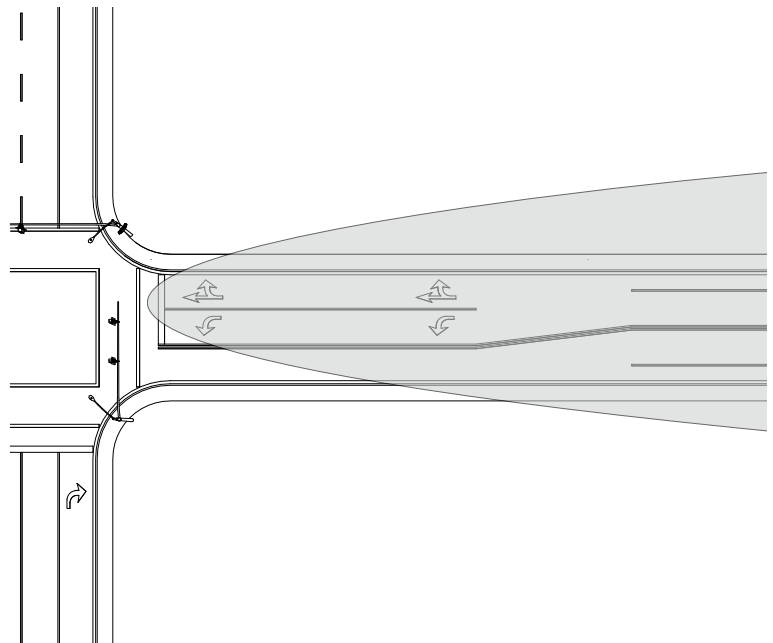
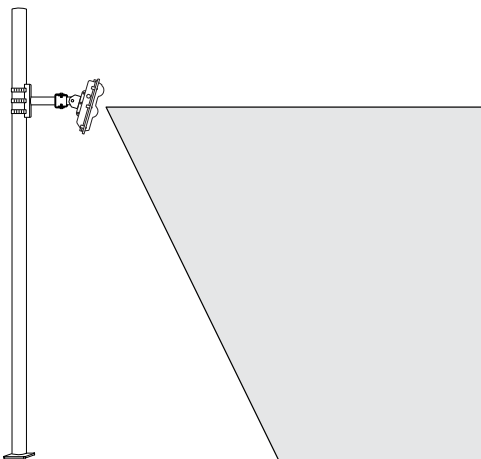


## Forward-fire intersection sensor

The Wavetronix SmartSensor Advance bridges the gap between safety and efficiency with one-of-a-kind SafeArrival technology. SafeArrival allows for effective dilemma-zone protection based upon dynamic ETA tracking of vehicles as they approach the stop-bar.



- Advance detection at signalized intersections
  - Patented Digital Wave Radar
  - Dynamic ETA Tracking over the entire detection area
  - Easy integration with the SmartSensor Matrix into the same backplate or Click 65x cabinet interface device
  - Latched channel functionality for queue length detection
  - Cost savings due to 600-ft. range of detection
  - Auto-configuration software for PC
  - Consistent all-weather, all-condition performance
- Breakthrough SafeArrival technology for safe and efficient dilemma zone protection
  - Easy integration with Wavetronix Click products
  - Non-intrusive, aboveground position makes sensor easy to install
  - Low-maintenance design



## Technical specifications

### Measured quantities

- Per-vehicle range, speed
- Dynamic stop-bar ETA tracking, adjusted as vehicles change speeds
- Dynamic density (a measure of instantaneous roadway efficiency)
- Number of simultaneous vehicle detections: 25
- Logic filters for zone output
- Combinational logic applied to zone outputs for alert output
- Channel output from multiple alerts
- Latched channel output controlled by alerts and timer
- Delay and extend settings used for channel outputs
- Number of channels: 8
- Detection data available via serial communications
- Pulse channel outputs for intersection arrival-time information

