



Wrong Way Vehicle Detection
Intelligent Warning System
Solar Charged, Battery Powered,
Four Pole System for roadway off-ramps

Specification Guide

Ver 1.0, May 17, 2018

Primary Function:

The primary function of the TAPCO Wrong Way Vehicle Detection Intelligent Warning System is to reliably detect, warn the driver of, verify, notify and quantify wrong-way vehicles as they pass through a pre-determined detection zone on an off-ramp. The Wrong Way Detection System (WWDS) sensors will either be structure mounted or in-pavement installed based on a site survey performed by a TAPCO engineer and will provide near real-time notifications to local authorities via the TAPCO BlinkLink™ Cloud-based web service.

Required Functionality:

When properly installed, tested and certified within TAPCO guidelines the WWDS shall:

- Automatically capture images of wrong-way vehicles that proceed past the detection hardware
- Trigger multiple local LED warning devices, including, but not limited to: BlinkerSign® LED-enhanced signage, 12" BlinkerBeacon™ LED traffic beacons and RRFBs accompanying R5-1a and optional R5-1 signage. This initial step is executed to gain the driver's attention and hopefully trigger a correction
- Confirm continued Wrong Way behavior through a second set of sensors
- Generate alerts in the BlinkLink Cloud-based web user interface as well as e-mail and SMS alerts with a time-stamped picture of the vehicle with the ramp location and the proper ramp travel direction identified for all configured users.

When the local warning devices are activated, it shall be simultaneous via either the incoming detector's Flash Controller primary output or via a 900MHz FHSS wireless transceiver integrated into the Warning Device Flash Controller. The warning devices shall flash in a configurable synchronized pattern for a preset time period.

System Testing and Certification:

To ensure proper installation, configuration, and functionality, all TAPCO WWDS shall be tested and certified under the direct on-site supervision of the manufacturer. The manufacturer shall provide a written test plan to the installing agency at least 30 days prior to scheduled testing. The installing agency, or their appointed contractor, shall be responsible for full ramp closure during a portion of the night-time testing, including all applicable management of traffic and advance motorist notification as required by the agency. Expenses for on-site testing and configuration shall be a separate pay item, and shall be quoted by the manufacturer directly.

The test plan shall include provisions to verify the following:

- Activation of local warning devices
- Activation of local wireless activated warning devices
- Generation of Wrong Way alerts in BlinkLink™, from the detection of small, medium, and large size vehicles, in all lane positions, in a range of slow and high speeds traveling in the wrong direction on the off-ramp
- Delivery of e-mail alerts to a specified user, or users
- Doppler Radar detector aim and threshold adjustment (if equipped)
- Microwave Radar detector aim, configuration and tuning (if equipped)
- Inductive Loop pair detector configuration and tuning (if equipped)
- Confirmation camera aim and focus
- Proper installation and connection of all terminals and components
- Clear digital pictures of all system components

Description of Components:

The Manufacturer shall provide hardware components for a solar charged, battery powered Wrong Way Vehicle Detection, Warning, Confirmation and Alerting System along with the BlinkLink Cloud-based system management and notification service.

Hardware Components include:

- Detection Sensor Combinations are chosen or specified based upon a number of considerations, with off-ramp and surrounding geography at the forefront:

Incoming Sensor for Warning Device Activation	Outgoing or Confirmation sensor for Alert Notification
Doppler Radar	Doppler Radar
Microwave Radar	Doppler Radar
Doppler Radar	Inductive Loop Pair

- Incoming and Confirmation Cameras
- Camera Illuminators
- Wrong Way Master Cabinet key components: Solar Charge Controller, Batteries, power connection and component wiring terminal blocks, fusing, 4G LTE Cellular gateway and antenna, 900 MHz transceiver and antenna, Warning device Flash Controller and Wrong Way logic controller.
- Solar Panels
- LED Warning Device Control Cabinet key components: 900 MHz transceiver and antenna, Warning device Flash Controller w/integrated Solar Charge Controller, Battery
- LED Warning Devices as specified:
 - MUTCD legend R5-1a Red LED BlinkerSigns sized as specified
 - A pair of Red LED 12" BlinkerBeacons placed above and below each MUTCD R5-1a Sign
 - A pair of Red LED RRFBS placed above and below each MUTCD R5-1a Sign

