

**TEXAS DEPARTMENT OF TRANSPORTATION
SPECIAL SPECIFICATION
TO-8000
Radar Vehicle Detection System**

1.0 GENERAL REQUIREMENTS

This specification sets forth the minimum requirements for advance radar, side fire radar, and presence detection (stop bar) radar systems (RVDS) used to detect vehicles on a roadway via processing of radar electromagnetic waves. Radar requirements in this specification are intended for use in intersection control applications to detect vehicles on an approach to a intersection controlled by a traffic signal. Radar vehicle sensing device (RVSD) systems must be capable of providing detector contact closure to assigned detector channels in the traffic signal controller assembly.

1.1 An RVSD shall consist of the following components: Radar sensor (1), detector rack interface module (1) power and surge protection panel or module (1) (cabinet interface devices that combine one or more of the above components shall be acceptable as well), and all associated equipment required to setup and operate in a field environment including software, serial and ethernet communication ports, cabling, electrical connectors and mounting hardware.

1.2 The RVSD interface module(s) must comply and operate with NEMA TS-1, NEMA TS-2 Type 1 detector rack or Type 170/2070 input file and shall be capable of 16 contact closure inputs to the traffic signal controller via the detector rack or SDLC bus (Port 1). The user shall be able to assign each contact closure to an associated detector channel.

1.4 All components of the RVSD system housed in the controller cabinet shall be rated to operate in a temperature range from -34°C to $+74^{\circ}\text{C}$ (-30°F to $+165^{\circ}\text{F}$) at 0 percent to 95 percent relative humidity, non-condensing. The radar sensor and other components of the RVSD system not housed in the controller cabinet shall be rated to operate in temperatures ranges from -34°C to 60°C (-30°F to $+140^{\circ}\text{F}$) at 0 percent to 95 percent relative humidity, non-condensing. In addition:

- RVSD must meet the temperature and humidity requirements of NEMA TS 2, Section 2.1;
- RVSD must meet the mechanical shock and vibration requirements of NEMA TS 2, Section 2.1; and

- Radar sensor enclosure of RVSD must meet or exceed Type 4X enclosure requirements of NEMA 250.
- 1.5 The RVSD shall be able to operate in all types of weather conditions including: rain, snow, sleet, ice, fog and wind blown dust.
 - 1.6 Lightning and surge protection will be provided for power connections and communications links to the radar RVSD meeting or exceeding EN 61000-4-5 class specifications.
 - 1.7 The RVSD shall provide a “fail safe” operation that triggers when communication between the radar vehicle sensor and the interface module is broken. Contact closure from the interface module will occur on all programmed detector channels associated with the affected radar sensor when the fail safe is triggered and will remain in this state until communication is re-established between the interface module and the radar vehicle sensor.
 - 1.8 The RVSD shall comply with all applicable Federal Communications Commission (FCC) requirements. The manufacturer will provide documentation of compliance with FCC specifications. Each RVSD will be FCC certified under CFR 47, Part 15, Section 15.245 as a field disturbance sensor or Section 15.249 as an intentional radiator. This certification will be displayed on an external label on each device according to the rules set forth by the FCC.
 - 1.9 The RVSD shall maintain frequency stability without the use of manual tuning elements by the user.
 - 1.10 The RVSD as a minimum must provide 4 separate RF channels selectable by the user to avoid interference with other devices working on the same frequency.
 - 1.11 The communication port(s) shall support a communication speed that will not introduce excessive latency between when a vehicle is detected and the contact closure in the traffic signal cabinet.
 - 1.12 RVSD interface modules that utilize the detector rack must operate at 12V or 24V DC. Shelf mounted interface modules must operate within a range of 89V to 135V AC, 60 Hz single phase. Power to the RVSD radar sensor must be from the transient protected side of the AC power distribution system in the traffic control cabinet in which the RVSD is installed.
 - 1.13 RVSD documentation shall include a comprehensive user guide as well as quick-reference guide(s)
 - 1.14.0 Definitions

