. Rack-mounted extension modules must have 2, 4 or 8 LEDs (depending upon extension module type) to indicate detection.

The front panel of the DP must have detector test switches to allow the user to manually place calls on each DP output channel. The test switch must be able to place either a constant call or a momentary call depending on the position of the switch.

A USB mouse port must be provided on the front panel of the rack mount detection processing unit. The mouse port must not require special mouse software drivers. The mouse port must be used as part of system setup and configuration. A mouse must be provided with each detection processor.

Extension modules must be connected to the DP by an 8-wire twisted-pair cable with modular RJ45 connectors. DP and EM communications must be accommodated by methods using differential signals to reject electrically coupled noise.

Extension modules (EM) must be available to eliminate the need of rewiring the detector rack, by enabling the user to plug an extension module into the appropriate slot in the detector rack to provide additional open collector outputs. The extension module must be available in both 2 and 4 channel configurations. EM configurations must be programmable from the DP. A separate I/O module with 32 outputs through a 37-pin "D" connector on the front panel and 8 inputs through a 15-pin "D" connector using an external wire harness for expanded flexibility must also be available.

The DP and EM must be specifically designed to mount in a standard detector rack, using the edge connector to obtain power, provide contact closure outputs and accept logic inputs (e.g. delay, extend). No adapters must be required to mount the DP or EM in a standard detector rack. Detector rack rewiring must not be required.

The DP must utilize non-volatile memory technology to store on-board firmware and operational data.

The DP must enable the loading of modified or enhanced software through the EIA232 or USB port (using a USB thumb drive) and without modifying the DP hardware.

The DP and EM must be powered by 12 or 24 VDC. DP and EM modules must automatically compensate for either 12 or 24 VDC operation. DP power consumption must not exceed 7.5W. The EM power consumption must not exceed 3W.

The DP must operate satisfactorily in a temperature range from -34°C to +74°C and a humidity range from 0 to 95% RH, non-condensing as set forth in NEMA specifications.

An Edco CX-06M video surge suppresser must be provided for each sensor input. The surge suppresser must be appropriately grounded to the cabinet ground rod using 14 AWG minimum.

2.7.

System Software. Detection zones must be programmed via an on board menu displayed on a video monitor and a pointing device connected to the DP. The menu must facilitate placement of detection zones and setting of zone parameters or to view system parameters. A separate computer must not be required for programming detection zones or to view system operation.

The DP must store up to 3 different detection zone patterns in non-volatile memory. The DP can switch to any one of the 3 different detection patterns within 1 sec. of user request via menu selection with the pointing device. Each configuration must be uniquely labeled and able to be edited by the user for identification. The currently active configuration indicator must be displayed on the monitor.

The DP must detect vehicles in real time as they travel across each detection zone.

The DP must accept new detection patterns from an external computer through the EIA232 port when the external computer uses the correct communications protocol for downloading detection patterns. A Windows™-based software designed for local or remote connection and providing video capture, real-time detection indication and detection zone modification capability must be provided with the system.

The DP system must have the capability to automatically switch to any one of the stored configurations based on the time of day which must be programmable by the user.

The DP must send its detection patterns to an external computer through the EIA232 port when requested when the external computer uses the appropriate communications protocol for uploading detection patterns.

The DP must default to a safe condition, such as a constant call on each active detection channel, in the event of unacceptable interference or loss of the sensor signal.

The system must be capable of automatically detecting a low-visibility condition such as fog and respond by placing all effected detection zones in a constant call mode. A user-selected alarm output must be active during the low-visibility condition that can be used to modify the controller operation if connected to the appropriate controller input modifier(s). The system must automatically revert to normal detection mode when the low-visibility condition no longer exists.

Up to 24 detection zones per camera input must be supported and each detection zone can be sized to suit the site and the desired vehicle detection region.

The DP must support 2 independent trigger points for radar outputs for dilemma zone applications.

The DP must provide up to 24 open collector output channels per sensor input using one or more extension modules.

A single detection zone must be able to replace multiple inductive loops and the detection zones must be OR'ed as the default or may be AND'ed together to indicate vehicle presence on a single approach of traffic movement.

Placement of detection zones must be done by using only a pointing device, and a graphical interface built into the DP and displayed on a video monitor, to draw the detection zones on the video image from each video camera. No separate computer must be required to program the detection zones.

When a vehicle is detected within a detection zone, a visual indication of the detection must activate on the video overlay display to confirm the detection of the vehicle for the zone.

Detection must be at least 98% accurate in good weather conditions, with slight degradation possible under adverse weather conditions (e.g. rain, snow, or fog) which reduce visibility.

Detection accuracy is dependent upon site geometry, camera placement, camera quality and detection zone location, and these accuracy levels do not include allowances for occlusion or poor video due to camera location or quality.

The DP must provide dynamic zone reconfiguration (DZR). DZR enables normal operation of existing detection zones when one zone is being added or modified during the setup process. The new zone configuration must not go into effect until the configuration is saved by the operator.

