MS SEDCO

Engineered for Motion

TC-CK1-VMS
INTERSECTOR MICROWAVE VEHICLE MOTION SENSOR

PRODUCT MANUAL

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1   General Information

1.1   Theory of Operation

The TC-CK1-VMS uses microwave radar to identify, classify, and track vehicles by position and speed. This information is overlaid in an X-Y coordinate system, allowing users to set up detection zones. Detection of a vehicle in a user-defined zone will produce a signal to the assigned TCIB output. Users can associate unique outputs, time delays, or output delays with individual zones.

The TCIB card monitors whether the sensor is functioning and provides a means for end users to set up zones via a connection to a laptop computer. It also provides the outputs to the control panel and includes LEDs that allow end users to verify operation without having to connect a laptop.

1.2   General Description

The TC-CK1-VMS is a radar vehicle motion tracking sensor designed for intersection control. The TC-CK1-VMS offers several advantages when compared to cameras or loop detectors:

- Detection is not affected by weather[1]
- Immune to sunrise / sunset or post-rain glare
- Not susceptible to in-road breakage
- Multiple lanes can be covered by a single unit
- Easily installs to corner signal poles and signal mast arms
- No privacy concerns
- Reduces construction costs

Through its user interface, the TC-CK1-VMS allows users to visually track vehicles as they approach the intersection and allows easy setup of detection zones to provide programmable inputs to a traffic control cabinet. The interface also provides the ability to verify that the system is functioning properly, or to troubleshoot the system.

1.3   Glossary

Sensor / TC-CK1-VMS: MS Sedco radar sensor for motion-only detection. This sensor operates similarly to the original motion and presence sensor (TC-CK1-SBE), but utilizes a simplified user interface and the presence features are removed to optimize motion-only applications.

Traffic Cabinet Interface Board (TCIB): MS Sedco detector rack interface board that is compatible with NEMA, 170, 179, and 2070 cabinets. At least 1 TCIB is required to communicate with the controller in the cabinet and power the sensor. There are 3 different types of TCIBs:

- **TCIB-2.1:** Provides 2 outputs and uses a single slot in the detector rack
- **TCIB-4.1:** Provides 4 outputs and uses a single slot in the detector rack
- **TCIB-4.2:** Provides 4 outputs and uses two slots in the detector rack

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[1] Up to 2 in/hour rain

TC-CK1-VMS System: The combination of MS Sedco equipment necessary to detect moving vehicles and register activations to the traffic cabinet. Typically, this system includes a TC-CK1-VMS and a TCIB. Additional equipment required to properly operate these units may also be included. Examples include an Ethernet Cable Extender (ECX), External POE power supply (TCIPI-4), and/or TCIB Card Cage (TCIB-CC).

Boresight / Gun-site: Centerline of the radar beam, designated by raised plastic moldings on the front cover of the sensor.

Azimuth Angle: Angle, in degrees, that comprises the radar beam's / detection coverage's "left – right" boundary. The radar beam's boundary is the "pie-wedge" that is centered at the radar's boresight.

Offset Angle: Angle, in degrees, between the centerline of the radar's beam and the flow of traffic in the region of interest.

Elevation Angle: Angle, in degrees, of the radar beam's "up – down" boundary.

Tilt Angle: Angle, in degrees, the radar is tilted up or down. Unless explicitly stated, tilt angles are relative to the natural slope / grade of the road.

TC-CK1-VMS Portal Page: The webpage that can be displayed in a modern web browser when the TC-CK1-VMS is connected to the Setup Port of the TCIB, a laptop is connected to the Laptop Ethernet Port, and the laptop's Ethernet settings are set to be on the same Ethernet network as the TC-CK1-VMS System. This webpage consists of five main parts: SENSOR INFORMATION, TARGET SETUP TABLE, SETTINGS TAB, VEHICLE TABLE, and TC-CK1-VMS DATA DISPLAY.

Sensor Information: This section of the TC-CK1-VMS Portal Page provides general information about the connected sensor (TC-CK1-VMS). This section consists of mostly read-only fields with basic information (sensor model number, software versions, and an operation timer), as well as user description field. This portion of the TC-CK1-VMS Portal Page also displays error notifications if the system has an internal failure that would prevent the sensor from operating optimally.

Target Setup Table: This section of the TC-CK1-VMS Portal Page provides the user the ability to customize the following characteristics of each zone (up to 8):

- Location of the zone relative to the sensor
- Time criteria a vehicle must be in the zone prior to activation
- Activation time following a vehicle activating the zone
- Count of vehicles meeting the activation criteria passing through the zone
- Correlation of zone activation to actual Opto Output on the TCIB
- Size / Classification of a vehicle required to activate the zone
- Minimum and/or maximum speed of a vehicle required to activate the zone
- Toggle for emulated vehicle length
- Vehicle travel direction required to activate the zone

Zone: User-defined detection area that is customizable, based on the desired activation criteria.

Vehicle Classification: Generically, vehicle classification refers to the type of vehicle being referred to. In the Vehicle Table, a numerical value is assigned to each tracked object to represent its relative size, which defines how the sensor distinguishes classification automatically. Classifications include:

- ***Vehicle:*** Any object capable of being tracked by the radar sensor.
- ***Bike:*** An object being tracked by the radar that is smaller in size / radar cross section, and whose speed never exceeds 18 mph (29 kmph).
- ***Car:*** An object being tracked by the radar that is larger in size / radar cross section, and/or any vehicle whose speed exceeds 18 mph (29 kmph) in the detection coverage area.

Settings Tab: Menu of TC-CK1-VMS Portal Page declutter options and advanced TC-CK1-VMS settings. Menu options are hidden until the "Settings" button is selected from the TC-CK1-VMS Portal Page.

Vehicle Table: The real-time numerical data values for vehicles being tracked by the radar. Information displayed in this table are typically used by more advanced users during initial zone setup, and is therefore hidden by default. To view the table, enable the "Vehicle Table" checkbox in the Settings Tab.

TC-CK1-VMS Data Display: The real-time visual display of TC-CK1-VMS zones, graphical representation of vehicles being tracked by the radar, multiple display options and the Opto-Output activation display.

2 Select Mounting Location

If an Intersection Pre-Analysis performed by MS Sedco is available, utilize the mounting specifications provided in the analysis. Please contact your distributor or MS Sedco if clarifications or deviations from the Intersection Analysis is needed.

If an Intersection Pre-Analysis is not available, continue with the content in this section.

2.1 Mounting Pole Selection

Selecting the best location to mount the sensor is vital for optimal performance of the TC-CK1-VMS System. The sensor should be mounted on a metal support pole or mast arm at a mounting height of 14 to 20 feet. The regions of desired detection should be between 50 to 600 feet from the sensor, and the offset angle between -15 to +15 degrees. If mounting on a mast arm, the sensor should be mounted within 10 feet of the support pole or before the first signal light, whichever distance is shorter. Figure 1 below provides an illustration of the acceptable mounting locations. Wooden support poles are not recommended as installation locations due to the high variability in their stability over temperature and humidity.
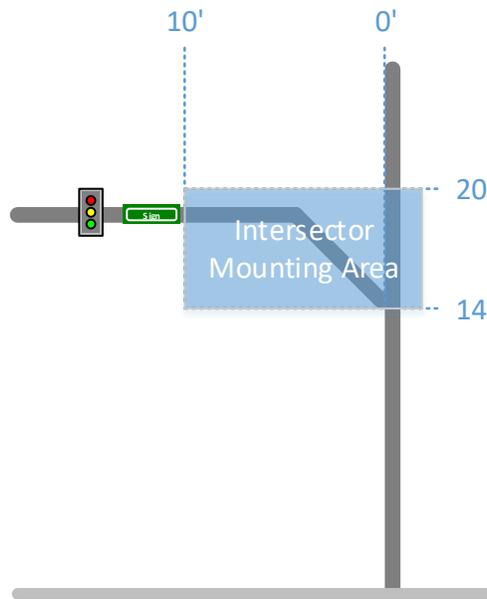
Figure 1: Mounting Location Pictorial

In addition to basic TC-CK1-VMS System setup optimization locations, the location selected should also minimize environmental radar interference objects, such as trees with branches or large signs that would block the radar and its desired coverage area.

2.2 Mounting Height

The sensor should be mounted high enough to reduce occlusions from large vehicles and meet area minimum mounting height requirements, but low enough to get proper stop bar coverage with minimizing tilt angle for shorter stop bar distances. The table below provides theoretical

values of starting tilt angle (relative to road slope / grade) values based on Mounting Height and Stop Bar Distance[2].

Table 1: Tilt Angle Starting Matrix

Tilt Angle (Deg.)		Dist. To Front of Zones (ft)					
		60	70	80	90	100	110+
Mounting Height (ft)	14	-6	-3	-1	0	0	0
	15	-7	-4	-1	0	0	0
	16	-8	-5	-2	-1	0	0
	17	-9	-6	-3	-1	0	0
	18		-7	-4	-2	0	0
	19		-8	-5	-3	-1	0
	20		-8	-6	-3	-2	0

The table below illustrates the maximum detection distance in relation to mounting height and distance to stop bar based on the tilt angles and mounting heights from the previous table.

Table 2: View Distance based on Tilt Angles

View Dist (ft)		Dist. To Front of Zones (ft)					
		60	70	80	90	100	110+
Mounting Height (ft)	14	133	267	600	600	600	600
	15	122	215	600	600	600	600
	16	114	183	458	600	600	600
	17	107	162	324	600	600	600
	18		147	257	515	600	600
	19		135	217	363	600	600
	20		142	190	382	573	600

2.3   Offset Angle

If an Intersection Pre-Analysis from MS Sedco is available, find a "landmark" that aligns with the center line of the sensor. If such a natural landmark is not readily available, use a traffic cone to mark the spot where the centerline of the radar meets the side of the road if a cone is available and it is safe to do so. Once a landmark is located or a cone is placed, use the gun site on the

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[2] Tilt angles provided in Table 1 are recommended starting values. Actual results will depend on the environment of the installation site, and may need to be adjusted during setup to optimize performance.

front of the sensor to aim the unit left or right until the center of the unit aligns with the landmark.

