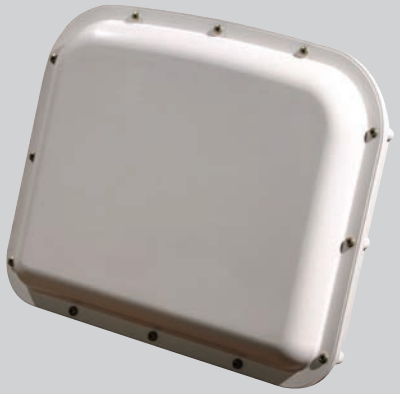
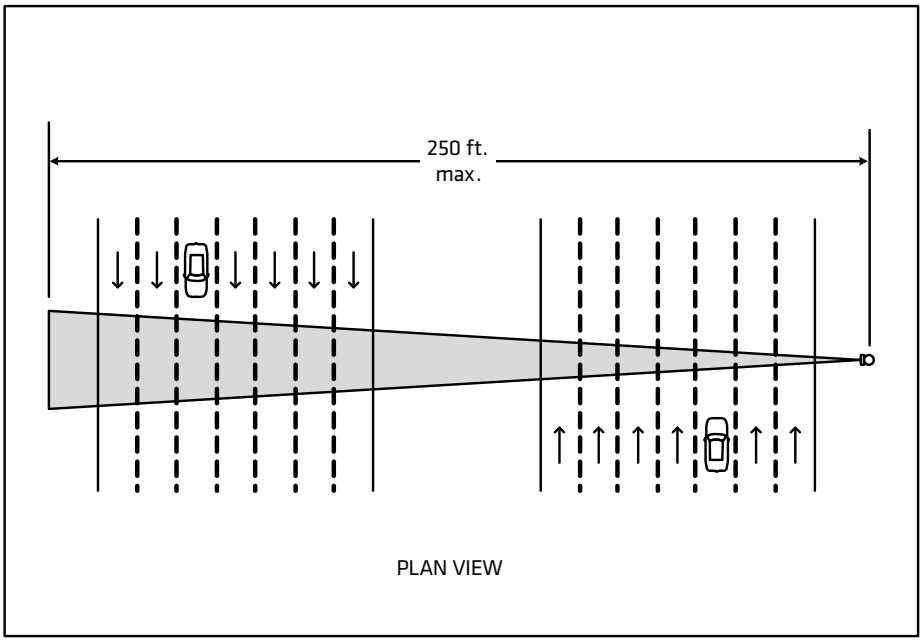
SmartSensor HD

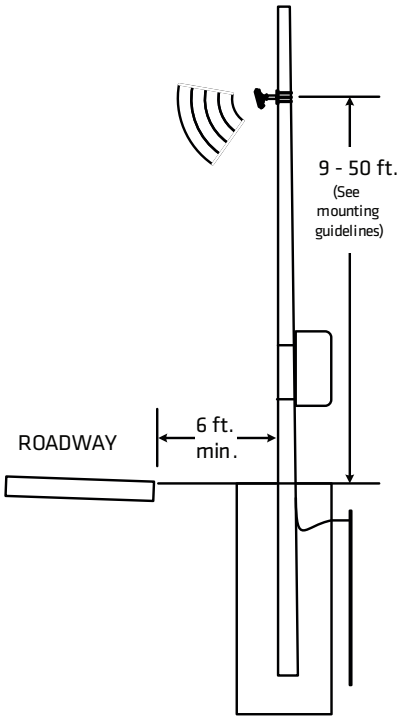
The SmartSensor™ HD delivers consistently accurate data for traffic monitoring systems, even in slow or congested traffic. Operating at five times the bandwidth of the original SmartSensor, the HD also has five times the resolution, a detection range of 250 feet and the ability to simultaneously detect up to 22 lanes of traffic.

Features

- Detects up to 22 lanes of traffic
- Reports the speed, length and classification of individual vehicles
- Works over barriers, guardrails, medians and gores
- Accurately detects lane-changing vehicles
- Patented Digital Wave Radar II™ technology
- Patented auto-configuration process
- Easy to install and operate
- Remote accessible for easy management
- Flash upgradeable
- Integrates with Wavetronix Click products
- Requires no tweaking or tuning
- All-weather, all-condition performance
- No performance variance due to temperature
- Flash memory protects data storage
- Automated manufacturing process







Technical Specifications

Measured Quantities

- Per-lane interval data: volume, average speed, occupancy, classification counts, 85th percentile speed, average headway, average gap, speed bin counts, direction counts
- Classification bins: 8
- Interval speed bins: 15
- Per-vehicle data: speed, length, class, lane assignment, range
- Presence data in 22 lanes

Detectable Area

- Number of lanes: up to 22
- Detection range: 6 to 250 ft. (1.8 m to 76.2 m)
- Any lane spacing is supported
- Detection over barriers is supported