- All system component mounting hardware and wiring

BlinkLink Cloud-based system management and notification service:

- The BlinkLink™ Cloud-based service shall provide a secure user interface and shall be capable of delivering on-screen notifications with images, e-mail notifications with images, and SMS text messages when the detection hardware has been triggered
- As a Cloud-based service, BlinkLink shall not require any locally installed software applications other than an up-to-date web browser
- Historical alert data and system statistics shall be accessible through easy-to-use user-configurable reports
- BlinkLink shall be capable of displaying detection hardware system status, including but not limited to DC power supply voltage and cabinet temperature.
- BlinkLink is a subscription based service, sold annually per WWDS system

General Requirements:

The BlinkerSign® Manufacturer shall have a minimum of ten years of relevant intelligent traffic product manufacturing experience.

Specific Functional and Electrical Hardware Requirements:

System

- Each Wrong Way Vehicle Detection System shall consist of the following:
 - For the Master Pole, or Pole #1:
 - A solar charged, battery powered Wrong Way Master Cabinet containing:
 - Solar Charge Controller
 - Batteries and battery interconnect cabling
 - 4G Cellular antenna externally mounted
 - 900Mhz radio, antenna externally mounted
 - Terminal block landings for the solar panels as well as the external sensors and warning devices:
 - Incoming Wrong Way Vehicle sensor
 - Confirmation Wrong Way Vehicle sensor
 - Incoming and Confirmation Cameras
 - Incoming and Confirmation Camera illuminators if required
 - LED Warning Device(s)
 - System Test Switches
 - An Incoming and Outgoing Wrong Way Vehicle sensor
 - An Incoming and Confirmation Camera
 - An Incoming and Confirmation Camera Illuminator if required
 - Solar Panel(s)
 - An LED Warning device that is connected directly to the Wrong Way Master Cabinet
 - Pole mounting hardware for each assembly
 - For the Warning Poles, or poles 2, 3 and 4:
 - A Solar charged, battery powered Flash Control Cabinet per pole containing:
 - 900Mhz radio antenna externally mounted
 - Solar charged battery
 - Warning Device Flash Controller with integrated Solar Charge Controller and 900 MHz transceiver (radio)
 - Terminal block landings for the solar panel as well as LED Warning device(s)
 - A LED Warning Device or Device pair per pole that is connected directly to the Flash Control Cabinet
 - Solar Panel
 - Pole mounting hardware for each assembly

Master Control and Radio Activated Warning Device Control Cabinets

- Shall be NEMA 3R Type
- Shall be constructed of minimum 0.080" thick aluminum.
- The cabinet outer dimensions are:

- Master Control Cabinet – 51” tall x 24” wide x 16” deep
 - Warning Device Control Cabinet – 12” tall x 7.5” wide x 7” deep
- To promote airflow for internal components, each cabinet shall be vented with screening or filter material included on all vents and drains to prevent insects and other foreign matter from entering.
- For security, the Master Control Cabinet must include tamper-resistant stainless steel hinges for the access door and two tamper-resistant stainless steel hinges for the Warning Device Control Cabinet access door.
- Shall have a replaceable Corbin #2 traffic lock installed on the door with two keys included.
- To facilitate maintenance or repairs, the cabinet shall include a removable control panel to which all control circuit components either mount or connect.
- For easy installation on a wide range of pole sizes and types, the cabinet shall utilize common mounting brackets that are secured to the back of the bracket via:
 - Two pole strap brackets for the Master Control Cabinet
 - Two pairs of 5/16”-18 stainless steel mounting studs for the Warning Device Control Cabinet
- Shall adapt to a range of mounting bracket options that are secured to each pair of mounting studs on the back of the cabinet. For installation, banding style brackets that fit poles with a 2-3/8” or larger diameter shall be included as standard equipment. Mounting brackets also available for U-Bolt mounting or square pole, wooden post, and wall mount applications. Mounting brackets and hardware are included.
- To prevent corrosion, all materials used in the construction or mounting of the control cabinet shall be either aluminum or stainless steel. Anti-vandal mounting hardware shall be available as an option.
- A UV resistant label shall be applied to the exterior of the cabinet and include system specific information including model number, serial number, date of manufacture, as well as any applicable regulatory compliance information.