### Detectable area

- Maximum mounting distance from center of lanes: 50 ft. (15.2 m)
- Maximum mounting height: 40 ft. (12.2 m)
- Detection area: 50 to 600 ft. (15.2 m to 182.8 m)
- Percentage of vehicles detected before 400 ft. (121.9 m): large vehicles 95%; all motor vehicles 90%

### Performance

- Detection accuracy: large vehicles 98%; all motor vehicles 95%
- Range accuracy: ±10 ft. (3 m) for 90% of measurements
- Speed accuracy: ±5 mph (8 kph) for 90% of measurements
- ETA accuracy: ±1 sec. for 85% of measurements

### Performance maintenance

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

### Physical properties

- Weight: 3.8 lbs. (1.7 kg)
- Physical dimensions: 13.2 in. × 10.6 in. × 3.8 in. (33.5 cm × 26.9 cm × 9.7 cm)
- Resistant to corrosion, fungus, moisture deterioration and ultraviolet rays
- Enclosure: Lexan polycarbonate
- Outdoor weatherable: UL 746C
- 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)

## Ordering information

SmartSensor Advance  
**SS-200V**

Retrofitted SmartSensor Advance  
**SS-200-001**

### Accessories

**102-0416/102-0451** – Click 650/656 cabinet interface device

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

**SS-704-xxx/705** – SmartSensor 6-conductor cable

**SS-708-xxx/707** – SmartSensor 8-conductor cable (for retrofitted sensor)

**SS-611** – SmartSensor mount

**SS-B01-0003/0005/0008** – Intersection preassembled backplate – AC

**SS-B01-0004/0006** – Intersection preassembled backplate – DC

**SS-B02-0002/0003** – Intersection preassembled 19-inch rack

**SS-710** – Sensor cable junction box

### Contact us

801.734.7200

sales@wavetronix.com

www.wavetronix.com

- Withstands 5-ft. (1.5-m) drop
- Connector: MIL-C-26482
- Rotational backplate for 360° of roll

### Electrical

- Power consumption: 3.2 W @ 12 VDC
- Supply voltage: 10–28 VDC
- Onboard surge protection

### Communication ports

- Two half-duplex RS-485 COM ports support:
  - Dedicated detection communications
  - Configuration, verification, or traffic display without disrupting detection communications
- Firmware upgradability over any COM port

- User configurable:
  - Baud rate
  - Response delay
  - Contact closure data output frequency
- Supported baud rates: 9600, 19200, 38400, 57600 and 115200 bps
- Contact closure data output frequency:
  - Minimum: 50 ms
  - Default: 130 ms
- Contact closure data latency (varies with baud rate and output frequency):
  - Minimum: 55 ms (this is achieved using 57600 bps baud rate and 50 ms output frequency)
  - Default: 142 ms (this is achieved using 9600 bps baud rate and 130 ms output frequency)

### Radars design

- Operating frequency: 10.5–10.55 GHz (X-band)
- No manual tuning to circuitry
- Transmit 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): 10.5°
- Antenna two-way sidelobes -40 dB
- Transmit bandwidth: 45 MHz
- Un-windowed resolution: 11 ft. (3.4 m)
- RF channels: 8

### Configuration

- Automatic and manual configuration of detection sensitivity in 5-ft. (1.5-m) increments
- Channel outputs: 8
  - Alerts per channel: 4 (32 total)
  - Zones per alert: 4 (128 total)
- Zone size increment: 5 ft. (1.5 m)
- Maximum detection zone size: 550 ft. (167.6 m)
- High speed and low speed detection filters
- Speed filter increment: 1 mph (1.6 kph)
- Upper and lower ETA filters
- ETA filter increment: 0.1 seconds
- Upper and lower count filters
- Count filter increment: 1
- Graphical user interface with traffic representation
- Display of configured alerts and their actuation
- Vehicle track file logging
- Supported operating systems:
  - Windows 7
  - Windows 8
  - Windows 10