Performance

- Per-direction volume accuracy:
  - Typical: 98%–99%
  - Minimum: 95%
- Per-lane volume accuracy:
  - Typical: 98%–99%
  - Minimum: 90%
- Minimum separation between two vehicles: 5.5 ft. (1.67 m)
- Per-direction average speed accuracy: ±3 mph (5 kph)
- Per-lane average speed accuracy: ±3 mph (5 kph)
- Percentage of vehicles generating per-vehicle-speed measurements:
  - Typical: 98%
  - Minimum: 95%
- Per-vehicle speed measurement accuracy: ±3mph (5 kph) for 90% of measurements
- Method of speed measurement: dual radar speed trap
- Per-direction occupancy accuracy: ±10%
- Per-lane occupancy accuracy: ±20%
- Classification accuracy:
  - Typical: 90%
  - Minimum: 80%

Performance Maintenance

- No cleaning or adjustment necessary
- No battery replacement necessary
- No recalibration necessary
- Mean time between failures: 10 years (estimated based on manufacturing techniques)

Physical Properties

- Weight: 4.2 lbs. (1.9 kg)
- Physical dimensions: 13.2 in. × 10.6 in. × 3.3 in. (33.5 cm x 26.9 cm x 8.4 cm)
- Resistant to corrosion, fungus, moisture deterioration, and ultraviolet rays
- Enclosure: Lexan polycarbonate
- Outdoor weatherable: UL 746C, IP66 rated
- Watertight by NEMA 250 standard
- NEMA 250 compliant for:
  - External icing (clause 5.6)
  - Hose down (clause 5.7)
  - 4X corrosion protection (clause 5.10)
  - Gasket (clause 5.14)
- Withstands 5-ft. (1.5-m) drop
- Connector: MIL-DTL-26482

Ordering Information

SmartSensor HD
101-0415

Retrofitted SmartSensor HD
101-0416

SmartSensor HD with rotating backplate
101-0403

ACCESSORIES

CLK-201/202 – Click 201/202 power supply

CLK-200 – Click 200 surge protector

CLK-112/114 – Click 112/114 rack cards

SS-706-xxx/707 – SmartSensor 8-conductor cable

SS-611 – SmartSensor mount

Wavetronix
78 East 1700 South
Provo, UT 84606
801.734.7200
sales@wavetronix.com
www.wavetronix.com

Power

- Power consumption: 7.6 W
- Supply voltage: 10–28 VDC

Communication Ports

- Com ports:
  - Full-duplex RS-232 with RTS/CTS
  - Half-duplex RS-485
- Firmware upgradability over any com port
- User configurable:
  - Baud rate
  - Response delay
  - Data push
  - RS-232 flow control
- Supported baud rates: 9600, 19200, 38400, 57600 and 115200 bps

Data Protocols

- Protocol support for interval, event, presence
- Data protocol document available free of charge
- Interval data for each lane:
  - Sensor ID
  - Timestamp
  - Volume
  - Average speed
  - Occupancy
  - Classification counts
  - Speed bin counts
  - Direction counts
  - Average headway
  - Average gap
  - 85th percentile speed
- Event data for each detection:
  - Sensor ID
  - Timestamp
  - Lane assignment
  - Speed
  - Length
  - Class
  - Range
- Presence data for each lane:
  - Sensor ID
  - Per-lane presence

Data Buffering

- At least 9,000 intervals stored internally
- Intervals timestamped using real-time clock

Radar Design

- Operating frequency: 24.0–24.25 GHz (K-band)
- Dual-radar
- No manual tuning to circuitry
- Transmits modulated signals generated digitally
- No temperature-based compensation necessary
- Bandwidth stable within 1%
- Printed circuit board antennas
- Antenna vertical 6 dB beam width (two-way pattern): 65°
- Antenna horizontal 6 dB beam width (two-way pattern): 6°
- Antenna two-way sidelobes: -40 dB
- Transmit bandwidth: 245 MHz *
- Un-windowed resolution: 2 ft. (0.6 m)
- RF channels: 4
- EIRP: 18.1 dBm
- Antenna gain: 14 dB

Configuration

- Auto-configuration of lanes/detection zones:
  - Internal to the sensor
  - Uses positions of the vehicles
  - Based on probability density function estimation
- Manual configuration supported
- Lane boundary increment: 1 ft. (0.3 m)
- Graphical user interface with traffic pattern display
- Pointing assistant for horizontal alignment
- Windows Mobile–compatible software
- Supported operating systems:
  - Windows Vista
  - Windows 7
  - Windows 8
  - Windows 10
- Software-supported functionality:
  - Auto-find baud rate
  - Auto-find serial port
  - TCP/IP connectivity
  - Sensor configuration back-up and restore
  - Virtual sensor connections

Operating Conditions

- Accurate performance in:
  - Rain up to 2 in. (5.08 cm) per hour
  - Freezing rain
  - Snow
  - Wind
  - Dust

** Limited operating frequency and bandwidth available in some areas.*

  - Fog
  - Changing temperature
  - Changing lighting (even direct light on sensor at dawn and dusk)
- Ambient operating temperature: -40°F to 165°F (-40°C to 74°C)
- Humidity: up to 95% RH (non-condensing)

Testing

- Tested under FCC CFR 47, part 15, section 15.249
- FCC certification on product label
- FCC regulation–compliant for life of the sensor
- Tested under NEMA TS 2-2003
  - Shock pulses of 10 g, 11 ms half sine wave
  - Vibration of 0.5 g up to 30 Hz
  - 300 V positive/negative pulses
  - Stored at -49°F (-45°C) for 24 hours
  - Stored at 185°F (85°C) for 24 hours
  - Operation at -29.2°F (-34°C) and 10.8 VDC
  - Operation at -29.2°F (-34°C) and 26.5 VDC
  - Operation at 165.2°F (74°C) and 26.5 VDC
  - Operation at 165.2°F (74°C) and 10.8 VDC