Warning Device Flash Controller

The Programmable Warning Device Flash Controller is housed within the NEMA 3R type Control Cabinet, and shall:

- Include integrated constant-current LED drivers with a minimum of two-channel output for driving one or two sets of Warning Devices.
- Flash the Warning Device LEDs 50 to 60 flashes per minute.
- Shall be programmed to run the connected LED Warning Device for a specific time period when activated via contact closure from an external sensor such as a Doppler Radar, Microwave Radar, or Loop Detector, or when activated internally from its integrated 900 MHz transceiver when it receives a wireless trigger signal.
- Shall be capable of providing multiple levels of LED brightness through LED drive current control
- If specified, automatically adjust the BlinkerSign LED drive current control to optimize brightness for the ambient lighting conditions.

- Have the BlinkerSign LED drive outputs reach the full output current as programmed within the duration of the 100ms on-time.
- Include an integrated Real Time Clock (RTC) with on-board battery backup.
- Have the capability of RS232 communication for programming with Windows-based software.
- Include a minimum of two General Purpose Inputs and Outputs (GPIO).
- For the remote warning devices, shall also function as the solar charge controller
- Seamlessly integrate with the 900 MHz FHSS wireless transceiver to form a network of connected devices.
- Be internally housed in the NEMA 3R cabinet in its own IP67 type enclosure.
- Be independently replaceable of other control panel components
- Be able to monitor internal temperature.
- Operate between the temperatures of -40° to +176°F (-40° to +80°C).

900 MHz FHSS Wireless Transceiver

- Shall be housed inside the IP67 rated Flash Controller Cabinet
- Shall seamlessly integrate with any of the system controllers to ensure sequential activation of other radio-equipped devices in the system
- Shall include an integrated LCD and two user-interface buttons for setup and troubleshooting, including readouts of flash duration (timeout), battery conditions, and LED testing functionality
- Shall include two LED indicators for status and troubleshooting
- Shall be capable of operating as a Transmitter or Receiver
- Shall be capable of providing site-survey data for verification of signal strength between network devices
- Shall include network-wide modification of sign controller settings and output durations, using programmability from any networked transceiver without the use of additional equipment or software
- Shall synchronize the system components to activate the indications within 120msec of one other and remain synchronized throughout the duration of the flash (timeout) cycle.
- Shall have an antenna connector for easily connecting to multiple antenna options
- Shall operate on the license-free ISM band
- Shall comply with part 15 of FCC rules
- Shall operate from 3.3VDC to 15VDC
- Shall be, in the unlikely event of failure, replaceable independently of other components.

Wrong Way Sensors

Based upon the geography of the roadway off-ramp and some of the challenges to sensor equipment that can be presented, some are more reliable than others for certain applications.

- Doppler Radar
- Microwave Radar

- Inductive Loop Pair
- **Doppler Radar**
 - Shall be a one-piece programmable, stationary, directional, true Doppler Radar
 - Shall be programmed to monitor only the speed of the vehicles coming towards or away from the system.
 - The operating band shall be the K-Band operating at a frequency of 24.125 Ghz \pm 5 Mhz with a power output of 5 mW.
 - Shall operate between 9 VDC and 18 VDC with reverse polarity protection
 - Shall have a typical detection range of 300 feet on an open and level road when mounted 5 feet high
 - Shall be programmable via an RS232 port or an optional Infrared remote programmer
 - Shall have be accurate to \pm 0.5%, with a resolution of \pm 0.006 mph
 - Shall have a trigger range from 2 to 100 miles per hour
 - Shall have the ability to 'track' a target for a time period prior to generating a trigger output
 - Shall have a nominal operating current of 9mA @ 12VDC
 - Shall operate from -40° to +185°F (-40° to +85°C)
- **Microwave Radar**
 - Shall be completely sealed and protected from water intrusion
 - Shall have a universal mounting bracket to mount on wall, post or mast arm
 - Shall have a temperature range of -40 °C to 85 °C
 - Shall have selectable frequencies at 24 GHz with a beam angle of \pm 15
 - Shall utilize Ethernet communication for programming
 - Shall be programmable to create up to eight (8) independent detection zones up to a maximum of 600 feet
 - Shall detect Motorcycles
 - Shall include a built-in self-test, including self-power usage
 - Shall automatically recover from power failure
 - Shall be protected from reverse polarity power connections and power surges
 - Shall be capable of detecting targets as slow as 5MPH and as fast as 150MPH
 - Shall comply with part 15 of FCC rules
 - Shall operate from 12VDC to 24VDC
 - Shall be programmable from windows-based software
- **Inductive Loop Pair Sensor**
 - Shall be four channel models, with each multi-loop array using two channels. (One card per two monitored lanes)
 - Shall consist of a single printed circuit module that plugs into a standard NEMA/170/2070 card rack
 - Shall utilize serial communications for programming