- Software supported functionality:
  - Auto-find baud rate
  - Auto-find serial port
  - TCP/IP connectivity
  - Virtual sensor connections
  - Sensor configuration backup and restore

### Operating conditions

- Accurate performance in:
  - Rain up to 2 in. (5.08 cm) per hour
  - Freezing rain
  - Dry snowfall and moist snowfall
  - Wind
  - Dust
  - Fog
  - Changing temperature
  - Changing lighting (even direct light on sensor at dawn and dusk)
  - Ice and dry snow buildup up to 0.2 in. (0.5 cm) on sensor front
- Ambient operating temp: -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 15.245
- FCC certification on product label
- FCC regulation-compliant for life of the sensor
- Tested under IEC 61000-4-5 class 4 (lightning surge protection)
- Tested under NEMA TS 2-1998
  - 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 and wave solder 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
- 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:
  - Detection accuracy
  - Range accuracy
  - Earliest range of detection
  - Speed accuracy
  - ETA accuracy
  - FCC CFR 47 certification
  - NEMA 250 standard for type 4X enclosure third-party test data
  - NEMA TS 2-1998 standard third-party test data
  - IEC 61000-4-5 class 4 test report

### **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).*

## Bid specifications

**1.0 General.** This item shall govern the purchase of aboveground continuous tracking advance detector (CTAD) equivalent to the Wavetronix SmartSensor Advance.

A CTAD 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 CTAD.

The returned signals are then processed to determine traffic parameters. CTADs are not affected by normal weather and environmental conditions such as rain, wind, dry snowfall, moist snowfall, dust, etc. They also do not require cleaning and can maintain performance over a wide range of ambient temperatures.

CTADs 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 and outputs.** The CTAD shall detect range and speed to the stop bar for vehicles or clusters of vehicles moving in the user-selected direction of travel. The CTAD shall dynamically track and update the estimated time of arrival (ETA) for each vehicle as it approaches the stop-bar; each newly-measured ETA result will be continually compared against the pre-determined ETA ranges that define the dilemma zone, and a green light extension request will be provided to the controller when one or more vehicles are within that range. The CTAD shall also detect instantaneous roadway efficiency.

*Dynamic ETA tracking allows the sensor to adjust the ETA over time when approaching vehicles accelerate or decelerate. This allows the ETA-based zone detections to be more accurate than single ETA figures based on spot-speeds from a single location.*

The CTAD shall be able to simultaneously detect and report information from up to 25 vehicles on the roadway when they are serially sequenced between the near and far boundaries.

The CTAD shall turn on a zone output when the range, speed, ETA, and qualified count or instantaneous roadway efficiency requirements for that zone are satisfied.

The CTAD shall turn on an alert output on when the userdefined zone output combinational logical is satisfied.

The CTAD shall turn on a normal channel output when any of the channel's alerts is on and the channel's delay and extend time constraints are satisfied.

The CTAD shall turn on a latched channel output when the on alert is turned on and the delay time is satisfied. The CTAD shall turn off a latched channel output when the off alert is turned on or the max timer expires and the extension time is satisfied.

*Channel outputs are used to create contact closures which can be used as inputs into a traffic controller.*

The CTAD shall provide vehicle call and extend data on up to eight channels that can be connected to contact closure modules compliant with NEMA TS 1, NEMA TS 2, 170, and 2070 controller cabinets.

The CTAD shall be capable of providing data for each tracked detection over the serial ports.

The CTAD shall have Pulse channel outputs for intersection arrival-time information.

*When vehicular track file data is available on the serial ports, the data is then available on the communications network without the use of a traffic controller or a contact closure data recorder. Vehicular track file data is useful for traffic study applications and for performing comparisons between traffic sensors.*

### 3.0 Detectable area.

**3.1 Mounting location.** The CTAD shall be able to detect and report vehicle information when mounted within 50 ft. (15.2 m) of the center of the lanes of interest.

The CTAD shall be able to detect and report vehicle information when mounted at heights up to 40 ft. (12.2 m) above the road surface.