Manufacturing

- Manufactured in the USA
- Surface mount assembly
- IPC-A-610C Class 2–compliant
- Operational testing:
  - Sub-assembly test
  - 48-hour unit level burn-in
  - Final unit test
- Unit test results available

Support

- Training and tech support available from Wavetronix
- Wavetronix training includes:
  - Installation and configuration instruction to ensure accurate performance
  - Classroom and in-field instruction
  - Knowledgeable trainers
  - Use of presentation materials
  - Virtual configuration using computer playback
  - Instruction in use of computer and other necessary equipment
- Wavetronix tech support includes:
  - Technical representatives available for installation and configuration
  - Ongoing troubleshooting and maintenance support

Documentation

- Comprehensive user guide
- Installer quick-reference guide
- User quick-reference guide
- Documentation available upon request:
  - Volume accuracy
  - Speed accuracy
  - Occupancy accuracy
  - Classification accuracy
  - Auto-configuration performance
  - FCC certification
  - CE certification
  - NEMA TS 2-2003 third-party test data
  - NEMA 250 third-party test data

Warranty

- Two-year warranty against material and workmanship defect (see SmartSensor Warranty datasheet for complete details)

The advertised detection accuracy of the company's sensors is based on both external and internal testing, as outlined in each product's specification document. Although our sensors are very accurate by industry standards, like all other sensor manufacturers we cannot guarantee perfection or assure that no errors will ever occur in any particular applications of our technology. Therefore, beyond the express Limited Warranty that accompanies each sensor sold by the company, we offer no additional representations, warranties, guarantees or remedies to our customers. It is recommended that purchasers and integrators evaluate the accuracy of each sensor to determine the acceptable margin of error for each application within their particular system(s).

SmartSensor HD Bid Specification

1.0 General. This item shall govern the purchase of aboveground radar vehicle sensing devices (RVSD) equivalent to the Wavetronix SmartSensor™ HD.

An RVSD detects vehicles by transmitting electromagnetic radar signals through the air. The signals bounce off vehicles in their paths and part of the signal is returned to the RVSD. The returned signals are then processed to determine traffic parameters.

RVSDs are not affected by normal weather and environmental conditions such as rain, wind, snow, dust, etc. They also do not require cleaning and can maintain performance over a wide range of ambient temperatures.

RVSDs provide a non-intrusive means of detecting traffic because they can be installed at the side of a roadway. This property not only makes them safer to install but also more cost effective than sensors that require roadway modifications or placement.

2.0 Measured Quantities. The RVSD shall provide volume, average speed, occupancy, classification counts, 85th percentile speed, average headway, average gap, speed bin counts and direction counts for user-configurable time intervals for up to 22 lanes of traffic.

The RVSD shall provide up to eight length-based classification bins.

The RVSD shall provide up to 15 speed bins.

The RVSD shall provide speed, length, class, lane assignment, and range data for each vehicle detection.

The RVSD shall provide presence data for up to 22 lanes of traffic.

3.0 Detectable Area.

3.1 Maximum Lanes. The RVSD shall be able to detect and report information from up to 22 lanes.

3.2 Detection Range. The RVSD shall be able to detect and report information in lanes with boundaries as close as 6 ft. (1.8 m) from the base of the pole on which the RVSD is mounted.

The RVSD shall be able to detect and report information in lanes located with the far boundary at 250 ft. (76.2 m) from the base of the pole on which the RVSD is mounted.

The RVSD shall be able to simultaneously detect and report information from a lane located at the minimum offset and from a lane located at the maximum range.

3.3 Lane Size and Spacing. The RVSD shall allow any spacing of traffic lanes positioned from the minimum offset to the maximum range. Gore and unequally sized or spaced lanes shall be handled so that detections from the lanes meet all performance specifications.

Not all roadways have lanes that lie on evenly spaced intervals. Some roadways have gore, odd-sized medians and unequal lane sizes. An RVSD should be able to handle all these cases.

3.4 Barrier Performance. The RVSD shall detect vehicles with the specified accuracy in lanes that are adjacent to a barrier when 50% of a sedan is visible over the barrier from the point of view of the RVSD.

4.0 Performance.

4.1 Volume Accuracy. The volume data shall be within 5% of truth for a direction of travel during nominal conditions. Individual lane volume data shall be within 10% of truth during nominal conditions. The percentage of missed detection and the percentage of false detections for each lane shall not exceed 15% during nominal conditions. Nominal conditions exist when true occupancy is less than 30%, without merging traffic; when average speeds are greater than 10 mph (16 kph) in

every lane; when there is less than 20% truck traffic per lane; and when at least 50 cars per lane are counted in the interval.

The RVSD shall detect a minimum separation of 5.5 ft. (1.67 m) between two vehicles depending on vehicle speed and range.

4.2 Speed Accuracy. Average speed data shall be accurate to within 3 mph (5 kph) for any direction of travel when there are more than five cars per lane in an interval. Average speed data for any individual lane shall be accurate to within 3 mph (5 kph) when there are more than five cars per lane in an interval.