If an Intersection Pre-Analysis is not available, visualize the detection coverage region. Using the gun site on the front of the sensor, aim the unit left/right until the center of the desired detection zone lines up in gun-sites[3]. See the figure below.
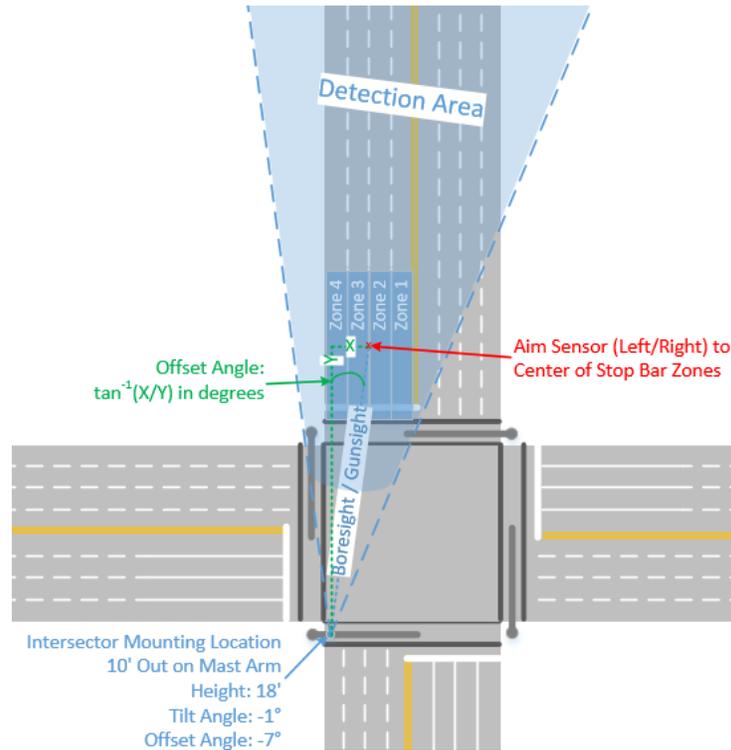
Figure 2: Offset Angle Illustration

2.4   Tilt Angle

After setting the Offset / Azimuth Angle, set the tilt angle of the unit using an angle-meter to the value determined in Table 1 + natural road slope / grade. Note: If bicycle detection is necessary, increase the tilt angle by -2° to -3°.

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[3] The alignment of offset / azimuth angle is a recommended starting position. Actual results will depend on the environment of the installation site, and may need to be adjusted during setup to optimize performance.
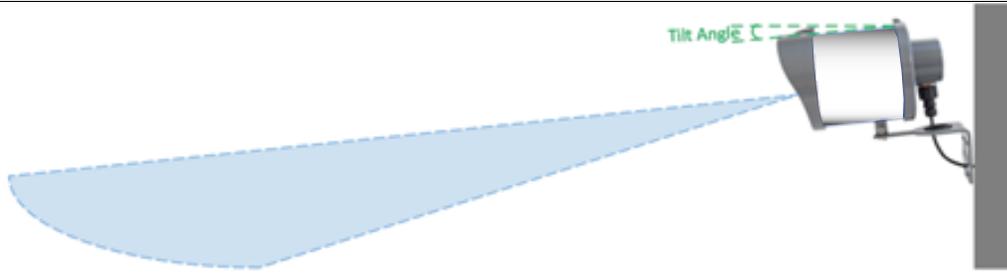
Figure 3: Tilt Angle Pictorial

2.5 Mounting Sensor for Accurate Bicycle Classification

Sensor mounting is crucial for accurate bicycle classification. For best results for bike classification, the TC-CK1-VMS should be installed at a mounting height between 16 and 20 feet, an offset angle between 0 and ±10 degrees, and an additional tilt angle of approximately 3 degrees downward (to a maximum of -9 degrees) relative to the slope of the road.

2.6 Mounting Examples

The subsections below provide guidance for common installation applications for the TC-CK1-VMS. Note that the guidelines stated above should be followed. These examples are meant to be guidelines and for reference only.

2.6.1 Mounting Example 1: Stop Bar Detection / Advanced Detection

The first example in the figure below demonstrates the scenario where advanced detection is used and stop bar detection is required. The TC-CK1-VMS is mounted such that the vehicles are approaching it with a minimum offset angle, and the front of the stop bar zone(s) are at least 60 feet from the sensor. Note that the TC-CK1-VMS unit is a motion-only sensor, unlike the TC-CK1-SBE that is the motion and presence sensor in the Intersector product line. In this type of configuration where the TC-CK1-VMS provides detection at the stop bar, the setup of the controller should be such that the VMS is only providing green phase extension and/or the phase the TC-CK1-VMS is servicing is "locked" such that detections made during the red phase will place a call to service the approach on the next service cycle.
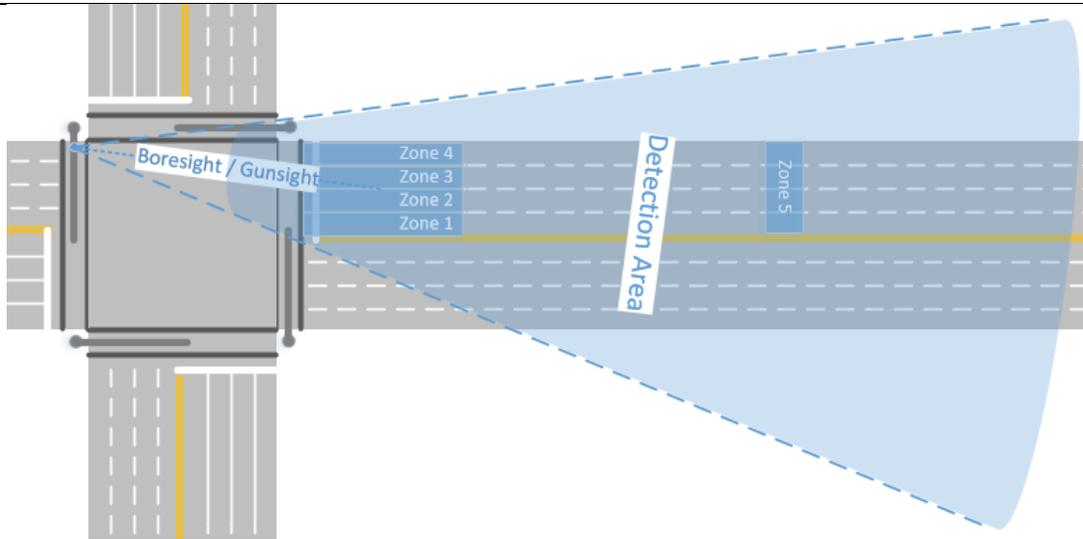
Figure 4: Stop Bar Detection with Advanced Detection

2.6.2 Mounting Example 2: Advanced Only Detection

The next example in the figure below demonstrates the scenario where detection is set back from the stop bar by at least 60 feet, and the region of interest is on the approach with typical traffic going toward the intersection. The most common application for this is advance detection on a main street. In this scenario, the sensor is mounted on the "back side" of the intersection to limit the potential for occlusions. This location also reduces the distance needed for detection farther down the approach.
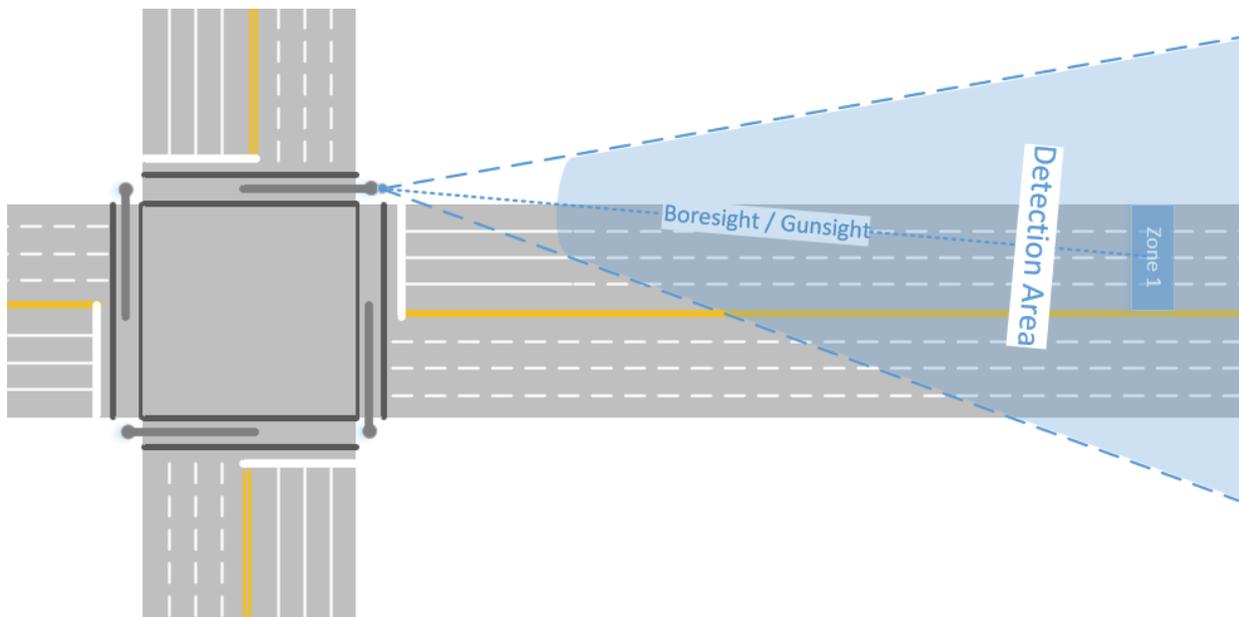
Figure 5: Advanced Only Detection

2.6.3 Mounting Example 3: Departure Detection

A third common use case for the TC-CK1-VMS is for Departure Detection. This is common in managed corridors where zone activation(s) are used to "count" the number of vehicles proceeding to the next intersection. In this situation, the sensor is also mounted on the "back side" of the intersection to minimize occlusions. This sensor is mounted to minimize the offset angle to track vehicles moving in the lanes leaving the intersection. In this situation, zones should be set to "pulse" so the output is activated for each vehicle, as well as put in "Departure" detection.
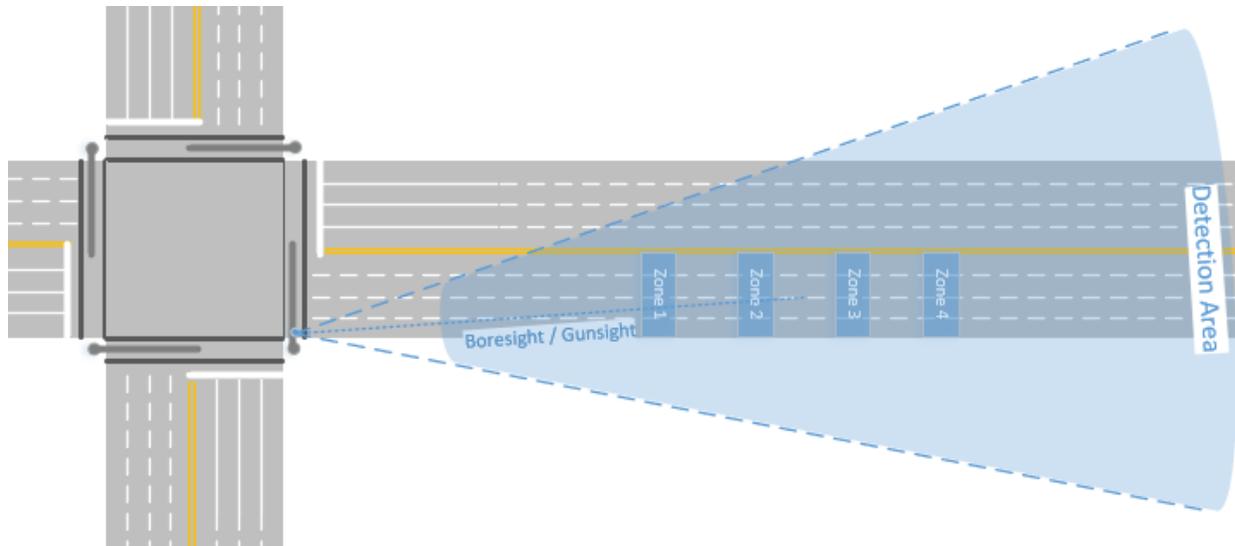
Figure 6: Departure Detection

2.6.4 Mounting Example 4: Wrong Way Detection

The final common use case for the TC-CK1-VMS is wrong way detection in common wrong-way driving conditions, such as one-way streets on city streets or exit ramps coming from major highways or freeways. The TC-CK1-VMS's ability to track individual vehicles and customize multiple, resizable zones with speed settings makes the TC-CK1-VMS a valuable tool in wrong way detection systems.