**3.2 Detection range.** The CTAD shall be able to detect and report information on the roadway located with the near boundary at 50 ft. (15.2 m) from the base of the pole on which the CTAD is mounted.

The CTAD shall be able to detect and report information on the roadway located with the far boundary at 600 ft. (182.8 m) from the base of the pole on which the CTAD is mounted.

For incoming traffic, 95 percent of large vehicles within the line-of-site of the CTAD shall be detected and reported before they arrive 400 ft. (121.9 m) from the sensor. For incoming traffic, 90 percent of all motor vehicles within the line-of-site of the CTAD shall be detected and reported before they arrive 400 ft. (121.9 m) from the sensor.

## 4.0 Performance.

**4.1 Detection accuracy.** The CTAD shall detect at least 98 percent of large vehicles like truck-trailer combinations and at least 95 percent of all motor vehicles within the line-of-sight of the CTAD sensor where multiple detections of multi-unit vehicles are not considered false detections and merged detections of adjacent lane vehicles are not considered missed detections.

**4.2 Range accuracy.** The CTAD shall provide range measurements in which 90% of the measurements are accurate within 10 ft. (3 m) when the vehicle is tracked independently.

**4.3 Speed accuracy.** The CTAD shall provide per vehicle speed measurements in which 90% of the measurements are accurate within 5 mph (8 kph) when tracked independently.

**4.4 ETA accuracy.** The CTAD shall provide estimated time-of-arrival (ETA) measurements in which 85% of the measurements are accurate within one second, when the detected vehicles are tracked independently at a constant speed above 40 mph (64 kph) and are within 2.5 and 5.5 seconds of the stop bar.

**5.0 Performance maintenance.** The CTAD shall not require cleaning or adjustment to maintain performance.

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

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

The mean time between failures shall be 10 years, which is estimated based on manufacturing techniques.

**6.0 Physical properties.** The CTAD shall not exceed 4 lbs. (1.8 kg) in weight.

The CTAD shall not exceed 14 in. × 11 in. × 4 in. (35.6 cm x 27.9 cm x 10.2 cm) in its physical dimensions.

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

**6.1 Enclosure.** The CTAD shall be enclosed in a Lexan polycarbonate.

The enclosure shall be classified “ff” outdoor weatherability in accordance with UL 746C.

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

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

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

**7.0 Electrical.** The CTAD shall consume less than 4 W at 12 VDC.

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

The CTAD shall have onboard surge protection.

**8.0 Communication ports.** The CTAD shall have two communication ports, and both ports shall communicate independently and simultaneously.

*Two independent communication ports allow one port to be used for configuration, verification and traffic monitoring without interrupting communications on the dedicated data port.*

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

The CTAD shall support the user configuration of the following:

- Baud rate
- Communication port response delay
- Contact closure output frequency

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

The contact closure output frequency shall be user configurable as short as 10 ms, with a default near 130 ms for compatibility.

Contact closure data shall be reliably communicated over homerun cable connections as long as 600 ft. (182.9 m) with latency from the time of channel requirement satisfaction to the eventual reporting of the detections on the back edge of the contact closure card in 15 ms or less.

*Contact closure data latency is dependent on baud rate and output frequency settings. The required minimum must be achievable when the baud rate is set to a high value and the output frequency is set to a frequent value.*

## **9.0 Radar design.**

**9.1 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 CTAD strictly conforms to FCC requirements and that the radar signal quality is maintained for precise algorithmic quality. Analog and microwave components within a CTAD have characteristics that change with temperature variations and age. If the output transmit signal is not referenced to a stable frequency source, then the CTAD 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 CTAD 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 CTAD shall not vary by more than 1% under all specified operating conditions and over the expected life of the CTAD.

*The bandwidth of a CTAD 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 CTAD will need to be frequently reconfigured to maintain the specified accuracy.*

**9.2 Antenna design.** The CTAD 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 CTAD at the 6 dB points of the two-way pattern shall be 65 degrees or greater.