The RVSD shall provide per-vehicle speed measurements on 95% of vehicles that are not occluded by other vehicles or by barriers. The RVSD shall provide per-vehicle speed measurements in which 90% of the measurements are within 3 mph (5 kph).

The RVSD shall measure speed using a dual-radar speed trap that calculates the time delay between two different radar beams.

The dual-radar time delay method of calculating speed produces accurate per-vehicle speeds which enable accurate length measurements, classification, 85th percentile speed measurements and responsive average speed measurements. In contrast, algorithms that derive the speed from presence measurements or vehicle durations have been shown to produce significant biases in the speed measurements especially during congestion.

4.3 Occupancy Accuracy. Occupancy data shall be within 10% of truth for any direction of travel on a roadway during nominal conditions. For example, if the true occupancy in a lane is 20%, then the measured occupancy shall be between 18% and 22%. Individual lane occupancy shall be within 20% during nominal conditions. Nominal conditions exist when true occupancy is less than 30%, without merging traffic; when average speeds are greater than 10 mph (16 kph) in every lane; when there is less than 20% truck traffic per lane; and when at least 50 cars per lane are counted in the interval.

4.4 Classification Accuracy. The RVSD shall correctly determine classification for 80% of detected vehicles when the classification bins are at least 10 ft. (3 m) wide and occupancy of all lanes is below 30%.

5.0 Performance Maintenance. The RVSD shall not require cleaning or adjustment to maintain performance.

The RVSD shall not rely on battery backup to store configuration information, thus eliminating any need for battery replacement.

Once the RVSD is calibrated, it shall not require recalibration to maintain performance unless the roadway configuration changes.

The RVSD shall be manufactured using techniques that will yeild a mean time between failures of 10 years.

6.0 Physical Properties. The RVSD shall not exceed 5 lbs. (2.3 kg) in weight.

The RVSD shall not exceed 14 in. by 12 in. by 4 in. (35.6 cm x 30.5 cm x 10.2 cm) in its physical dimensions.

All external parts of the RVSD shall be ultraviolet-resistant, corrosion-resistant, and protected from fungus growth and moisture deterioration.

6.1 Enclosure. The RVSD shall be enclosed in a Lexan polycarbonate.

The enclosure shall be classified "f1" outdoor weatherability in accordance with UL 746C and shall be IP66 rated.

The RVSD shall be classified as watertight according to the NEMA 250 standard.

The RVSD enclosure shall conform to test criteria set forth in the NEMA 250 standard for type 4X enclosures. Test results shall be provided for each of the following type 4X criteria:

- External icing (NEMA 250 clause 5.6)
- Hose-down (NEMA 250 clause 5.7)

- 4X corrosion protection (NEMA 250 clause 5.10)
- Gasket (NEMA 250 clause 5.14)

The RVSD shall be able to withstand a drop of up to 5 ft. (1.5 m) without compromising its functional and structural integrity.

The RVSD enclosure shall include a connector that meets the MIL-DTL-26482 specification. The MIL-DTL-26482 connector shall provide contacts for all data and power connections.

7.0 Power. The RVSD shall consume less than 8.5 W.

The RVSD shall operate with a DC input between 10 VDC and 28 VDC.

8.0 Communication Ports. The RVSD shall have an RS-485 port and an RS-232 port, and both ports shall communicate independently and simultaneously.

The two simultaneous ports are necessary whenever simultaneous access to the RVSD is needed or redundancy is required. For example, two ports are needed if event data and interval data must be collected at the same time. For an example of redundancy, the RS-232 port and RS-485 port could each be connected to separate communications device to provide a backup means of communication in case a device fails.

The RS-232 port shall be full-duplex and shall support true RTS/ CTS hardware handshaking for interfacing with various communication devices.

The RVSD shall support the upload of new firmware into the RVSD's non-volatile memory over either communication port.

The RVSD shall support the user configuration of the following:

- Baud rate
- Response delay
- Data push
- RS-232 flow control (RTS/CTS or none)

The communication ports shall support all of the following baud rates: 9600, 19200, 38400, 57600 and 115200 bps.

9.0 Data Protocols. The RVSD shall support three different data protocols for all lanes being monitored: interval (bin) data, event (per vehicle) data, and real-time true presence data.

The RVSD manufacturer shall provide the data protocol document free of charge.

The interval (bin) data packet protocol shall support:

- Sensor ID
- A timestamp that records the year, month, day, hour, minute, and second of the end of time interval
- Total volumes of more than 65536
- Average speed values in either mph or kph
- Occupancy in 0.1% increments
- Volume in up to eight length-based user-defined vehicle classification bins
- Volume in up to 15 user-defined speed bins (bin by speed)
- Volume for both directions of traffic (bin by direction)
- Average headway in seconds
- Average gap in seconds
- 85th percentile speed in either mph or kph

The event (per vehicle) data packet protocol shall support:

- Sensor ID

- A timestamp that records the year, month, day, hour, minute, second and millisecond of the time the vehicle left the detection zone
- Lane assignment
- Speed values in either mph or kph
- Vehicle length
- Classification using up to eight user-defined classes
- Range

The real-time true presence data packet protocol shall support:

- Sensor ID
- True presence information for each lane being monitored

10.0 Data Buffering. The RVSD shall store, in non-volatile memory, at least 9,000 interval data packets with the maximum number of lanes and approaches configured and all interval fields enabled.