Sensor placement, and subsequent zone placements, ultimately depend on the desired detection trigger points for the final systems. There are two common methodologies for determining zone placement. The first method emphasizes detection at the stop bar. This allows wrong-way drivers to be detected immediately to attempt to minimize the distance they travel the wrong direction. Care must be taken with this type of detection for scenarios where erratic wrong-way motion is common around the stop bar that can cause false activations. Erratic wrong-way motions in this case can include pedestrians moving around at bus stops or cross walks by the stop bar or cars backing up to drive into a different lane. The second method is to place detection farther down the approach to guarantee any activation is for true wrong-way drivers. Care should be taken to place zones far enough from the stop bar that the erratic wrong-way motions are minimized or not present, yet wrong-way drivers do not proceed too far along the approach before being notified of their wrong-way driving.

Since the TC-CK1-VMS can activate for approach or departing motion, there are multiple mounting options for the sensor, and each option is optimized for reducing Ethernet cable runs to the controller. Note that for either option, the TC-CK1-VMS should be mounted such that detection starts at least 60 feet from the sensor, mounted to reduce the tilt angle required, and should avoid as much cross-traffic that could cause occlusions as possible.

Option 1 is depicted in the figure below. This mounting option is common in situations where the wrong-way detection system is installed in the intersection's cabinet. Note that any zones used in this orientation for wrong-way detection should have their "Depart" checkboxes enabled.
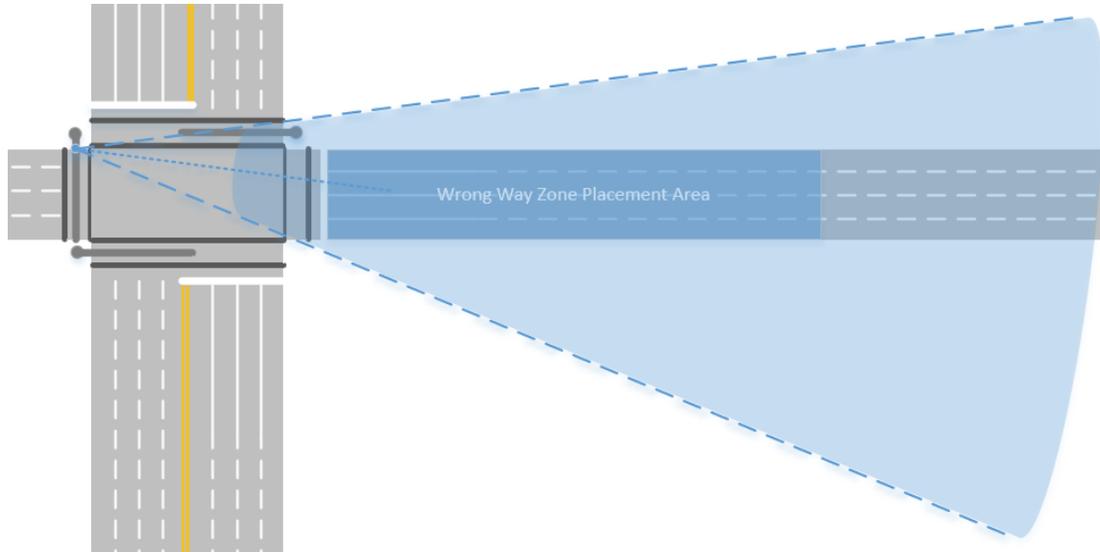
Figure 7: Wrong Way Detector Placement Option 1 - At the Intersection

Option 2 is depicted in the figure below. This mounting option is common in situations where the TC-CK1-VMS is included in a separate wrong-way detection system where the controller not installed in the intersection's cabinet. In this application, all zones should keep the "Depart" checkboxes disabled since the wrong-way motion would be approaching the sensor.
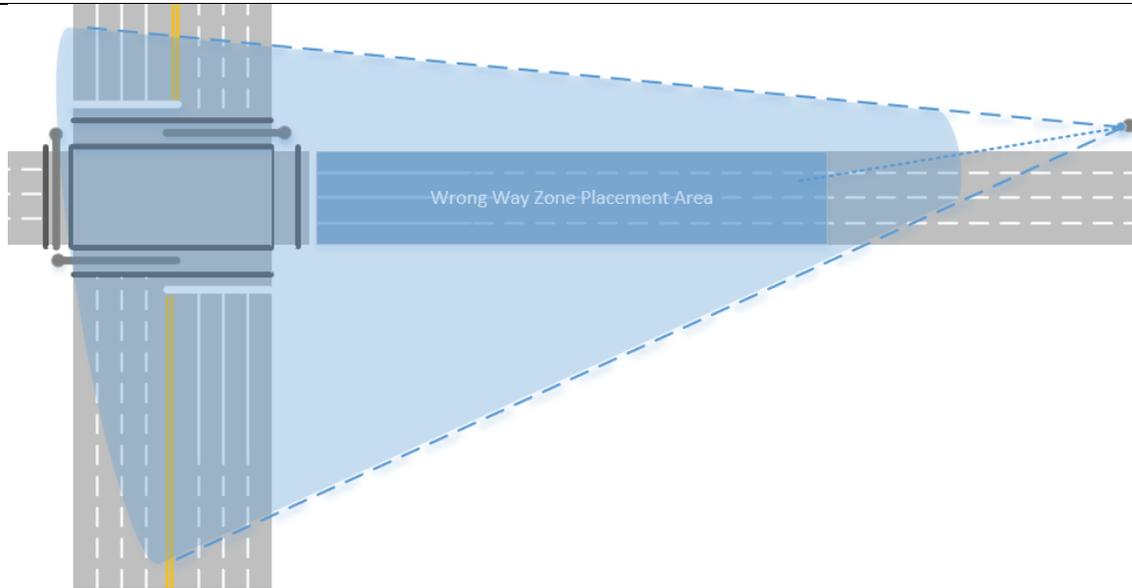
Figure 8: Wrong Way Detector Placement Option 2 - Along the Approach

The number of zones, their placements, and customizable options should be determined based on the wrong-way detection controller. The list below provides best practices found over time:

- If there is a bend along the approach (such as a clover exit ramp), the optimal sensor placement is the location that keeps the most amount of road in the radar beam "wedge".
- Using multiple zones activating in a sequence tends to filter wrong-way false detections due to erratic wrong-way motion common around a stop bar.
- Minimum speed threshold can assist in filtering pedestrians and road or lawn maintenance crews that may pass through the zone on wrong-way motion. Industrial lawn mowers typically drive anywhere from 5 to 13 miles-per-hour.

3   Sensor Installation

Connection of the sensor to the traffic cabinet is accomplished using an Ethernet cable. The cable should be routed through a quick connect assembly that is then connected to the sensor. The other end of the cable is routed to the traffic cabinet and plugs into the TCIB.

3.1   Tool Requirements

To properly install the TC-CK1-VMS, it is necessary to have the following tools on hand:

- Angle Meter (Digital Preferred)
- 7/16" Box Wrench or Socket
- Modular Plug Termination Tool (Crimp Tool)
- Ethernet Cable Tester
- "Screw Pack" Included with the TC-CK1-VMS

3.2   TC-CK1-VMS Ethernet Cable Termination

The TC-CK1-VMS utilizes a quick connect that consists of a Shielded Cat. 5e RJ45 Plug, a load bar, and a Plug Housing Assembly. The figure below shows an exploded view of this assembly.
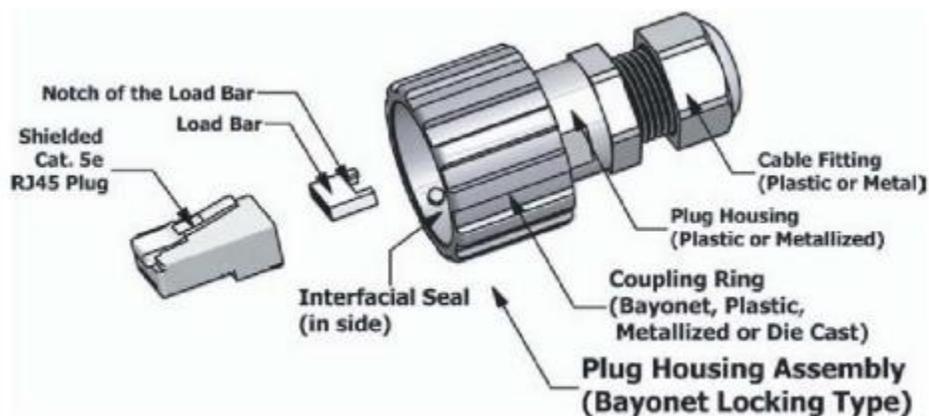
Figure 9: Quick Connect Assembly Diagram

1. It is necessary to prepare the cable and insert it through the housing prior to attaching the load bar and Ethernet connector (RJ45 plug). Using Cat. 5e direct burial cable, strip the insulation jacket back by approximately 25 millimeters to expose the conductor wires. See the figure below.
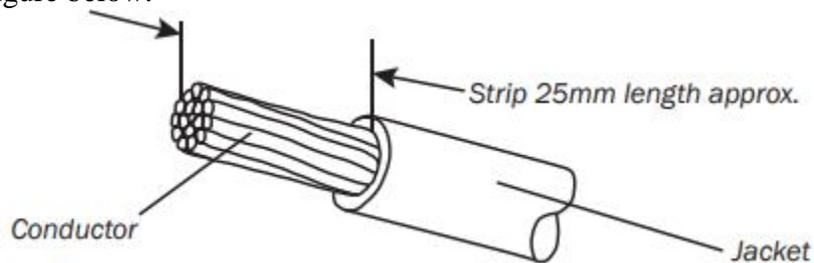
Figure 10: Ethernet Cable Preparation Pictorial

2. Slide the Coupling Ring, Plug Housing, and Cable Fitting over the Cat. 5e cable such that the Cable Fitting end is toward the spool and the Coupling Ring is toward the cut end of the cable.

3. Conductors should be untwisted and aligned side by side for an RJ45 connector. The figure below shows the EIA/TIA 568B standard that is common for USA applications. For regions that use the EIA/TIA 568A standard, reverse the green and orange pairs on both ends of the Ethernet cable.

4. Once all wires are aligned and straightened, trim wires so they are all approximately 20 millimeters. Be careful not to remove the insulation of individual conductors.