- Shall be programmable to detect directional movement
- Shall include a built-in self-test
- Shall include status LEDs for basic diagnostics
- Each channel of the traffic monitoring cards shall have four frequency settings:
 - High (~43.4 KHz @ 100 μH sensor)
 - Medium High (~35.7 KHz @ 100 μH sensor)
 - Medium Low (~34.5 KHz @ 100 μH sensor)
 - Low (~33.1 KHz @ 100 μH sensor)
- Shall operate from -29° to +165°F (-34° to +74°C)
- Shall include Power Loss Protection: All settings are stored in non-volatile memory.
- Shall operate from 10.8 to 37.8VDC
- Shall be programmable from Windows-based software

Incoming and Confirmation Cameras:

- Shall include cross-line detection software analytics
 - Detection area and direction shall be programmable
- Shall be capable of storing images saved in a buffer to capture events that occurred in the recent past
- Shall have programmable event-based logic that integrates with Wrong Way Logic Controller
- Shall have adjustable image settings, including:
 - Compression, color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, backlight compensation, fine tuning of behavior at low light, and rotation
- Shall have a shutter time of 1/6s to 1/24500s
- Shall utilize a ¼" progressive scan RGB CMOS
- Shall have a minimum of one input and one output
- Shall comply with part 15 of the FCC rules
- Shall operate from -4° to +122°F (-20° to +50°C)
- Shall have a sensor that is IP66 NEMA 4X-rated
- Shall operate from 8VDC to 28VDC
- Shall be programmable from Windows-based software

LED Illuminators:

- Shall be triggered by the WWDS logic controller under specific adjustable conditions
- Shall be mounted to the WWDS detector pole/structure assembly
- Shall include a photodiode capable of determining ambient light levels
- Shall offer adjustable lenses to disperse light based on site-specific requirements
- Shall operate from 12-24VDC
- Shall be constructed of polycarbonate and aluminum
- Shall be rated for outdoor use
- Shall operate from -58° to +122°F (-50° to +50°C)

- Shall include Deutsch DTM series IP67 rated connectors for power and trigger inputs

Programmable Wrong Way Logic Controller:

- Shall analyze discrete inputs from multiple sensors and confirmation cameras
- Shall provide programmable outputs per event criteria, including sign activation and wrong way alert generation
- Shall have the ability to drive two mechanical relays for integration with existing infrastructure
- Shall provide a minimum of four additional GPIO for future functionality
- Shall include screw-type terminals for all wire connections
- Shall include multiple programmable status LEDs for on-site testing and troubleshooting
- Shall include a micro-USB interface for future updates
- Shall operate on 9VDC to 18VDC

4G LTE Cellular Gateway:

- Shall provide communication to BlinkLink™ Cloud-Based Web Service
- Shall be offered in Verizon and AT&T variants
- Shall include an integrated five-port 10/100 Ethernet switch
- Shall include an integrated RS232 serial port
- Shall include LED indicators for Power, WAN, Signal, RS232, Ethernet Link, and Activity
- Shall comply with part 15 of FCC rules
- Shall operate from -40° to +167°F (-40° to +75°C)
- Shall have a sensor that is IP66 NEMA 4X-rated
- Shall operate on 8VDC to 30VDC
- Shall be capable of Over the Air (OTA) firmware updates and remote management
- Shall be capable of IPSEC VPN
- Shall be programmable from windows-based software

Master Control Cabinet Solar Charge Controller

The Solar Charge Controller shall:

- Utilize an intelligent 4-stage algorithm and Pulse Width Modulation (PWM) for battery charging
- Automatically provide Low Voltage Disconnect (LVD) to protect batteries when needed
- Automatically provide Load-Reconnection once battery levels have been restored to an acceptable value
- Supply 12VDC power 24 hours a day, 7 days a week
- Protect against and automatically recover from: short circuit, overload, reverse polarity, high temperature, lightning and transient surge, as well as voltage spikes
- Be independently replaceable of other control panel components
- Operate from -40° to +140°F (-40° to +60°C)

Master Control Cabinet Battery Power

- Shall consist of a multitude of 35Ah batteries connected electrically in parallel that have a nominal output voltage of 12VDC and a total capacity rating, based upon a C/100 discharge rate, of from 105Ah to 280Ah
- Shall be valve regulated, AGM type
- Shall be sealed and spill proof
- Shall have terminals that accept screw or bolts for secure wiring connections.
- Shall be replaceable independently of other components.
- Shall be fused for short circuit protection

Radio Activated Warning Device Battery Power

- Shall be 4.8V, 27Ah Nickel Metal Hydride (NiMH)
- Shall be sealed in a plastic film to provide resistance to moisture and corrosion.
- Shall operate between the temperatures of -40° to 176°F (-40° to +80°C)
- Shall be protected from overcurrent by means of a resettable fuse device
- Shall be replaceable independently of other components.
- Shall be protected from overheating by means of a thermocouple sensor

Master Control Cabinet Solar Panel(s)

Each solar panel shall:

- Be IEC61215, TUV, and UL 1703 certified.
- Operate at 12VDC nominal with a maximum individual output rating of either 85W or 130W.
- Include an IP65 rated junction box with terminals sized for 8-16AWG wire.
- Be constructed of an anodized aluminum frame, high-transmission 1/8" tempered glass, with silicon cells encapsulated in double-layer EVA, and with a white polymer backing.
- Be affixed to an aluminum plate and bracket, adjustable at an angle of 45°- 60° to facilitate adjustment for maximum solar collection to optimize battery charging.
- Shall include mounting bracket and hardware for mounting to the support pole. The same mounting bracket can accommodate either one 130W panel or two 85W panels
- Have an overall size of 21" Wide x 47.5" tall (85W) or 26" Wide x 58" tall (130W)
- Have a maximum power voltage 17.8V (85W) or 18.1V (130W)
- Have a maximum power current 4.78A (85W) or 7.38A (130W)
- Have a short circuit current 5.35A (85W) or 7.89A (130W)
- Have an open circuit voltage 22.2V (85W) or 22.0V (130W)
- Operate from -40° to +194°F (-40° to +90°C)

Radio Activated Warning Device Solar Panels

The solar panel shall:

- Be IEC61215, TUV, and UL 1703 certified.
- Operate at 6VDC nominal with a maximum output rating of 26W.
- Include an IP65 rated junction box with terminals sized for 8-16AWG wire.

- Be constructed of an anodized aluminum frame, high-transmission 1/8" tempered glass, with silicon cells encapsulated in double-layer EVA, and with a white polymer backing.
- Be attached to a panel, plate and bracket to facilitate mounting and adjustment for maximum solar collection and optimal battery strength.
- Shall include mounting bracket and hardware for mounting to the support pole.
- Have an overall size of 18" x 21"
- Have a maximum power voltage 8.8V
- Have a maximum power current 3.06A
- Have a short circuit current 3.24A
- Have an open circuit voltage 10.4V
- Operate from -40° to +194°F (-40° to +90°C)

LED Warning Devices

Each pole shall have either a single BlinkerSign, two BlinkerBeacons or two RRFBs as required per the specifications functioning to warn the Wrong Way driver in an effort to stimulate a correction. There are three different options:

- Red LED BlinkerSigns with a MUTCD R5-1a legend
 - Two Red LED BlinkerBeacons – one above and one below a MUTCD R5-1a legend static sign
 - Two Red LED RRFBs – one above and one below a MUTCD R5-1a legend static sign
- **BlinkerSign® LED Signs**
 - All signs shall conform to 2009 Federal Highway Administration’s MUTCD section 2A.07 on retro reflectivity and illumination.
 - Each sign shall have eight quantity Day-Viz® Daylight-Visible, high power 1 watt LEDs.
 - Each sign blank material shall be a minimum of 0.080" thick aluminum and sized to meet the requirements.
 - Each sign face shall consist of 3M™ Diamond Grade™ DG3 reflective red sheeting, as required.
 - Sign sheeting shall be applied to the sign blank with a 3M™ 1160 Premium Protective Overlay film to provide an additional layer of graffiti protection.
 - The BlinkerSign legend shall be a MUTCD approved unless specified otherwise.
 - The LEDs shall be embedded individually into 1" diameter holes around the perimeter of the sign and shall be ultrasonically welded to the sign assembly to provide maximum strength and rigidity.
 - LED color shall be red.
 - Each LED shall be sealed within a 7/8" diameter, heat-dissipating plastic enclosure to provide resistance to weather and vibration.
 - LEDs shall be wired in parallel electrically so that remaining LEDs continue to flash in the unlikely event of the failure of any individual LED.

- Wiring between BlinkerSign® LEDs shall be encapsulated inside 1" x 3/8" aluminum extrusions secured to the back of each sign assembly, to provide weather resistance and protection.
 - Each sign shall have adequate holes for mounting to a pole or post. Optional vandal-resistant fasteners to mount the BlinkerSign® LED sign assembly to a pole or post shall be available.
 - UV-resistant label(s) shall be applied to the back of each sign assembly and shall include specific information such as the manufacturer, manufacturer phone number, model number, serial number, date of manufacture and any applicable regulatory compliance information.
- **LED BlinkerBeacon Warning Assemblies**
 - Each of the two warning beacon assemblies shall consist of:
 - A black polycarbonate vehicle traffic signal housing
 - A black polycarbonate door
 - A black poly visor
 - A 12" Red LED beacon module
 - An aluminum mounting arm with black powder coat finish.
 - The signal housing shall be a one-piece unit with serrations in 5° increments at each end to allow for positive positioning during mounting and include provisions for attaching back plates if required (Optional Back plates available).
 - The housing, door and visor shall be injection molded of ultraviolet stabilized, pre-colored opaque polycarbonate.
 - To prevent water entry, a neoprene gasket shall be included between the door and housing.
 - A black cut visor shall be included as standard equipment, with other colors and styles available as options.
 - To prevent any marring of the finished surface, the arm assembly shall be assembled prior to powder coat application with all internal threads completely masked to prevent paint build-up.
 - To prevent corrosion, all materials used in the construction and mounting of the beacon assembly shall be either polycarbonate, powder coated aluminum, aluminum, or stainless steel.
 - The beacon assembly will be provided with the bracketry and hardware necessary for mast arm mounting per the requirements.
 - The LED beacon module shall provide incandescent-like appearance, be a fully sealed module featuring robust high flux LED technology, include abrasion resistant lens coating and easily install into existing signal enclosures if needed. The LED beacon module shall come pre-installed in the beacon assembly.
 - The 12" Red LED Beacon module shall at a minimum:
 - Utilize Dialight's LED Robust High Flux LED Technology

- Be driven directly from the constant current DC output of the programmable Flash Controller
 - Include a yellow power wire and white ground wire quick connect spade terminals
 - Meet or exceed Military Standard 883, test method 2007 for vibration resistance
 - Meet or exceed Military Standard 810F, test method 506.4 for moisture resistance to rain and blowing rain
 - Have a dominant wavelength of 625nm (Red)
 - Operate from -40° to +165°F (-40° to +74°C)
- **RRFB Warning Assemblies**
 - Shall house two rapidly and alternately flashing rectangular red LED array vehicle indications.
 - When activated, each of the two vehicle indications of an RRFB Light Bar shall wig-wag at a rate of approximately 60 flashes per minute
 - Active vehicle indications shall be visible at distances over 1000 feet during the day and over 1 mile at night.
 - Have a housing that shall be constructed of durable, corrosion-resistant powder-coated aluminum with stainless steel vandal resistant fasteners.
 - Have enclosed components that are modular in design whereby any component can be easily replaced without having to uninstall the RRFB assembly.
 - Include mounting hardware for either single or back-to-back pole mounting and shall be universal to the pole type.
 - Have two vehicle RRFB indications that are approximately 7" wide x 2.8" high, each with an 8 red LED array.
 - Have overall dimensions of approximately 23.6" wide x 3.8" high x 1.4" deep.

Warranty

The Manufacturer shall offer a three-year unconditional warranty against all defects in material and workmanship.