- 1.14.1 RADAR: Radio Detection And Ranging. A system for detecting the presence, direction, distance, and speed of objects (e.g. motor vehicles including motorcycles), by sending out pulses of high-frequency electromagnetic waves that are reflected off the object back to the source (e.g. sensor).
- 1.14.2 Radar Advance Detection Devices (RADD): Accurately and continuously detects speed and range data of vehicles or clusters of vehicles simultaneously moving within 100 ft. to 500 ft. from the sensor in the selected direction of travel.
- 1.14.3 Radar Presence Detection Devices (RPDD): Detects and reports presence of vehicles stopped or traveling under 50 miles per hour in lanes within the field of view and boundaries of an intersection. RPDD are capable of true presence detection as described in section 1.14.10. The radar sensor shall maintain detection of a vehicle moving or stopped within a programmed detection zone set-up by the user. RPDD may be a forward fire or other type radar.
- 1.14.4 Side Fire Radar: Detects tracks and identifies speed of passing vehicles through radar detection zones.
- 1.14.5 Vehicle Radar Sensor: RVSD device that emits electromagnetic waves and senses return waves from passing and/or approaching vehicles. The vehicle radar sensor shall be spatially monostatic; the transmitter and receiver shall be located on the same sensor device.
- 1.14.6 Interface Module: Device that interfaces with the cabinet detector rack or SDLC bus (Port 1) allowing for contact closure to occur on a selected detector channel in the traffic signal controller.
- 1.14.7 Communications Link: The communications connection between the RVSD Interface Module and a remote computer on a local area network (LAN) over Ethernet or laptop computer at the signal cabinet.
- 1.14.8 Detection Accuracy: Performance measure of the basic operation of a detection system (shows detection when a vehicle is in the detection zone and shows no detection when there is not a vehicle in the detection zone).
- 1.14.9 Passage Detection: The ability of a vehicle detector to detect the passage of a vehicle moving through the zone of detection and to ignore the presence of a vehicle stopped or object within the zone of detection.
- 1.14.10 Presence Detection: The ability of a vehicle detector to sense that a vehicle, whether moving or stopped, has appeared in the zone of detection.

- 1.14.11 Delay Timing: When selected, applies delayed contact closure to the associated sensor or detector channel input. When a vehicle is detected by the RVSD, the delay timing must time out before contact closure can occur to the detector channel.
- 1.14.12 Extension Timing: When selected, applies additional contact closure to the associated sensor or detector channel input. When a vehicle is no longer detected within a detection zone, extension timing must time out before contact closure is removed from the associated detector channel.
- 1.14.13 GUI: Graphical User Interface. A type of software interface that allows users to interact with electronic devices through graphical icons and other visual indicators such as windows, menus, buttons or mouse pointer.

2.0 RADAR ADVANCE DETECTION DEVICES (RADD) FUNCTIONAL REQUIPEMENTS

- 2.1 RADD (via interface module) shall provide detection and contact closure to the signal controller for vehicles (including motorcycles) approaching the intersection.
- 2.2 RADD must continuously provide vehicle detection, tracking and speed of moving vehicles or clusters of vehicles simultaneously approaching an intersection at a range between at least 100 feet to 500 feet from the radar sensor. The sensor firmware must be able to calculate the vehicles speed and range and output contact closure to the appropriate detector channel.
- 2.3 RADD system shall be capable of creating a minimum of 3 detection zones in advance of the stopbar that cover up to 5 lanes of approach traffic. Zone length will be user definable with-in the detection range. Conditional logic to the detection zones that allows contact closure to occur only when logic conditions are satisfied shall be provided. Conditional logic programming will allow the user to control when contact closure occurs to the detector rack interface module.
- 2.4 RADD software shall be capable of applying minimum and maximum speed settings within a detection zone to create a desired speed range for contact closure to the detector channel. Vehicles detected within the minimum and maximum speed settings will apply contact closure to the assigned detector channel input in the signal controller.
- 2.5 RADD must achieve a minimum of 95 percent detection accuracy for vehicles or clusters of vehicles within the detection zone. A cluster is defined as vehicles side by side or single file within approximate 1 second spacing. Radar GUI will indicate detection, show when logic conditions for speed are satisfied and when contact closure to the assigned controller detector channel is applied to the controller.