*This enables the CTAD to provide simultaneous detection from the nearest to the farthest ranges. The vertical beam width of a CTAD determines the field of view in which it can detect traffic.*

The horizontal beam width of the CTAD at the 6 dB points of the two-way pattern shall be 11 degrees or less.

*A narrow horizontal beam width narrows the field of view of the CTAD to the lanes of interest and helps to exclude the traffic traveling in the opposite direction.*

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

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

**9.3 RF channels.** The CTAD shall provide at least eight RF channels so that multiple units can be mounted in the same vicinity without causing interference between them.

## 10.0 Configuration.

**10.1 Auto-configuration.** The CTAD shall have a method for automatically configuring the sensitivity of detection in at least 5-ft. (1.5-m) increments.

*This allows the sensor to quickly and accurately record the intensity of roadside clutter and set appropriate rejection thresholds to avoid false detections at different ranges.*

The auto-configuration method shall not prohibit the ability of the user to manually adjust the CTAD configuration.

The CTAD shall support the configuration of up to eight channel outputs with up to four alerts per channel and up to four zones per alert, resulting in 32 configurable alerts and 128 configurable zones.

**10.2 Zone configuration.** The CTAD shall support the configuring of zones in 5-ft. (1.5-m) increments.

The CTAD shall support detection zones as long as 550 ft. (167.6 m).

*The ability to define one large zone simplifies and enhances configuration when compared to point detection schemes.*

The CTAD shall support user configurable high-speed and low-speed detection filters for each zone.

The CTAD shall support the configuring of speed filters in 1-mph (1.6-kph) increments.

*The speed thresholds can be used to provide superior gap management for green extension applications at signalized intersections, especially when a high-speed traffic stream presents a limited number of opportunities to gap out. For example, when the operational objective is to increase safety by extending the green light for law-abiding high-speed drivers, reporting of low-speed vehicles is not desirable. On the other hand, when the operational objective is to increase efficiency by extending the green light for clearance of a low-speed traffic queue, reporting of high-speed vehicles is not desirable.*

*In addition, these speed filters can be configured to screen out reporting of detections that may adversely impact operational objectives. For example, low speed filters can also be used to screen out detection of low-speed clutter like unwanted detection of turn-only bays, pedestrians, swaying trees, and vibrating signs.*

The CTAD shall support user configurable upper and lower estimated time-of-arrival (ETA) filters for each zone.

The CTAD shall support the configuring of ETA filters in increments of 0.1 seconds.



*The ETA thresholds can be used to provide superior gap management for green extension applications at signalized intersections, especially when a high-speed traffic stream presents a limited number of opportunities to gap out. For example, when the operational objective is to increase safety by extending the green light for law-abiding high-speed drivers, reporting of vehicles upstream of 5.5 seconds and downstream of 2.5 seconds may not be desirable. Vehicles with 2.5 to 5.5 seconds are commonly considered to be in the driver dilemma zone when the light turns yellow. However, motorists closer than 2.5 seconds can easily clear the intersection and those beyond 5.5 seconds can be expected to stop. Dilemma zone protection has been shown to reduce red-light running and rear-end collisions.*

*ETA filtering provides a dynamic form of dilemma zone protection that adapts when traffic speeds rise above or fall below design assumptions used with traditional methods of fixed-point detection. ETA filtering also constrains reporting of detections to provide more gap out opportunities, avoid the likelihood of reaching maximum green, and maximize the effective use of green by timing clearance of the last vehicle. ETA filtering—in combination with dynamic ETA tracking to continuously update vehicle ETA based on speed changes—provides many practical efficiency and safety benefits.*

The CTAD shall provide configurable upper and lower count filters that help determine if a required number of qualified detections are present.

The CTAD shall support the configuring of qualified count filters in increments of one.