The RVSD shall timestamp interval data using a real-time clock that maintains accurate time even when power is disconnected from the sensor for extended periods of time.

11.0 Radar Design. The RVSD shall employ a dual radar design that includes two receive channels.

In order to achieve accurate per vehicle speed measurements, two radar channels are necessary so that a speed trap–type speed measurement can be made.

11.1 Frequency Stability. The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time.

All transmit modulated signals shall be generated by means of digital circuitry, such as a direct digital synthesizer, that is referenced to a frequency source that is at least 50 parts per million (ppm) stable over the specified temperature range, and ages less than 6 ppm per year. Any upconversion of a digitally generated modulated signal shall preserve the phase stability and frequency stability inherent in the digitally generated signal.

This specification ensures that, during operation, the RVSD strictly conforms to FCC requirements and that the radar signal quality is maintained for precise algorithmic quality. Analog and microwave components within an RVSD have characteristics that change with temperature variations and age. If the output transmit signal is not referenced to a stable frequency source, then the RVSD is likely to experience unacceptable frequency variations which may cause it to transmit out of its FCC allocated band and thus will be non-compliant with FCC regulations.

The RVSD shall not rely on temperature compensation circuitry to maintain transmit frequency stability.

Temperature-based compensation techniques have been shown to be insufficient to ensure transmit frequency stability. One reason this type of technique is not sufficient is that it does not compensate for frequency variations due to component aging.

The bandwidth of the transmit signal of the RVSD shall not vary by more than 1% under all specified operating conditions and over the expected life of the RVSD.

The bandwidth of an RVSD directly affects the measured range of a vehicle. A change in bandwidth causes a direct error in the measured range, i.e., a 5% change in bandwidth would cause a range error of 10 ft. (3 m) for a vehicle at 200 ft. (61 m). If the bandwidth changes by more than 1% due to seasonal temperature variations and component aging, then the RVSD will need to be frequently reconfigured to maintain the specified accuracy.

11.2 Antenna Design. The RVSD antennas shall be designed on printed circuit boards.

Printed circuit board antennas eliminate the need for RF connectors and cabling that result in decreased reliability. Printed circuit antennas are less prone to physical damage due to their extremely low mass.

The vertical beam width of the RVSD at the 6 dB points of the two-way pattern shall be 65 degrees or greater.

This enables the RVSD to provide simultaneous detection from a lane located at the minimum offset and a lane located at the maximum range. The vertical beam width of an RVSD determines the field of view in which it can detect traffic. If the field of view is smaller than the distance between the minimum offset and the farthest range, then the RVSD will be unable to detect vehicles over the entire range. A vertical beam width of less than 65 degrees will not allow an RVSD, mounted at a typical height of 17 ft. (5.2 m), to simultaneously detect and report information when the lanes are positioned from the minimum offset of 6 ft. (1.8 m) to the maximum range of 250 ft. (76.2 m).

The horizontal beam width of the RVSD at the 6 dB points of the two-way pattern shall be 6 degrees or less.

A narrow horizontal beam width allows the RVSD to resolve vehicles at the farthest ranges. If the horizontal beam width is too large, a trailing vehicle may be merged with the vehicle in front.

The sidelobes in the RVSD two-way antenna pattern shall be -40 dB or less.

Low sidelobes ensure that the performance from the antenna beam widths is fully achieved.

11.3 Resolution. The RVSD shall transmit a signal with a bandwidth of at least 240 MHz.

The bandwidth of the transmit signal translates directly into radar resolution, which contributes directly to detection performance. For example, an RVSD that transmits at a low bandwidth will have low radar resolution, which could cause it to count a single vehicle as two vehicles in adjacent lanes. As another example of the adverse effects of low radar resolution, the response from a barrier or other radar target in the roadway may spill over into the lanes of travel and desensitize the radar. In order to achieve the specified detection accuracy in a variety of conditions, the unwindowed radar resolution cannot be larger than 2 ft. (0.6 m) at the half-power level, which requires a bandwidth of 240 MHz. The high radar resolution reduces the problem of vehicle responses getting drowned out by brighter vehicles in adjacent lanes and improves performance for moving and stopped vehicles near barriers.

11.4 RF Channels. The RVSD shall provide at least 4 RF channels so that multiple units can be mounted in the same vicinity without causing interference between them.

12.0 Configuration.

12.1 Auto-configuration. The RVSD shall have a method for automatically defining traffic lanes or detection zones without requiring user intervention. This auto-configuration process shall execute on a processor internal to the RVSD and shall not require an external PC or other processor.

The auto-configuration process shall automatically define traffic lanes or detection zones by detecting the relative position of vehicles within the RVSD's field of view.

The RVSD shall include a transceiver capable of detecting multiple vehicles present within its field of view. The RVSD shall also include a processor or computer with executable instructions that estimates the position of each of the vehicles, records the position of the vehicles, generates a probability density function estimation from each position of the vehicles, and defines traffic lanes from that probability density function estimation. The probability density function estimation represents the probability that a vehicle will be located at any range.