PIN	WIRE COLOR
1	White w/ Orange Stripe
2	Orange
3	White w/ Green Stripe
4	Blue
5	White w/ Blue Stripe
6	Green
7	White w/ Brown Stripe
8	Brown
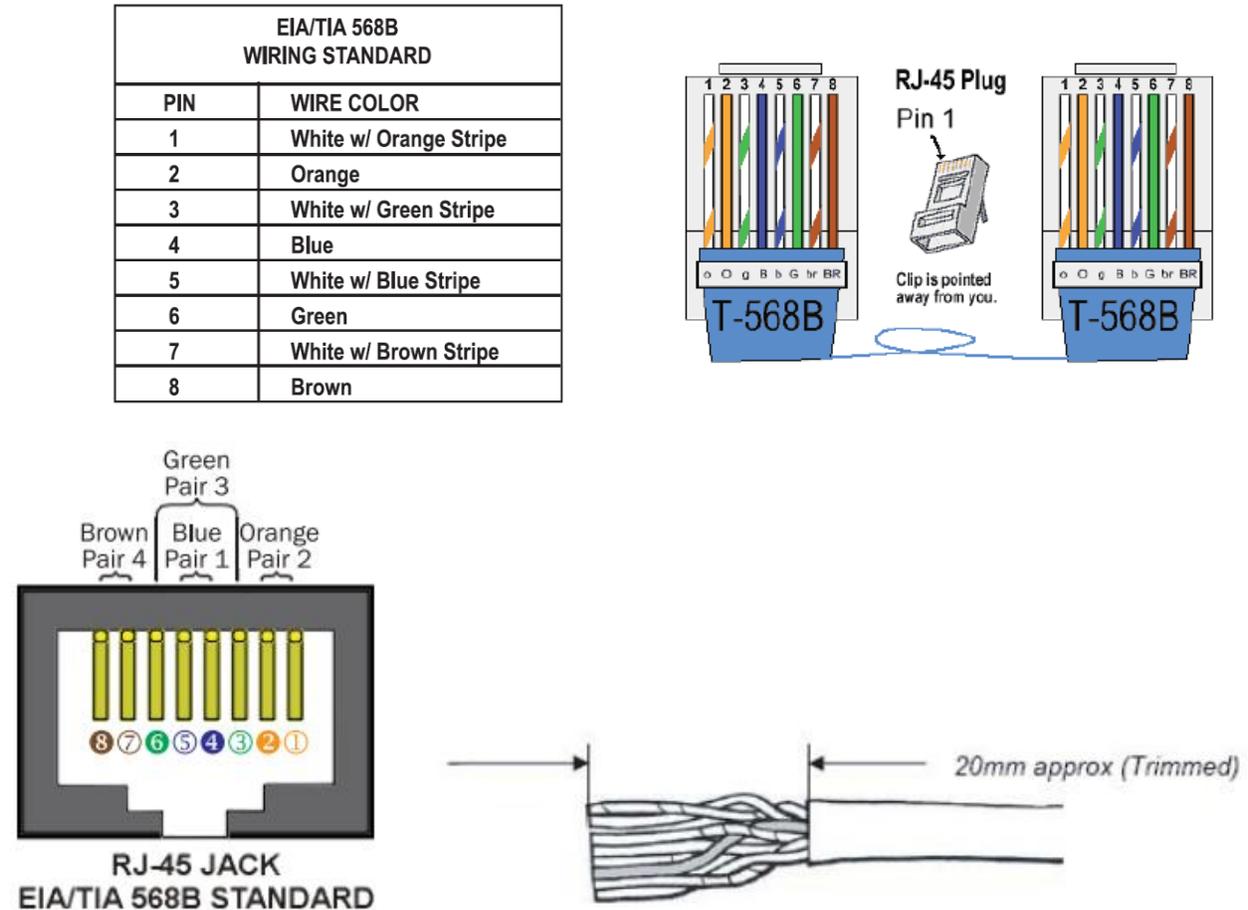
Figure 11: EIA / TIA 568B Standard Wiring

5. After inserting the wires into the appropriate positions of the load bar, slide the cable to a point where the cable jacket hits the notch of the load bar. Trim the remaining wire ends to approximately 5 millimeters in length, and then retract the cable, leaving approximately 1 millimeter of wire tips. See the figure below.
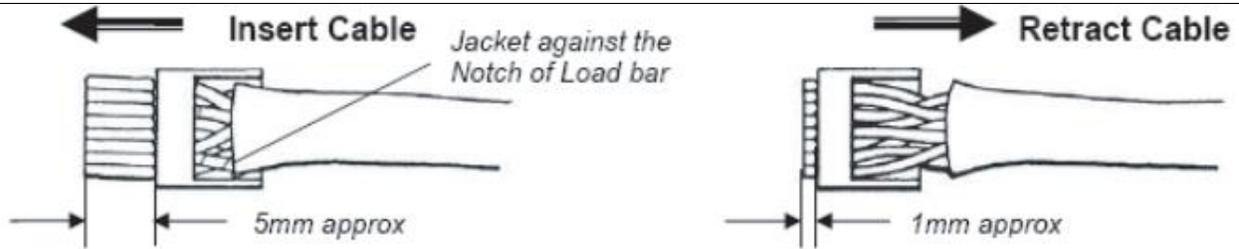
Figure 12: Insert Wires into Load Bar and Trim

6. Insert the wired load bar into the RJ45 plug all the way until the wire tips are sealed against the inside wall of the plug housing. See the figure below. NOTE: No wires should be exposed when the plug is fully in place.
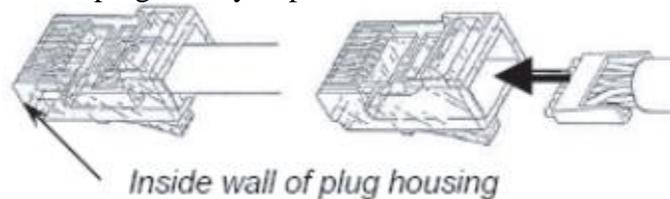
Figure 13: Inserting Load Bar into RJ-45

7. Terminate the cable and the RJ-45 plug with a modular plug termination tool similar to the one shown in the figure below.
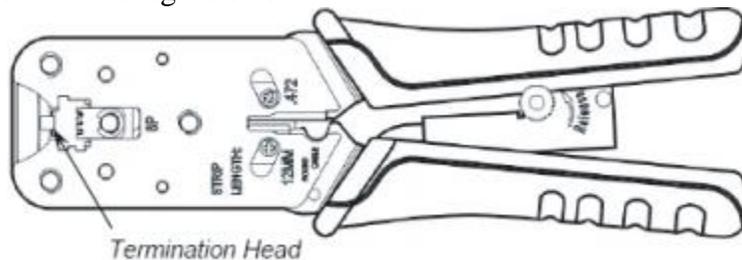
Figure 14: Modular Plug Termination Tool Example

3.3   TCIB / Cabinet Ethernet Cable Termination
1. Route the Cat. 5e Ethernet cable to the Detector Rack of the traffic cabinet. If installing more than one sensor at once, it may be helpful to designate which cable goes to each sensor. Common methods include masking tape with markings, varying colored electrical tape, or varying number of stripes of electrical tape.
2. Terminate the Ethernet cable with an RJ-45 similar to the method described in the previous section, but without the quick connect assembly shell. Note that this Ethernet cable should be "straight through", which means that the wire color convention selected for Step 4 above should be followed in the cabinet as well.

3.4   Connecting Equipment
Once the Ethernet cable has been terminated on each end, use the Ethernet Cable Tester to verify the cable was built properly. Note that if an ECX is inline, separate Ethernet tests need to be

performed: one on the Ethernet cable from the TCIB to the ECX, and then another test performed on the cable between the ECX and the TC-CK1-VMS.

Once the Ethernet cabling has been verified, connect the Ethernet cable to its respective component following the steps in the subsections below.

3.4.1 TC-CK1-VMS

1. Depress the locking tab of the RJ-45 plug and align it with the wide slot of the plug housing shown in Detail A of the figure below.
2. Gently pull the cable until the plug is fully seated. Hold the plug in position and rotate cable fitting until tightened to a torque of 3.4 Nm (30 lb-in) as shown in Detail B of the figure below.
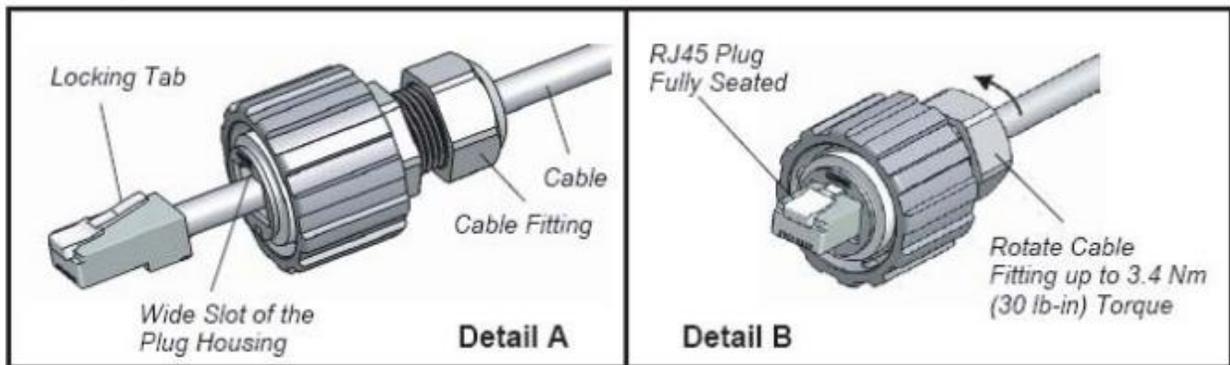
Figure 15: Securing Weather Sealed Connector to RJ-45 Cable