Detection zone setup must not require site specific information such as latitude and longitude to be entered into the system.

The DP must process the video input from each camera at 30 frames per second. Multiple camera processors must process all video inputs simultaneously.

The DP must output a constant call during the background learning period of no more than 3 min.

Detection zone outputs must be configurable to allow the selection of presence, pulse, extend, and delay outputs. Timing parameters of pulse, extend, and delay outputs must be user definable between 0.1 to 25 sec.

Up to 6 video detection zones per sensor input must have the capability to count the number of vehicles detected. The count value must be internally stored for later retrieval through the EIA232 port. The zone must also have the capability to calculate and store average speed and lane occupancy at bin intervals of 10 sec., 20 sec., 1 min., 5 min., 15 min., 30 min. and 60 min. One radar sensor zone must also count vehicles, calculate, and store the average speed and lane occupancy across the approach.

In addition to the count type zone, the DP must be able to calculate and/or acquire average speed and lane occupancy using both video and radar sensors. These values must be stored in non-volatile memory for later retrieval.

The DP must have an "advance" zone type where detection outputs to the traffic controller is compensated for angular occlusion and distance.

The DP must employ color overlays on the video output.

The DP must have the ability to show phase status (green, yellow, or red) for up to 8 phases. These indications must also be color coded.

The user must have the ability to enable or disable the display of the phase information on the video output.

The DP must have the capability to change the characteristics of a detection zone based on external inputs such as signal phase. Each detection zone must be able to switch from one zone type (i.e. presence, extension, pulse, etc.) to another zone type based on the signal state. For example, a zone may be a "count" zone when the phase is green but change to a "presence" zone type when the phase is not green.

Another application would be zone type of "extension" when the signal phase is green and then "delay" when red.

For alpha numeric user inputs, the DP must utilize a virtual keyboard on the video overlay system to ease user input. The virtual keyboard must use the standard QWERTY keyboard layout.

The DP must aid the user in drawing additional detection zones by automatically drawing and placing zones at appropriate locations with only a single click of the mouse. The additional zone must utilize geometric

extrapolation of the parent zone when creating the child zone. The process must also automatically accommodate lane marking angles and zone overlaps.

When the user wishes to modify the location of a zone, the DP must allow the user move a single zone, multiple zones or all zones simultaneously.

When the user wishes to modify the geometric shape of the zone, the DP must allow the user to change the shape by moving the zone corner or zone sides.

On screen zone identifiers must be modifiable by the user. The user must be allowed to select channel output assignments, zone type, input status, zone labels or zone numbers to be the identifier.

For multiple camera input DPs, the user must have the ability to enable automatic video output switching. The dwell time for each sensor input must be user programmable.

For radar sensor zones, the output can be triggered by presence of a vehicle only or by presence of a vehicle above a user-defined speed threshold.

3. CONSTRUCTION

The coaxial cable to be used between the multi-sensor assembly and the DP in the traffic cabinet must be Belden 8281. This cable must be suitable for installation in conduit or overhead with appropriate span wire. BNC plug connectors must be used where applicable. The coaxial cable, BNC connector, and crimping tool must be approved by the supplier of the MSDS, and the manufacturer's instructions must be followed to ensure proper connection.

The power cabling must be 16 AWG three-conductor cable with a minimum outside diameter of 0.325 in. and a maximum diameter of 0.490 in. The cabling must comply with the National Electric Code, as well as local electrical codes. Cameras may acquire power from the luminaire if necessary.

The MSDS must be installed by factory-certified installers as recommended by the supplier and documented in installation materials provided by the supplier. Proof of factory certification must be provided.

3.1. Testing.

The installed assembly will be field tested prior to being placed into service to ensure all components are functioning as described herein.

The supplier must provide a limited 5 yr. warranty on the MSDS. During the warranty period, technical support must be available from the supplier via telephone within 4 hr. of the time a call is made by a user, and this support must be available from factory-certified personnel or factory-certified installers. During the warranty period, updates to DP software must be available from the supplier without charge.

The supplier must maintain an adequate inventory of parts to support maintenance and repair of the MSDS. These parts must be available for delivery within 30 days of placement of an acceptable order at the supplier's then current pricing and terms of sale for said parts.

The supplier must maintain an ongoing program of technical support for the MSDS. This technical support must be available via telephone, or via personnel sent to the installation site upon placement of an acceptable order at the supplier's then current pricing and terms of sale for onsite technical support services.

Installation or training support must be provided by a factory-authorized representative and must be a minimum IMSA-Level II Traffic Signal Technician certified.

4. MEASUREMENT

This Item will be measured by each unit shown in the plans furnished, installed, made fully operational, and tested in accordance with this special specification or as directed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Video Imaging and Radar Vehicle Detection System." This price will be full compensation for furnishing, installing, internal electrical conductors, connectors and mounting hardware; and for all labor, tools, equipment, testing documentation and incidentals necessary to complete the work.