The RVSD auto-configuration process shall define all lanes within the detectable area of the RVSD, up to the maximum number of lanes, during free-flow conditions; when at least 50% of a sedan is visible above any barriers; when at least 10 cars pass in each lane during configuration time; and there are less than 10% lane-changing vehicles.

12.2 Manual Configuration. The auto-configuration method shall not prohibit the ability of the user to manually adjust the RVSD configuration.

The RVSD shall support the configuring of lanes or detection zones in 1-ft. (0.3-m) increments.

When lanes have variable widths or have variable spacing (e.g. gore between lanes), precise resolution is necessary.

12.3 Windows®–based Software. The RVSD shall include graphical user interface software that displays all configured lanes and the current traffic pattern using a graphical traffic history representing at least the last 1.5 seconds of detected traffic. This graphical traffic history shall also allow the option of displaying the measured speed or length of a detected vehicle.

A visual representation of traffic patterns allows an installer to quickly associate specific detections with corresponding vehicles, and it facilitates verification of RVSD performance.

The graphical interface shall operate on Windows XP, Windows Vista, Windows 7, Windows 8.1, and Windows 10 in the .NET framework.

The software shall support the following functionality:

- Automatically find the correct baud rate
- Automatically find the correct serial communication port
- 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 RVSD configuration from a file
- Provide a virtual connection option so that the software can be used without connecting to an actual sensor

13.0 Operating Conditions. The RVSD shall maintain accurate performance in all weather conditions, including rain, freezing rain, snow, wind, dust, fog and changes in temperature and light, including direct light on sensor at dawn and dusk.

RVSD operation shall continue in rain up to 2 in. (5.08 cm) per hour.

The RVSD shall be capable of continuous operation over an ambient temperature range of -40˚F to 165.2˚F (-40˚C to 74˚C).

The RVSD shall be capable of continuous operation over a relative humidity range of 5% to 95% (non-condensing).

14.0 Testing.

14.1 FCC. Each RVSD shall be certified by the Federal Communications Commission (FCC) under CFR 47, Part 15, section 15.249 as an intentional radiator.

The FCC certification shall be displayed on an external label on each RVSD according to the rules set forth by the FCC.

The RVSD shall comply with FCC regulations under all specified operating conditions and over the expected life of the RVSD.

14.2 NEMA TS 2-2003 Testing. The RVSD shall comply with the applicable standards stated in the NEMA TS 2-2003 Standard. Third-party test results shall be made available for each of the following tests:

- Shock pulses of 10 g, 11 ms half sine wave
- Vibration of 0.5 g up to 30 Hz
- 300 V positive/negative pulses applied at one pulse per second at minimum and maximum DC supply voltage
- Cold temperature storage at -49˚F (-45˚C) for 24 hours
- High temperature storage at 185˚F (85˚C) for 24 hours
- Low temp, low DC supply voltage at -29.2˚F (-34˚C) and 10.8 VDC
- Low temp, high DC supply voltage at -29.2˚F (-34˚C) and 26.5 VDC
- High temp, high DC supply voltage at 165.2˚F (74˚C) and 26.5 VDC
- High temp, low DC supply voltage at 165.2˚F (74˚C) and 10.8 VDC

15.0 Manufacturing. The RVSD shall be manufactured and assembled in the USA.

The internal electronics of the RVSD shall utilize automation for surface mount assembly, and shall comply with the requirements set forth in IPC-A-610C Class 2, Acceptability of Electronic Assemblies.

The RVSD shall undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Testing shall include the following:

- Functionality testing of all internal sub-assemblies
- Unit level burn-in testing of 48 hours' duration or greater
- Final unit functionality testing prior to shipment

Test results and all associated data for the above testing shall be provided for each purchased RVSD by serial number, upon request.

16.0 Support. The RVSD manufacturer shall provide both training and technical support services.

16.1 Training. The manufacturer-provided training shall be sufficient to fully train installers and operators in the installation, configuration, and use of the RVSD to ensure accurate RVSD performance.

The manufacturer-provided training shall consist of comprehensive classroom labs and hands-on, in-the-field, installation and configuration training.

Classroom lab training shall involve presentations outlining and defining the RVSD, its functions, and the procedures for proper operation. These presentations shall be followed by hands-on labs in which trainees shall practice using the equipment to calibrate and configure a virtual RVSD. To facilitate the classroom presentation and hands-on labs, the manufacturer-provided training shall include the following items:

- Knowledgeable trainer or trainers thoroughly familiar with the RVSD and its processes
- Presentation materials, including visual aids, printed manuals and other handout materials for each student
- Computer files, including video and raw data, to facilitate the virtual configuration of the RVSD
- Laptop computers with the necessary software, and all necessary cables, connectors, etc.
- All other equipment necessary to facilitate the virtual configuration of the RVSD

Field training shall provide each trainee with the hands-on opportunity to install and configure the RVSD at roadside. Training shall be such that each trainee will mount and align the RVSD correctly.

16.2 Technical Assistance. Manufacturer-provided technical support shall be available according to contractual agreements, and a technical representative shall be available to assist with the physical installation, alignment, and auto-configuration of each supplied RVSD. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of RVSDs should such services be required.