3. Once the quick connector assembly is completed, attach the cable to the sensor. Remove the protective cover from the sensor receptacle assembly by gently rotating the cover counter clockwise.
4. Apply dielectric grease to the interior of the sensor's receptacle assembly.
5. Gently insert the assembled plug (Bayonet) into the jack adaptor of the RJ45 receptacle. Align the 3 keys of the bayonet coupling ring with the 3 channels of the receptacle, then rotate the bayonet coupling ring until the 3 keys "click" into the bayonet channels.
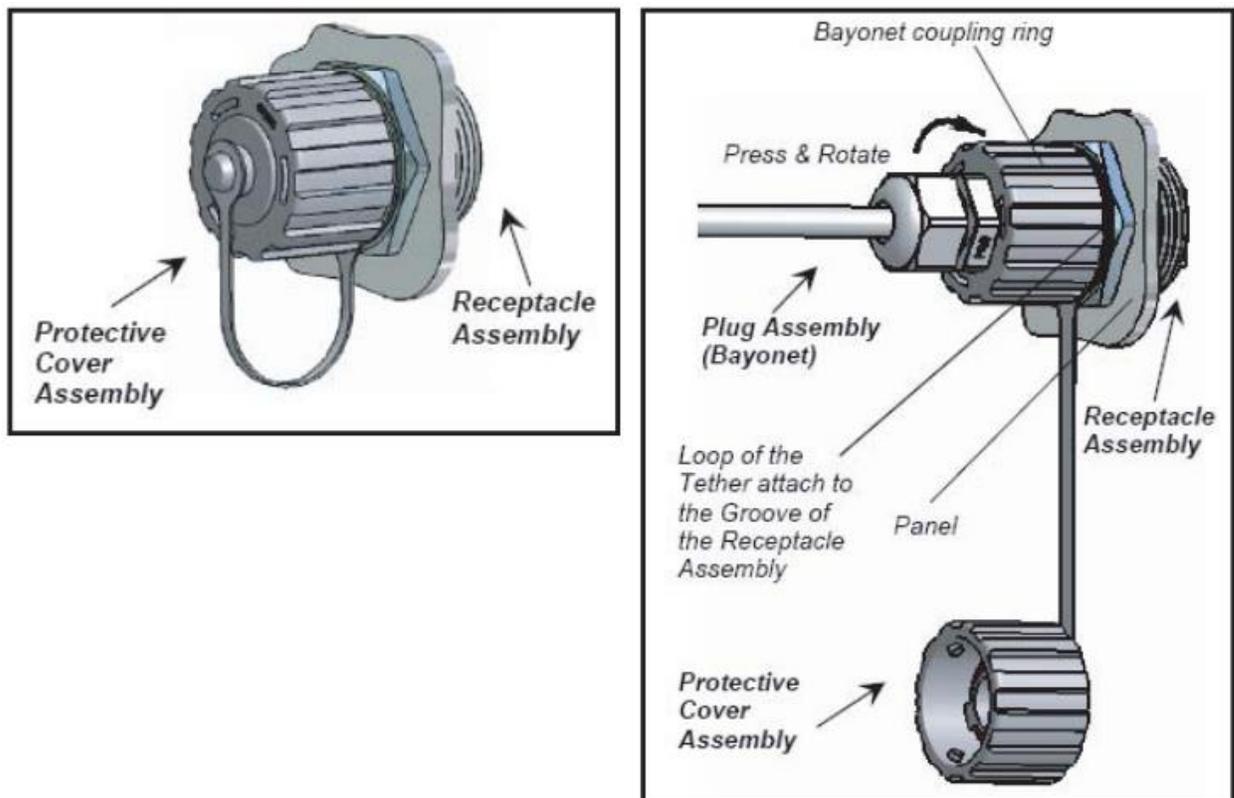
Figure 16: Mating Ethernet Cable to Sensor

3.4.2 TCIB

1. Plug the TCIB into the Detector Rack of the traffic cabinet.
   a. If using a TCIB-4.1 or -4.2, ensure that it is plugged into an even slot.
   b. If using a TCIB-2.1, plug the card into any desired slot.
2. Ensure proper power is applied to the Detector Rack. The TC-CK1-VMS System operations on 12 to 24 VDC. If a TCIPI-4 is not being used, the power supply to the Detector Rack must be capable of supplying 1 Amp of current to each TCIB card.
3. Apply dielectric grease into the "Sensor / Operational" Ethernet port.
4. If the TC-CK1-VMS is already set up, connect the Ethernet Cable into the "Sensor / Operational" Ethernet port. By default, the TCIB will be in recall for 120 seconds (2 minutes) and then go into operational mode where the outputs would only activate based on zone activations.
5. If the TC-CK1-VMS is not set up yet, move the Ethernet cable into the "Setup" port of the TCIB until setup is complete. Note that the TCIB will remain in recall until the sensor is communicating through the "Sensor / Operational" Ethernet port.

3.5 Connected System Diagram
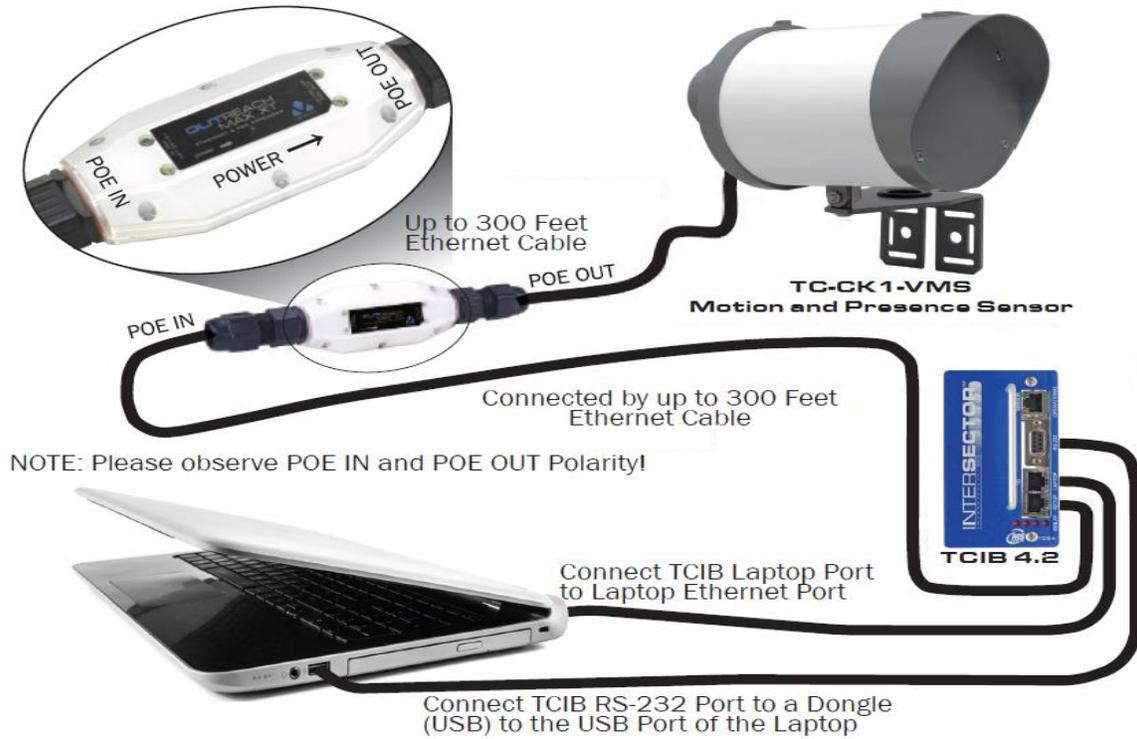
Figure 17: TC-CK1-VMS System Interconnection Diagrams

4 TC-CK1-VMS Configuration Setup

4.1 Equipment Needed

The following equipment is recommended for configuring the TC-CK1-VMS system:

- Laptop with the following features:
  - o Configurable Ethernet settings
  - o Modern web browser (Google Chrome, Mozilla Firefox, Internet Explorer, and/or Edge)
- 1x Regular Ethernet Cable; length should be long enough to reach from the Detector Rack to the laptop shelf

The following equipment is highly recommended, but optional, for setting up the TC-CK1-VMS System:

- Ethernet switch with at least 3 available ports
- 1 additional Regular Ethernet Cable
- 1 "Safe" Ethernet Cable (pins 4, 5, 7, and 8 are disconnected)
  - o If using a 100BaseT Ethernet switch, this can be substituted for an additional regular Ethernet cable

4.2 Hardware Configuration

Prior to following the instructions in this section, install the Intersector system per the instructions in Section 3. Make sure to connect the TC-CK1-VMS's Ethernet cable to the "SETUP" port of the TCIB.

If only the minimum required equipment is available, connect the laptop's Ethernet port to the "LAPTOP" port of the TCIB using the Regular Ethernet Cable. See the block diagram below.

Figure 18: Minimum Intersector Setup Configuration

If an Ethernet switch and additional cables are available, perform the following steps. See the figure below for a block diagram.

1. Connect the Ethernet switch's power cable to an available power source in the cabinet.
2. Using one of the Regular Ethernet Cables, connect the Ethernet port of the laptop to an available port of the Ethernet switch.
3. Using the other Regular Ethernet Cable, connect the "LAPTOP" port of the TCIB to an available port of the Ethernet switch.
4. Using the "Safe" Ethernet Cable, connect the "SENSOR / OPERATIONAL" port of the TCIB to an available port of the Ethernet switch.
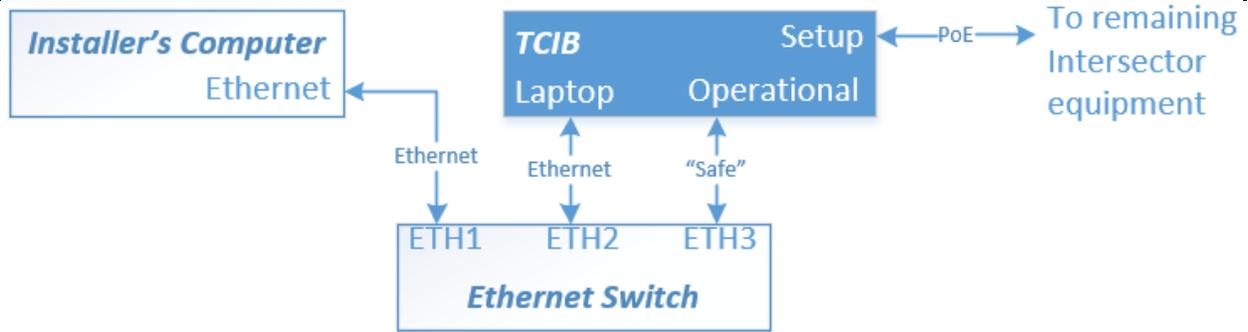
Figure 19: Recommended Intersector Setup Configuration

4.3 Laptop Ethernet Configuration

Prior to configuring the TC-CK1-VMS, the laptop must have a dedicated IP Address.