- 2.6 The RADD shall be capable of delay timing as defined in Section 1.14.11 of this specification. As a minimum the user shall be able to program and select delay timing from 0-25 seconds in one/tenth (.1) second increments from the GUI provided with the RVSD system.
- 2.7 The RADD shall be capable of extension timing as defined in Section 1.14.12 of this specification. As a minimum the user shall be able to program and select extension timing from 0-25 seconds in one/tenth (.1) second increments from the GUI provided with the RVSD system.
- 2.8 The RADD shall be capable of tracking and detecting up to 25 individual vehicles at a time.

3.0 SIDE FIRE RADAR FUNCTIONAL CAPABILITES AND REQUIREMENTS

- 3.1 Side fire radar must as a minimum, operate a radar detection range of 200 feet from the sensor.
- 3.2 Side fire radar must provide passage detection as defined in section this specification and provides contact closure to the detector rack interface module.
- 3.3 Side fire radar must provide detection, speed and lane identification from passing vehicles in a targeted area.
- 3.4 Side fire radar software must allow user programmable lane width ranges for at least eight 12 foot lanes.
- 3.5 Side fire radar must allow the user to assign vehicle directionality in the software GUI.
- 3.6 Side fire radar software must have a method of automatically identifying traffic lanes using a processor internal to the radar sensor. This auto-configuration method must identify traffic lanes or detection zones by detecting the relative position of vehicles within the radar sensors field of view.
- 3.7 Detection accuracy will be determined by the presence of any moving vehicle within a defined detection range. A minimum of 95 percent detection accuracy must be required for each detection zone set-up within the RVDS detection range using as many as 8 detection zones across 8 lanes of vehicle traffic (1 detection zone set-up for each lane).
- 3.8 Side fire radar must be able to collect volume occupancy and speed data on a per lane basis. Collection bin times must be user selectable. Bins must store data for a minimum of 48 hours.

4.0 RADAR PRESENCE DETECTION DEVICES (RPDD) FUNCTIONAL REQUIREMENTS

- 4.1 RPDD shall provide presence detection and contact closure to the interface module for vehicles (including motorcycles) approaching an intersection. Presence detection shall operate as defined in Section 1.14.10 of this specification.
- 4.2 RPDD shall, as a minimum detect vehicles within a 140 ft., 90 degree cone of detection from the sensor or for a forward fire type configuration detect at least 5 (minimum 10-ft wide) lanes of traffic with a range of at least 50 ft. to 325 ft. when mounted per manufacturers recommendations. The number of lanes used and detection zones shall be configured and selected from the GUI.
- 4.3 RPDD shall be able to assign up to 4 detector outputs per unit and capable of using 2 or 4 channel interface modules to the detector rack or shelf-mounted interface module connected directly to SDLC bus (Port 1).
- 4.4 RPDD shall be able to distinguish and omit wrong-way and cross-street traffic from activating an assigned detector output. A vehicle that enters the lane from a perpendicular or skewed angle and arrives at the stop bar shall be detected accurately.
- 4.5 RPDD shall as a minimum, maintain a detection accuracy of 95% for each detection zone set-up on the GUI. Detection accuracy shall apply to both stopped vehicle and vehicles traveling under 50 MPH. Total false calls lasting over 10 seconds within one hour period shall be less than 20. Total dropped call duration shall be less than 3 minutes in any one hour period.
- 4.6 In the presence mode contact closure will occur for as long as a vehicle is detected and conditional logic programming is satisfied.

5.0 RVSD SOFTWARE AND COMMUNICATION REQUIREMENTS

- 5.1 RVSD software must utilize a GUI that runs on Microsoft Windows7 64 bit or newer Microsoft operating system or viewable via webpage. The GUI must illustrate vehicle movement and directionality when detection is achieved by the RVSD.
- 5.2 Programmed parameters from the GUI to the sensor shall be stored in non-volatile memory devices such as Flash RAM or EEPROM within the sensor. The sensor shall not rely on battery backup or the use of a supercapacitor to retain memory.
- 5.3 The RVSD must provide an ethernet communications port allowing the user to interface the system and operate the GUI via a LAN and using TCP/IP protocol over an Ethernet network.