*These filters can be to provide superior gap management for green extension applications at signalized intersections, especially when a high-speed traffic stream presents a limited number of opportunities to gap out.*

*Qualified count is tied to the number of vehicles that meet the range, speed and ETA requirements of a zone. For example, for green extension it may be required that there are two vehicles detected within 2.5 to 5.5 seconds of the stop bar traveling above 35 mph (56 kph), instead of just one. The logic is that if only one vehicle is in the dilemma zone, this is not as threatening as if there are two vehicles (one following the other). The following vehicle may incorrectly assume that the lead vehicle will try to clear the intersection and cause a rear-end collision. Rear-end collisions are the most common form of collision at a signalized intersection.*

**10.3 Windows-based software.** The CTAD shall include graphical user interface software that displays the current traffic pattern using a graphical traffic representation.

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

The graphical user interface shall also display all configured alerts and provide visual representation of their actuation.

The graphical user interface shall provide a means of logging the vehicular track files with an update rate of greater than five times per second.

*The user configured baud rate will effect the rate at which log files are logged. This requirement must be met at higher baud rates.*

The graphical interface shall operate on Windows 7, Windows 8, 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
- Provide a virtual sensor connection for software usability without a sensor
- Give the operator the ability to save/back up the CTAD configuration to a file or load/restore the CTAD configuration from a file

**11.0 Operating conditions.** The CTAD shall maintain accurate performance in all weather conditions, including rain, freezing rain, dry snowfall, moist snowfall, wind, dust, fog and changes in temperature and light, including direct light on sensor at dawn and dusk. The CTAD shall maintain accurate performance with ice and dry snow buildup on the sensor front.

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

The CTAD shall be capable of continuous operation over an ambient temperature range of -40°F to 165°F (-40°C to 74°C).

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

*Dry snow and moist snow are terms defined by the International Hydrological Program of the United Nations in the publication "The International Classification For Seasonal Snow on the Ground." Dry snow has a water volume content of 0% and moist snow has water content of less than 3%. Wet snow has higher fractional volumes of water and varying fractional volumes of air. Depending on the precipitation rate and the fractional volumes of ice, air, and water, the CTAD shall be capable of continuous operation in wet snowfall. For example, with typical fractional volumes of ice, air, and water the CTAD shall be capable of continuous operation in wet snowfall with a precipitation rate less than 1 in. per hour (2.5 cm) per hour. Furthermore, as instructed in the user documentation, the sensor should be installed with a down tilt for accurate detection. A down tilt alignment will also help shield the sensor front and minimize the possibility of dry, moist, and wet snow buildup in extreme weather conditions.*

## 12.0 Testing.

**12.1 FCC.** Each CTAD shall be Federal Communications Commission (FCC) certified under CFR 47, part 15, section 15.245 or 15.249 as an intentional radiator.

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

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

The CTAD shall be tested under IEC 61000-4-5 class 4 (lightning surge protection).

**12.2 NEMA TS 2-1998 testing.** The CTAD shall comply with the applicable standards stated in the NEMA TS 2-1998 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

**13.0 Manufacturing.** The CTAD shall be manufactured and assembled in the USA.

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

The CTAD 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 CTAD by serial number, upon request.

**14.0 Support.** The CTAD manufacturer shall provide both training and technical support services.

**14.1 Training.** The manufacturer-provided training shall be sufficient to fully train installers and operators in the installation, auto-configuration, and use of the CTAD to ensure accurate CTAD 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 CTAD, 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 CTAD. 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 CTAD 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 CTAD
- Laptop computers with the necessary software, and all necessary cables, connectors, etc.

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

**14.2 Technical assistance.** The manufacturer-provided technical support shall be available according to contractual agreements and a technical representative available to assist with the physical installation, alignment, and configuration of each supplied CTAD. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of CTADs should such services be required.

**15.0 Documentation.** CTAD documentation shall include a comprehensive user guide as well as an installer quick-reference guide and a user quick-reference guide.