1. Select the START button in the lower left of the computer's desktop
2. Select either "Settings" or "Windows System" depending on operating system, and open "Control Panel".
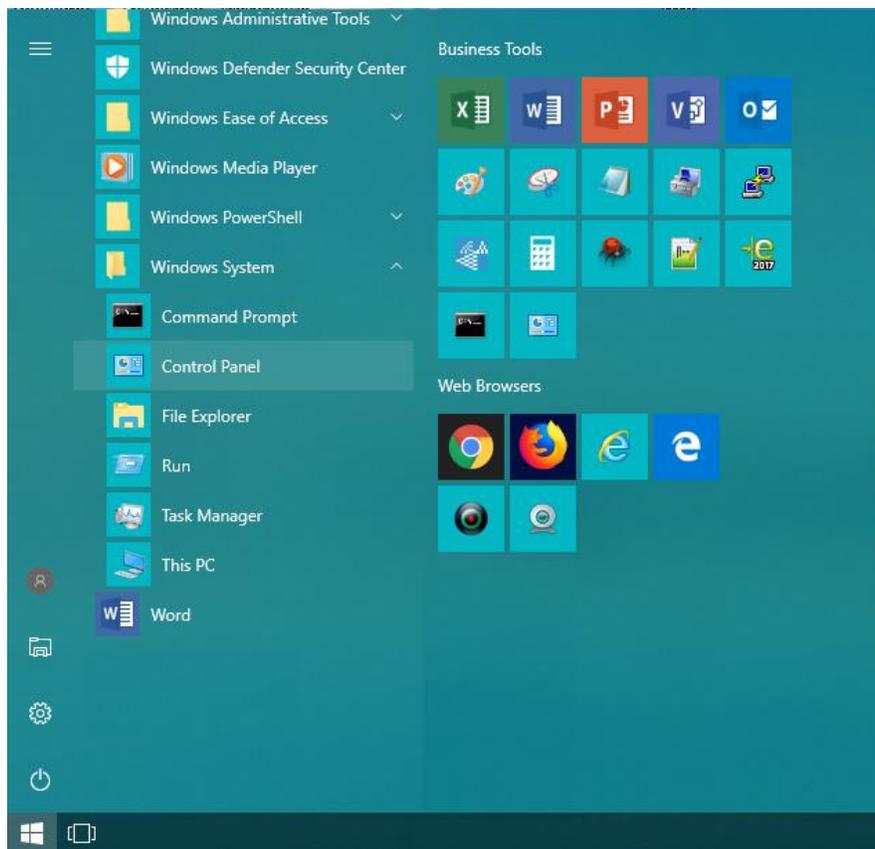
Figure 20: Select Control Panel - Windows 10

3. Find the Network and Sharing option based on the laptop's operating system.
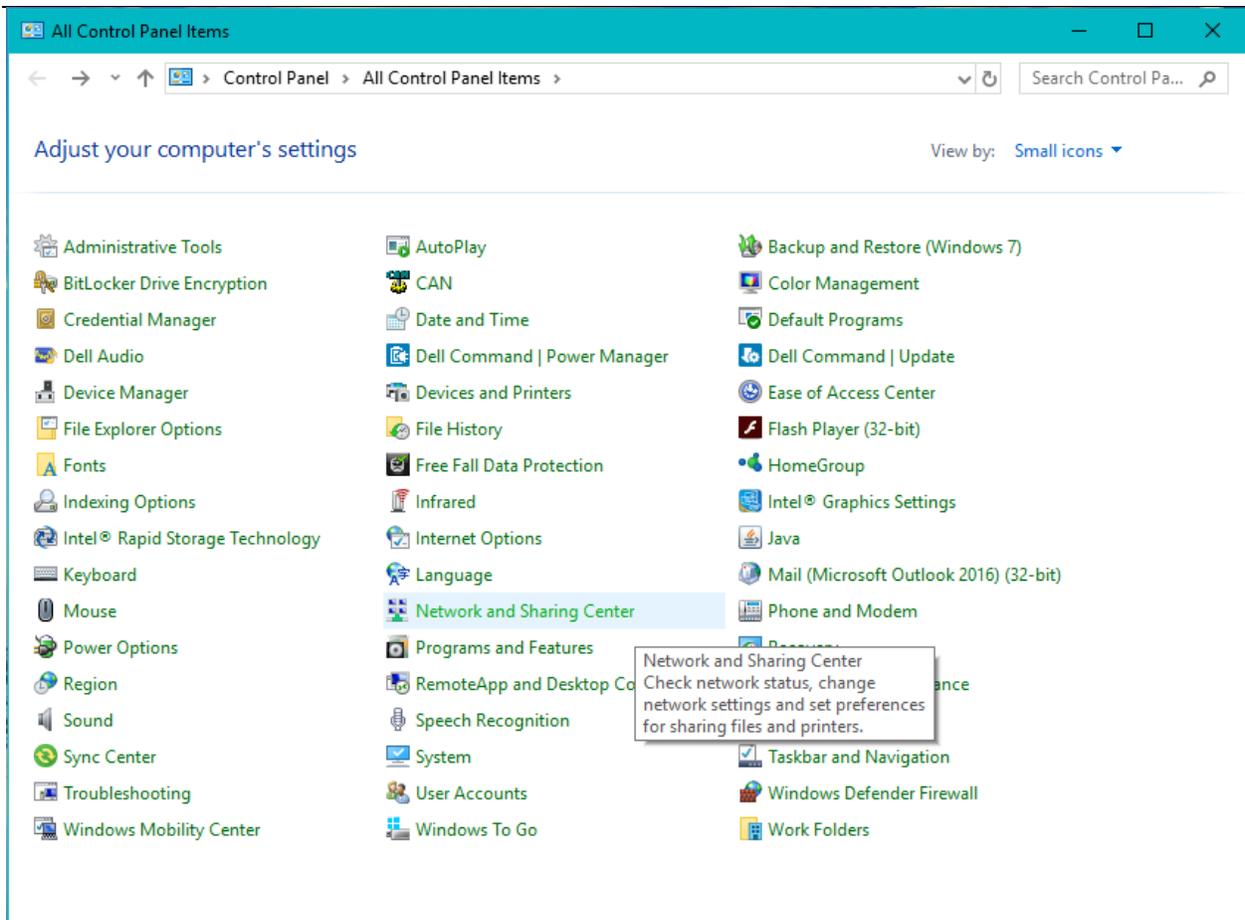
Figure 21: Select Network and Sharing Center - Windows 10

4. Select the "Change Adapter Settings" option based on the laptop's Operating System.
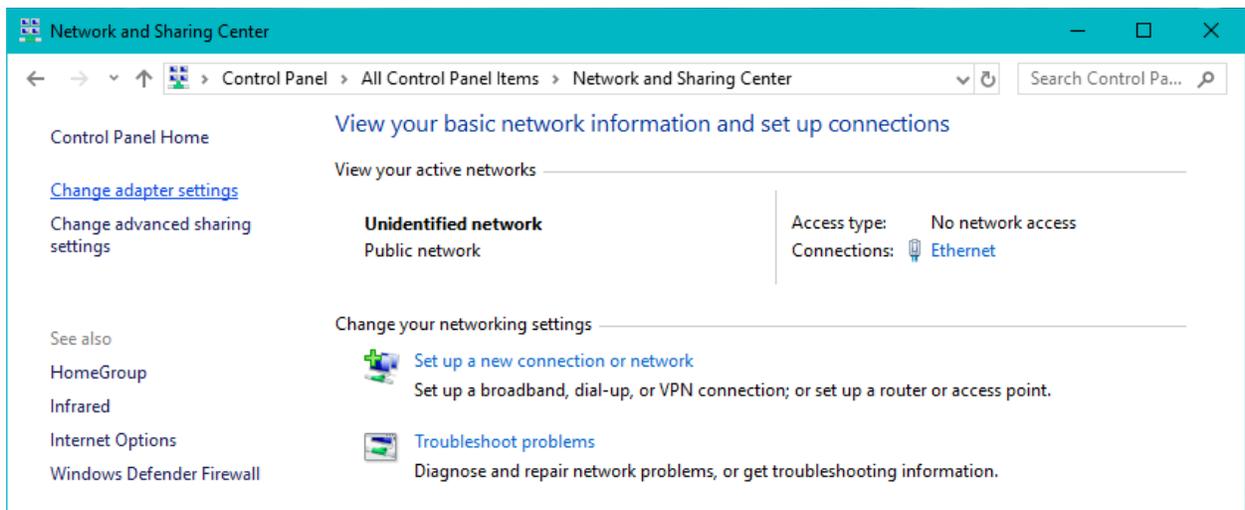
Figure 22: Select "Change Adapter Settings"

5. Right click the Ethernet port to configure the Ethernet settings for Intersector setup, and select the "Properties" option. Note: this can also be done by double clicking the Ethernet port and clicking "Properties" from the pop-up window.
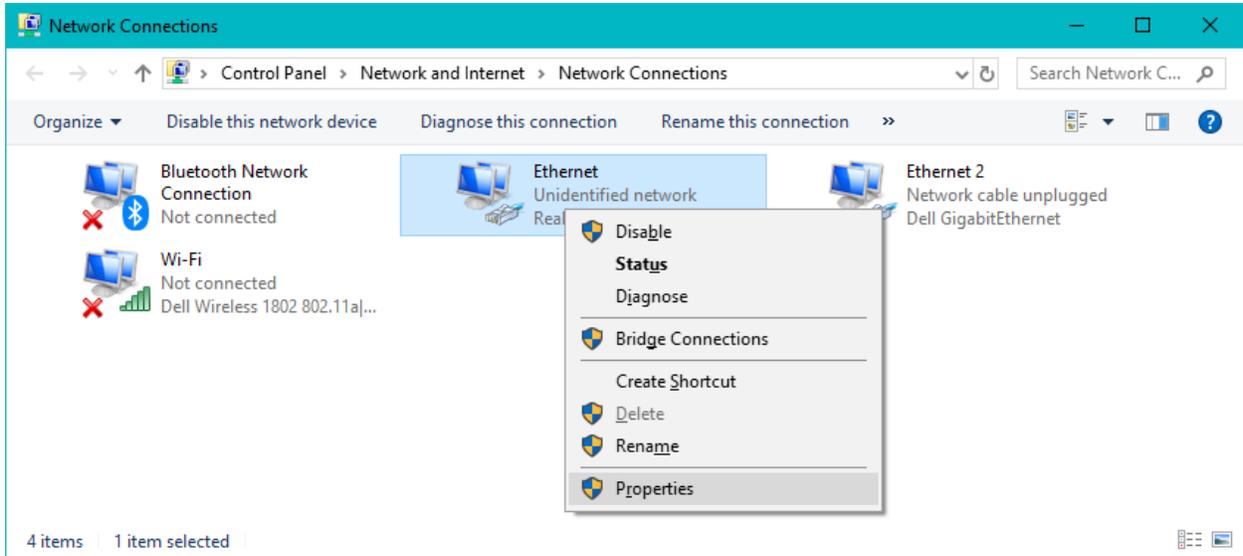
Figure 23: Select the Ethernet Port to Customize

6. In the window that appears, click the "Internet Protocol Version 4 (TCP/IPv4) so that it highlighted and check marked. Then click the "Properties" button under the window.
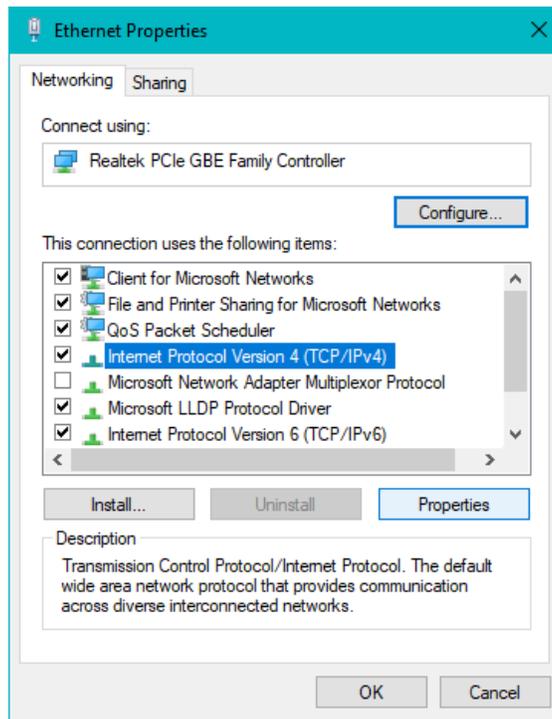
Figure 24: Ethernet Properties Selection

7. Select the "Use the following IP address:" option. To communicate with a default TC-CK1-VMS, set the Subnet mask to 255.255.255.0 and an IP address of 192.168.0.xxx where xxx is a number between 2 and 255 other than 90, 98, 100, or any other IP addresses that may already be on the network.
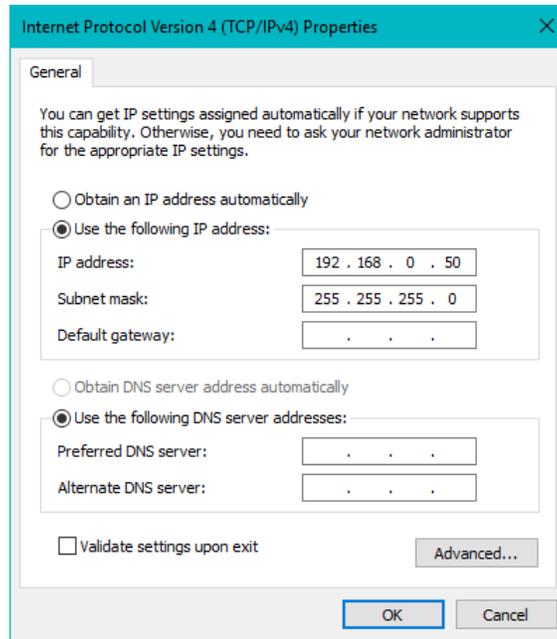
Figure 25: Internet Protocol Version 4 (TCP/IPv4) Properties Customization

8. Click "OK" in the Internet Protocol Version 4 (TCP/IPv4) and Ethernet Properties windows once the Ethernet settings are set up.