17.0 Documentation. RVSD documentation shall include a comprehensive user guide as well as an installer quick-reference guide and a user quick-reference guide.

The RVSD manufacturer shall supply the following documentation and test results at the time of the bid submittal:

- Volume accuracy data, including performance analyses for:
  - Free-flowing traffic
  - Traffic with a lane roughly 8 ft. (2.4 m) beyond a 4-ft. (1.2 m) concrete barrier
  - 6-ft. (1.8-m) and 240-ft. (73.2-m) lateral offset (simultaneous)
- Speed accuracy test data for both per-vehicle and average speed
- Occupancy accuracy test data
- Vehicle classification test data
- Auto-configuration documentation
- FCC CFR 47 certification
- CE certification

- NEMA 250 standard for Type 4X Enclosure third-party test data
- NEMA TS 2-2003 standard third-party test data

18.0 Warranty. The RVSD shall be warranted free from material and workmanship defects for a period of two years from date of shipment.

The advertised detection accuracy of the company's sensors is based on both external and internal testing, as outlined in each product's specification document. Although our sensors are very accurate by industry standards, like all other sensor manufacturers we cannot guarantee perfection or assure that no errors will ever occur in any particular applications of our technology. Therefore, beyond the express Limited Warranty that accompanies each sensor sold by the company, we offer no additional representations, warranties, guarantees or remedies to our customers. It is recommended that purchasers and integrators evaluate the accuracy of each sensor to determine the acceptable margin of error for each application within their particular system(s).

SmartSensor HD Installation Specification

1.0 General. This item shall govern the installation of an aboveground radar vehicle sensing device (RVSD) equivalent to the Wavetronix SmartSensor™ HD.

RVSDs can provide accurate, consistent and reliable data provided they are installed properly. The requirements in this specification are intended to ensure proper RVSD installation.

2.0 Mounting and Installation.

2.1 Mounting Assembly. The RVSD shall be mounted directly onto a mounting assembly fastened to a pole or other solid structure.

The RVSD mounting assembly shall provide the necessary degrees of rotation to ensure proper installation.

The RVSD mounting assembly shall be constructed of weather-resistant materials and shall be able to support a 20-lb. (9.1-kg) load.

2.2 Mounting Location. The RVSD shall be mounted at a height that is within the manufacturer's recommended mounting heights.

The RVSD shall be mounted at an offset from the first lane that is consistent with the RVSD's minimum offset.

The RVSD shall be mounted so that the farthest lane to be monitored is within the maximum range of the RVSD.

The RVSD shall be mounted with its cable connector down and shall be tilted so that the RVSD is aimed at the center of the lanes to be monitored. Typically, the RVSD is tilted off of vertical by 10–20 degrees.

The RVSD shall be aligned so that the horizontal angle is perpendicular to the flow of traffic. The RVSD alignment tool shall be used to verify pointing accuracy.

Two RVSD units shall not be mounted so that they are pointed directly at each other.

A distance of 40 ft. (12.2 m) or more, along the direction of the roadway, shall separate the RVSDs if they are located on opposing sides of a roadway, and the RVSDs shall be configured to operate on different RF channels.

RVSDs that are mounted within 20 ft. (6.1 m) of each other shall be configured to operate on different RF channels regardless of the pointing direction of the RVSDs.

When possible, the pole selected for the RVSD shall be where there is no guardrail or other type of barrier between the pole and the first lane of traffic.

If mounting to an overhead structure like a sign bridge or a truss, the RVSD shall use an extension arm to provide at least 3 feet of lateral separation from the structure. The RVSD shall not be installed in tunnels.

It is recommended that the manufacturer be consulted to verify final RVSD placement if the RVSD is to be mounted near large planar surfaces (sound barrier, building, parked vehicles, etc.) that run parallel to the monitored roadway.

2.3 Cabling. The cable end connector shall meet the MILC-26482 specification and shall be designed to interface with the appropriate MIL-C-26482 connector. The connector backshell shall be an environmentally sealed shell that offers excellent immersion capability. All conductors that interface with the connector shall be encased in a single jacket, and the outer diameter of this jacket shall be within the backshell's cable O.D. range to ensure proper sealing. The backshell shall have a strain relief with enough strength to support the cable slack under extreme weather conditions. Recommended connectors are Cannon's KPT series, and recommended backshells are Glenair Series 37 cable sealing backshells.

The cable shall be the Orion Wire Combo-2206-2002-PVCGY or an equivalent cable that conforms to the following specifications:

- The RS-485 conductors shall be a twisted pair.
- The RS-232 and RS-485 conductors shall have nominal capacitance conductor to conductor of less than 45 pF/ft at 1 kHz.
- The RS-232 and RS-485 conductors shall have nominal conductor DC resistance of less than 16.5 ohms/1000 ft. (304.8 m) at 68˚F (20˚C).
- The power conductors shall be one twisted pair with nominal conductor DC resistance of less than 11.5 ohms/1000 ft. (304.8 m) at 68˚F (20˚C).
- Each wire bundle or the entire cable shall be shielded with an aluminum/mylar shield with a drain wire.

The cable shall have a single continuous run with no splices.

The cable shall be terminated only on the two farthest ends of the cable.