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

- Detection accuracy
- Range accuracy
- Earliest range of detection
- Speed accuracy
- ETA accuracy
- FCC CFR 47 certification
- NEMA 250 standard for Type 4X Enclosure third-party test data
- NEMA TS 2-1998 standard third-party test data
- IEC 61000-4-5 class 4 test report (surge)

**16.0 Warranty.** The CTAD 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).*

## Installation specifications

**1.0 General.** This item shall govern the installation of an aboveground continuous tracking advance detector (CTAD) equivalent to the Wavetronix SmartSensor Advance.

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

### 2.0 Mounting and installation.

**2.1 Mounting assembly.** The CTAD shall be mounted directly onto a mounting assembly fastened to a pole, overhead mast arm, or other solid structure. In qualifying tethered (double) span wire intersections, the mounting assembly may be fastened to a hanger assembly that is affixed to the span wire.

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

The CTAD 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 CTAD shall be mounted at a height that is within the manufacturer's recommended mounting heights.

The CTAD shall be mounted at an offset from the center of the lanes of interest that is consistent with the CTAD's maximum offset.

The CTAD shall be mounted in a forward-fire position, looking towards either approaching or departing traffic.

The CTAD shall be mounted so that it is pointed within 10 ft. (3 m) of the target point as defined by the manufacturer's table of target points for mounting offsets and mounting heights.

The CTAD shall be mounted so that its vertical center line is within 5 degrees of the lanes of interest as described in the manufacturer's documentation.

Aligning the CTAD's center line with the roadway ensures that the antenna beam of the CTAD is positioned along the roadway.

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

CTADs 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 CTAD.

The CTAD shall not be installed in areas with overhead structures. For example, overhead sign bridges, tunnels and overpasses should be avoided. The CTAD shall be mounted at least 30 ft. (9.1 m) to the side of any such overhead structures.

**2.3 Cabling.** The cable end connector shall meet the MIL-C-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 Wavetronix SS-704-xxx or an equivalent cable that conforms to the following specifications:

- The RS-485 conductors shall be a twisted pair.
- The RS-485 conductors shall have nominal capacitance conductor to conductor of less than 40 pF/ft at 1 kHz.
- The RS-485 conductors shall have nominal conductor DC resistance of less than 16.7 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 be terminated only on the two farthest ends of the cable.

The cable length shall not exceed 2000 ft. (609.6 m) for the operational baud rate of RS-485 communications (9.6 Kbps).

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

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

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

*In the case of a retrofitted CTAD that has both RS-485 and RS-232 lines, the cable shall be the Wavetronix SS-708-xxx or an equivalent cable.*

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
- 2 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 abovementioned conditions are met.

**2.4 In-cabinet interface equipment.** The CTAD shall be installed using the Click 600, 650 or 656 cabinet interface device, a Wavetronix preassembled backplate, or an equivalent that provides input power surge suppression, sensor cable surge suppression, AC to DC power conversion (if necessary), and terminal blocks.

**2.5 Lightning surge protection.** The CTAD has onboard surge protection; proper grounding is required for effective surge protection. Consult the article titled *Intersection Grounding Schematics* in the knowledge base on the Wavetronix website for more information.

Appropriate lightning surge protection shall be installed in the traffic cabinet to protect the cabinet equipment. These lightning surge protection devices shall meet or exceed the IEC 61000-4-5 Class 4 specifications. The Wavetronix Click 222 and Click 65x devices both meet those standards. The lightning surge protection unit supplied shall be physically compatible with the cable provided.

**2.6 Power supply.** The CTAD shall be installed using the Click 65x, the Click 202 or Click 204 (included on the Wavetronix preassembled backplate), 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°F (74°C).

The power converter shall operate in the temperature range of to -29°F to 165°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 2 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 and EN 60950.

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.

**2.7 Input file cards.** The Click 112, Click 114 or an equivalent that meets the following specifications shall be used when using a preassembled backplate or Click 600:

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 CTAD into contact closure outputs.

The input file card shall support presence detection.

The input file card shall receive data packets over an RS-485 bus at a baud rate of 9600 bps.

The input file card shall autobaud and auto-detect an CTAD 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).