The laptop should be ready to program the TC-CK1-VMS. Programming instructions appear in Section 5 of this document.

4.4   TC-CK1-VMS Setup Configuration

The Intersector system has other tools available for advanced setup and software updating. These tools include an "IP Address Set" application that can update the IP Address for each Intersector system component, as well as a "Bootloader" application to update software in each Intersector component if changes to product software is available after delivery. These applications are available upon request from MS Sedco.

5   TC-CK1-VMS Settings Customization

This section provides instructions for basic setup of an TC-CK1-VMS System when a VMS configuration TC-CK1-VMS Settings file is not available. If the installation of the TC-CK1-VMS is a replacement of a previous TC-CK1-VMS and an TC-CK1-VMS Settings file is available, proceed to the Upload TC-CK1-VMS Settings section. This section assumes that the laptop and TC-CK1-VMS system is set up per the instructions from the previous section.

5.1   Sensor Information

The following parameters are used to provide information to the user about the status of the sensor.
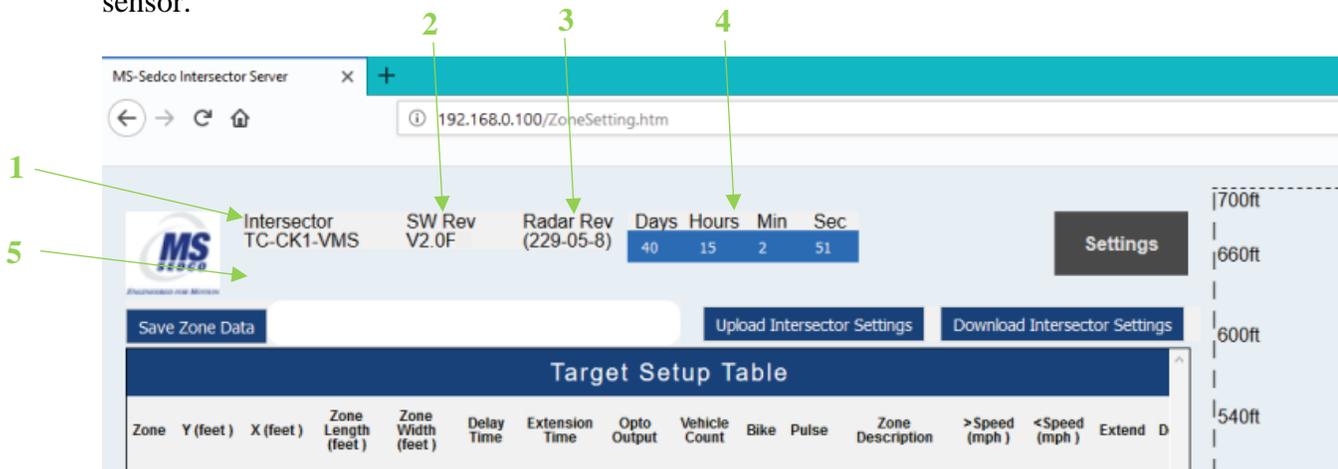
Figure 26: TC-CK1-VMS Portal Page - Sensor Information

1. ***Model Number:*** First line is the product line (TC-CK1-VMS), and the second line is the model number. For this product, the model number is TC-CK1-VMS.
2. ***Software Revision Number:*** Software version number for the logic processor inside the sensor.
3. ***Radar Firmware Revision Number:*** Firmware version number for the radar algorithm processor inside the sensor.
4. ***Operation Timer:*** A timer amount that displays the amount of time the sensor has been operational. This timer increments every second on the user interface and can be used to determine whether the laptop's Ethernet connection to the sensor is operating properly.
5. ***Sensor Malfunction Notification:*** If no issues are detected on the sensor, this area should remain blank. If there are any detected malfunctions or known reasons the sensor would not operate properly, a message will be displayed in this area in bold red text. Example error messages include, "Sensor Error", "Sensor Interference", and "Error Flag". "Sensor Error" displays for critical system malfunction and will result in the TC-CK1-VMS system going into recall. The other error messages are not critical failures so recall will not be initiated, but a maintainer should service the unit should either of these messages display for a period lasting longer than 3 cycles.

5.2   Initial Setup

This section provides instructions for the initial setup of the TC-CK1-VMS System. The items in this section should be completed prior to building zones. It is also recommended to have a crew on standby to make physical adjustments as needed throughout the alignment process.
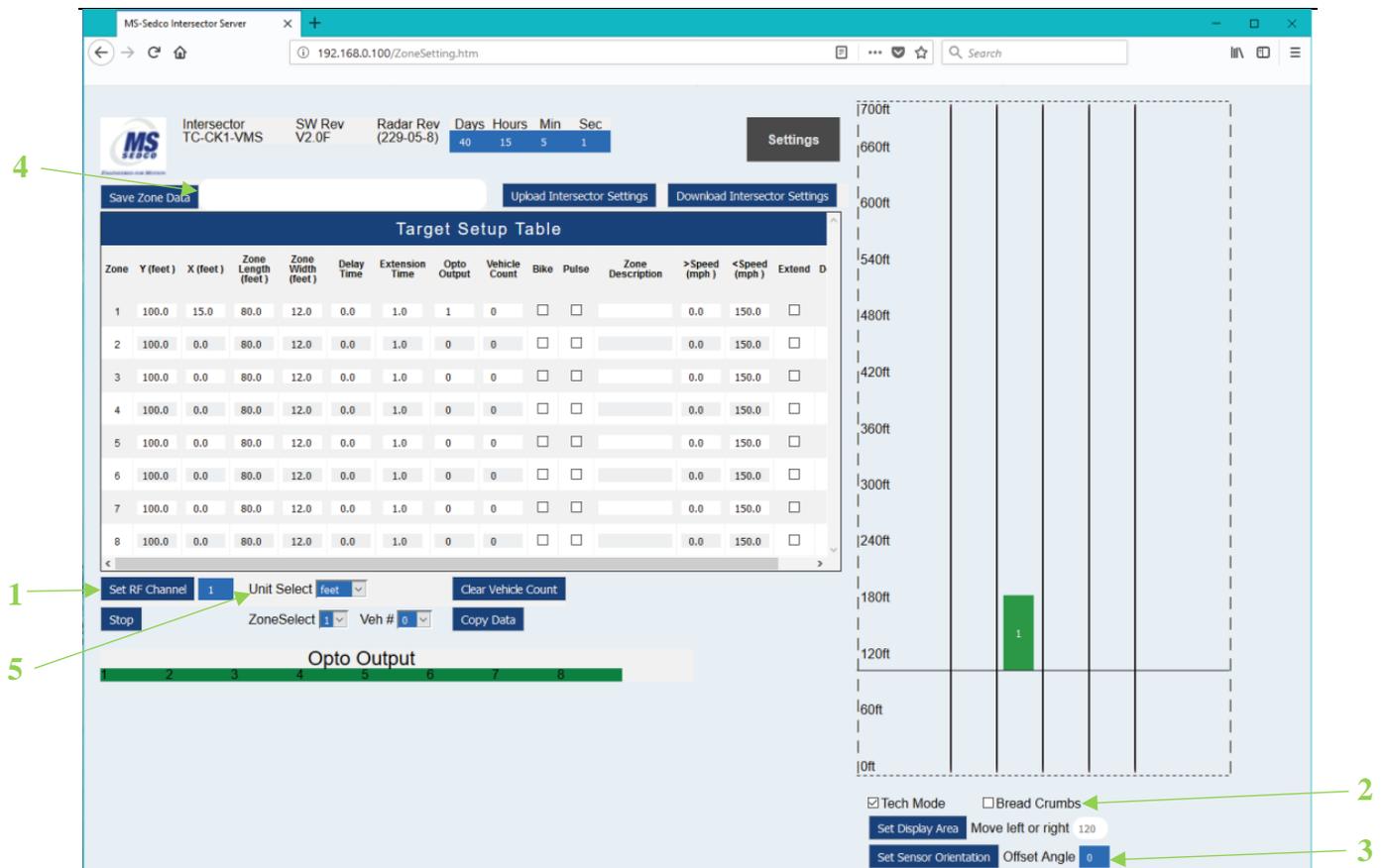
Figure 27: Initial Setup Screen Shot

1. **RF Channel:** Sets the Radio Frequency (RF) channel the sensor transmits on. This field is an integer value ranging from 1 through 7, with a default value set to 1. To modify the RF Channel, change the number in the text entry field to the desired value and then press the "Set RF Channel" button.

2. **Bread Crumbs:** This feature simplifies zone alignment by displaying the path that each detected vehicle has traveled, illustrating lanes of traffic flow. By default, this feature is disabled, and can be enabled by checking the box next to the text "Bread Crumbs". To reset the view, disable and re-enable Bread Crumbs or refresh the web page.

3. **Offset Angle:** This field adjusts the radar's processing of vehicles. The Offset Angle is the angle between the vehicle's trajectory and the boresight of the radar. Installation sites should be selected to keep this value between -15 and +15 degrees. This value can be edited by the user entering an integer value between -40 through 40 into the text box to the right of "Offset Angle", and is saved when the user presses the "Set Sensor Orientation" button to the left of "Offset Angle".

4. **TC-CK1-VMS Description Field:** This text entry field allows the user to input a customized description, up to 32-characters long (upper or lowercase letters and numbers only), that describe the TC-CK1-VMS and the approach it is providing detection for. Typically, this should record the approach direction (i.e. NB, EB, etc), the intersection (i.e. Main St. at 1st Ave), and/or the phase(s) the TC-CK1-VMS System is detecting. To

edit the value, set the text field to the desired text, then press the "Save Zone Data" button to the left of the text entry field.