The cable length shall not exceed the following limits for the operational baud rate of RS-485 communications:

Baud Rate	Cable Length
115.2 Kbps	300 ft. (91.4 m)
57.6 Kbps	600 ft. (182.9 m)
38.4 Kbps	800 ft. (243.8 m)
19.2 Kbps	1000 ft. (304.8 m)
9.6 Kbps	2000 ft. (609.6 m)

NOTE: These represent maximum data rates. The data rate used should be the minimum data rate required for operation.

If communication is conducted over the RS-232 bus, then the RS-232 driver must be able to source and sink ±7 mA or more.

The cable length shall not exceed the following limits for the operational baud rate of RS-232 communications:

Baud Rate	Cable Length
115.2 Kbps	40 ft. (12.2 m)
57.6 Kbps	60 ft. (18.3 m)
38.4 Kbps	100 ft. (30.5 m)
19.2 Kbps	140 ft. (42.7 m)
9.6 Kbps	200 ft. (61 m)

NOTE: These represent maximum data rates. The data rate used should be the minimum data rate required for operation.

If 12 VDC is being supplied for the RVSD then the cable length shall not exceed 110 ft. (33.5 m).

If 24 VDC is being supplied for the RVSD then the cable length shall not exceed 600 ft. (182.9 m).

If a cable length of 600 ft. (182.9 m) to 2000 ft. (609.6 m) is required, the power cable shall be an ANIXTER 2A-1402 or equivalent cable that meets the following requirements:

- 10 AWG conductor size/gauge
- Two conductor count
- Stranded cable type
- Bare copper material
- 600 V range
- 194˚F (90˚C) temperature rating
- PVC/nylon insulation material
- PVC—polyvinyl chloride jacketing material
- 25 A per conductor

Both communication and power conductors can be bundled together in the same cable as long as the above-mentioned conditions are met.

2.4 Lightning Surge Protection. The RVSD shall be installed using lightning surge protection on all communication and power lines. The surge protection devices shall meet or exceed the EN 61000-4-5 Class 4 specifications. The lightning surge protection unit shall be the Wavetronix Click 200 or equivalent. The lightning surge protection unit supplied shall be physically compatible with the cable provided.

2.5 Power Supply. The RVSD shall be installed using the Click 201, Click 202 or an equivalent AC to DC power converter that meets the following specifications:

The power converter shall be power rated at 15 W or greater at 77°F (25°C) and 10 W or greater at 165.2°F (74°C).

The power converter shall operate in the temperature range of to -29.2°F to 165.2°F (-34°C to 74°C).

The power converter shall operate in the humidity range of 5% to 95% at 77°F (25°C) non-condensing.

The power converter shall accept an input voltage of 85 to 264 VAC or 120 to 370 VDC.

The power converter shall operate at an input frequency of 47 Hz to 63 Hz.

The power converter shall produce an output voltage of 24 VDC ±4%.

The power converter shall have a hold-up time of greater than 20 ms at 120 VAC.

The power converter shall withstand a voltage across its input and output of 3 kV. The power converter shall withstand a voltage across its input and ground of 1.5 kV.

The power converter shall conform to safety standards UL 60950-1 and EN 60950-1 and be certified and tested to meet the limited power source requirement according to clause 2.5. Its output current shall be limited to a maximum current of 4A both under normal and single fault condition; with double/reinforced insulation between its input and output circuits.

The power converter shall conform to EMC standards EN 55022 Class B and EN 61000-3-2, 3.

In brown-out conditions (i.e. < 85 VAC input), the output voltage of the power converter shall be less than 1 VDC.

2.6 Input File Cards. If input file cards are used in the detection system, then the Click 112, Click 114 or an equivalent that meets the following specifications shall be used.

The input file cards shall be compatible with 170, 2070, NEMA TS 1, and NEMA TS 2 style input racks.

The input file card shall translate data packets from the RVSD into contact closure outputs.

The input file card shall support dual loop (speed trap) emulation, as well as the following modes of operation:

- Pulse (a single 125 ms output pulse for each vehicle)
- Presence (an output pulse corresponding to the duration of each vehicle in the detection zone)
- Actuation (true presence output in real time)
- Single loop speed (duration of the pulse is inversely proportional to the speed of the vehicle)

The input file card shall receive data packets over an RS-485 bus at any of the following baud rates: 9600, 19200, 38400 and 57600 bps.

The input file card shall autobaud and auto-detect an RVSD over wired and wireless communication channels that have a maximum latency of 500 ms.

The input file card shall comply with the NEMA TS 2-1998 Traffic Controller Assemblies with NTCIP Requirements (Section 2.8 specification).

2.7 Signaling Delay. For even detection applications, the RVSD mounting location, communication and contact closure options shall be selected to accommodate the total signaling delay.

The total signaling delay from the front of the vehicle shall be the sensor delay + communications delay + contact closure delay.

The sensor delay shall equal 1 second + actual vehicle length in feet divided by actual vehicle speed in fps.

The communication delay shall equal 10/8 * 34 bytes divided by the baud rate in bps.

The contact closure delay for a Click 512 shall be zero.

The contact closure delay for a Click 112/114 shall equal the detected duration + the effective virtual loop length in feet divided by the detected vehicle speed in fps.