- 5.4 Ethernet and/or serial communication links are permissible to interface the device from a laptop for installation and field observation of the RVSD.
- 5.5 RVSD firmware shall be upgradeable by external, local and remote download via serial or ethernet ports.
- 5.6 The RVSD firmware must allow the operator to save configurations settings to a file and reload the configuration settings to the RVSD sensor from a saved file using the GUI.
- 5.7 The RF channel must be selectable from the software GUI.
- 5.8 The software shall support the following functionality:
 - Operate over a TCP/IP connection
 - Give the operator the ability to save/back up the RVSD configuration to a file or load/restore the RSVD configuration from a file
 - Allow the backed-up sensor configurations to be viewed and edited
 - Provide zone and channel actuation display
 - Provide a virtual connection option so that the software can be used without connecting to an actual sensor
 - Local or remote sensor firmware upgradability

6.0 RVSD CABLING Requirements

- 6.1 Radar systems using RS-485 or RS-232 must use a Belden 9331 cable or equivalent cable.

The cable must use shielded twisted pairs with a drain wire. The nominal capacitance conductor to conductor must be 1 KHz less than or equal to 26 Pico farads per foot of cable. The nominal conductor DC resistance at 68° F must be less than or equal to 15 ohms per 1,000 feet of cable.

- 6.2 Radar systems communicating data over coaxial cable must use a Belden 8281 or equivalent cable. Cable impedance must be 75 ohms, capacitance less than or equal to 68.901 Pico farads per meter. DC resistance at 68° F must be less than or equal to 32.4819 ohms per kilo meter.
- 6.3 Radar systems communicating data over other types of cabling will require specific approval from the Traffic Managemnt section of TxDOT's Traffic Operations Division.
- 6.4 Radar systems cabling shall be capable of providing data communications over a minimum 1000 ft. distance.

- 6.5 The wire shall be a single continuous home-run cable with no splices allowed and terminated only in the junction box provided by the manufacturer and in the traffic signal cabinet at the other end. The connector shall be weatherproof.

7.0 INSTALLATION AND TRAINING

- 7.1 When requested by TxDOT personnel or purchasing agency, the supplier of the RVSD shall supervise the installation and testing of the radar equipment. A factory certified representative from the supplier shall be on-site during installation.
- 7.2 If requested by TxDOT personnel or purchasing agency, up to two days of training shall be provided on the operation, setup and maintenance of the radar detection system. Instruction and materials for a maximum of 20 persons at a location provided by the agency. TxDOT or purchasing agency shall be responsible for any travel and room and board expenses for its own personnel
- 7.3 Instruction personnel are required to be certified by the equipment manufacturer. The User's Guide is not an adequate substitute for practical, classroom training and formal certification by an approved agency.
- 7.4 Formal levels of factory authorized training are required for installers, contractors and system operators. All training must be certified by the manufacturer.

8.0 WARRANTY, MAINTENANCE AND SUPPORT

- 8.1 The radar vehicle detection system shall be warranted to be free of defects in material and workmanship for a period of 5 years from date of shipment from the supplier's facility. During the warranty period, the supplier shall repair with new or refurbished materials, or replace at no charge, any product containing a warranty defect or fails to operate properly after installation provided the product is returned FOB to the supplier's factory or authorized repair site at no expense to the Department. Product repair or replaced under warranty by the supplier will be returned with transportation prepaid. This warranty does not apply to products damaged by accident, improper operation, abused, serviced by unauthorized personnel or unauthorized modification.
- 8.2 Repair or full replacement will be required if a RVSD fails to operate as specified under normal operating conditions. Repaired or replaced components of the RVSD will be provided at no cost to TxDOT. The replaced or repaired units will inherit the remainder of the failed unit's warranty.
- 8.3 During the warranty period, technical support shall be available from the supplier via telephone within 4 hours of the time a call is made by a user, and this support shall be available from factory certified personnel or factory certified installers.

- 8.4 Ongoing software support by the supplier shall include firmware updates for the RVSD processor unit and external software needed to set-up and operate the RVSD system. These updates shall be provided free of charge during the warranty period. The update of the RVSD software shall be tested and approved by TxDOT before installation.
- 8.5 The supplier shall maintain a program for technical support and software updates following expiration of the warranty period. This program shall be made available to TxDOT in the form of a separate agreement for continuing support.
- 8.6 The supplier shall maintain an adequate inventory of parts to support maintenance and repair of the RVSD.