5. *Unit Select:* Toggle between English and Metric unit systems.

5.2.1 Set RF Channel

The RF Channel should be the first item to set on a new TC-CK1-VMS setup. The RF Channel setting changes the channel the sensor transmits on to reduce sensor interfering cross-talk. Each sensor at an intersection should be set to a unique RF Channel. For corridors with TC-CK1-VMS Systems, it is recommended that an RF Channel scheme be created (i.e. all sensors pointing Northbound are on RF Channel 1, all sensors pointing Eastbound are on RF Channel 2, etc).

The radar can determine if the RF Channel it is set to has too much signal interference to operate properly. The TC-CK1-VMS Portal Page will show "Sensor Interference" in the upper left corner in red letters under the model number. If "Sensor Interference" is displayed for longer than 2 cycles, change the RF Channel to a channel not currently in use.

5.2.2 Offset Angle

The Offset Angle adjustment is critical to a properly-functioning sensor. Ideally, the vehicle trajectories run straight down the webpage in the area(s) where zones will be placed for detection-purposes.

To set the Offset Angle, enable the "Bread Crumb" feature. Observe the lines that form as vehicles move through the radar's field of view. To rotate the vehicle trajectories clockwise, make the Offset Angle more negative. To rotate the vehicle trajectories counter-clockwise, make the Offset Angle more positive. Adjust the Offset Angle until these bread-crumb lines are running as parallel as possible to the lines on the grid view.

While determining the Offset Angle, observe the behavior of the sensor itself. Ideally, the sensor should begin detecting vehicles at least 60-feet before the back of where zones should be placed, and at least 15-feet in front of where zones will be. If the sensor is monitoring a left or right turn, ensure the sensor tracks vehicles making those turns throughout the apex of the turn. If additional radar detection is needed, physically re-adjust the sensor to provide additional radar coverage in the desired region.

After any physical adjustments are made to the sensor, the Offset Angle should be re-evaluated to ensure vehicles continue to move straight through the region(s) of interest.

5.2.3 Unit Selection

The "Unit Select" feature allows the user to set the TC-CK1-VMS either English or Metric. By default, the TC-CK1-VMS Portal Page uses English units where distance measurements are in feet and speed measurements are in miles-per-hour. If Metric is selected, distance measurements are in meters and speed measurements are in kilometers-per-hour.

To change units, select the desired unit system from the "Unit Select" drop down menu under the Target Setup Table. For English units, select "feet"; for Metric units, select "meter". If the unit

system is changed, the TC-CK1-VMS will automatically convert all customizable fields to the desired unit system.

5.3 Zone Configuration

The TC-CK1-VMS System configuration largely relies on the configuration of zones. Each zone can be customized in size, activation timings, output mapping, activation based on classification, minimum and maximum speeds, and travel direction.

Figure 28: Zone Configuration Fields

1. ***Target Setup Table:*** The Target Setup Table is comprised to 8 rows by 15 columns that allow the user to customize the TC-CK1-VMS activation options where each row is a unique zone and each column is a customizable parameter. The user can edit the values in the table based on each column's boundary conditions, and can save changes by pressing the "Save Zone Data" button to the left of the TC-CK1-VMS Description Field.
2. ***Copy Vehicle Data Feature:*** These fields under the Target Setup Table allow the user to copy a vehicle's X and Y coordinates into a zone to assist with zone setup.
3. ***Clear Vehicle Count:*** Allows the user to clear the Vehicle Count for all zones.

5.3.1 Opto Outputs

To enable a zone, set the Opto Output value to a non-zero value. Opto Outputs on the TC-CK1-VMS Portal Page correlate to the electrical outputs on the TCIB card. By default, only Zone 1 is set to Opto Output 1 and the remaining zones are disabled. The Target Setup Table allows the user to enter an integer value from 0 to 8. Note that the Opto Output does not need to match the zone number, and multiple zones can have the same Opto Output number.

Opto Outputs on the TCIB will depend on the type of TCIB card(s) are connected to each sensor.

- *(Primary) TCIB-2.1:* Opto Outputs 1 and 2
- *(Primary) TCIB-4.x:* Opto Outputs 1 through 4
- *Secondary TCIB-2.1:* Opto Outputs 5 and 6
- *Secondary TCIB-4.x:* Opto Outputs 5 through 8

5.3.2 Zone Location and Size Adjustment Parameters

All 8 zone sizes can be set independently through 4 different parameters for each zone: Y, X, Zone Length, and Zone Width. Changes to the zone size parameters will be previewed with the yellow zones in the Grid View. The figure below provides a visual example of these parameters.

- *Y:* Defines the "bottom edge" of the zone, which is the closest vertical axis. In addition, the Y-value of Zone 1 defines the "stop bar" line on the grid view.
    - o *Range:* 0 to 900'
    - o *Default:* 100'
- *X:* Defines the "center line" of the zone, which is the horizontal center of the zone.
    - o *Range:* -900' to 900'
    - o *Default:* 15 for Zone 1, 0 for all other zones
- *Zone Length:* Defines the "depth" of the zone, which defines the "top edge" of the zone when added to Y.
    - o *Range:* 0 to 900'
    - o *Default:* 80'
    - o *Best Practice Note:* Stop-bar zones should be between 60' to 80' to capture 3 to 4 cars. Advance zones should be between 20' to 40' depending on the average speed in the area. Ideally, vehicles should take ~3 seconds to get through the zone
- *Zone Width:* Defines the horizontal left and right boundaries of the zone, centered around the X value.
    - o *Range:* 0 to 900'
    - o *Default:* 12'
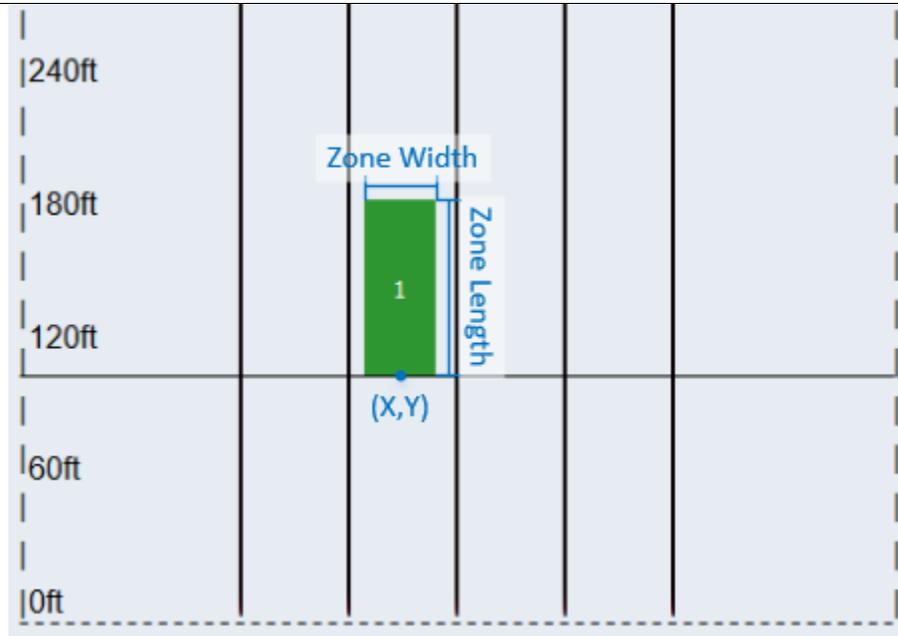
Figure 29: Zone Size Definition

In addition to manually entering a zone's X and Y value, the TC-CK1-VMS System allows the user to "copy" a vehicle's X and Y position into a zone. To use this feature, observe vehicles traveling in an approach. Once a vehicle reaches the location for a desired zone, press the "Stop" button under the Target Setup Table. This will temporarily stop live data from updating the TC-CK1-VMS Portal Page. Once the TC-CK1-VMS Portal Page is stopped, find the vehicle on the Grid View or Vehicle Table if it is visible. Note the Vehicle Number (the number next to the vehicle symbol on the Grid View), select it from the "Veh #" drop down menu under the Target Setup Table, select the desired zone number from the "Zone Select" drop down menu to the left of the "Veh #" drop down, and click the "Copy Data" button. This process can be repeated for any or all the desired zones. Once the zone's X and Y are copied and adjusted if needed, press the "Save Zone Data" button to save the changes.

5.3.3   Zone Activation Timing Parameters

Each zone has customizable settings for the timing in activating and deactivating the output.

- *Delay Time:* The amount of time a vehicle must be in the zone before it can activate the zone.
    - o *Range:* 0 to 60 seconds
    - o *Default:* 0 seconds
    - o *Best Practice Note:* If a non-zero value is entered, ensure the zone is large enough such that the desired vehicle to be detected would still be moving through the zone after "Delay" amount of time from entering the zone
- *Extension Time:* The time an activated zone remains active after all vehicles leave the zone.
    - o *Range:* 0 to 60 seconds
    - o *Default:* 1 second

- ***Pulse Checkbox:*** When enabled by that zone, the output will "pulse" active for a static 125 ms for each vehicle that meets the activation criteria.
  - *Default:* Disabled
  - *Miscellaneous Note:* If there are multiple zones that have the same Opto Output, selecting "Pulse" on one will enable "Pulse" on any other zone assigned to the same Opto Output
  - *Best Practice Note:* This is recommended for advance detection to ensure fast-moving vehicles get an activation notification to the controller

5.3.4   Vehicle Classification Parameters

The TC-CK1-VMS System allows the user to customize zone activations based on vehicle classifications.

- ***Bike Checkbox:*** When enabled, only activates the zone for "bike" classified vehicles. When disabled, zone will activate for any vehicle that meets the other zone activation criteria.
  - *Default:* Disabled
  - *Best Practice Note:* Selecting this checkbox only filters the type of vehicle to activate the zone. Changing the TC-CK1-VMS's sensitivity is set in the Settings Tab
- ***Extend Checkbox:*** When enabled, cars moving through the zone will get a 12' extension to their vehicle representation. This "tail" can be used to keep the zone activated until it goes more than 12' in front of the zone.
  - *Default:* Disabled

5.3.5   Speed Condition Parameters

Each zone is capable of activating based on the speed of vehicles moving through them. If a vehicle's speed is greater than the minimum speed while less than the maximum speed, the zone will activate once all other zone activation criteria is met.

These values are typically set for dilemma zone activations (i.e. if a car is going greater than a certain speed, it is not likely they can stop before the light turns red and will extend an all-red phase). This can also be used in areas where pedestrian or maintenance workers are commonly going into the zone by setting a minimum speed greater than an average walking or lawn maintenance equipment speed.

- ***> Speed:*** Vehicle speed must be greater than this value to activate the zone
  - *Range:* 0 to 150 mph
  - *Default:* 0 mph
- ***< Speed:*** Vehicle speed must be less than this value to activate the zone
  - *Range:* 0 to 150 mph
  - *Default:* 150 mph

5.3.6   Departure Detection

The TC-CK1-VMS System allows the user the ability to select whether each zone activates for either vehicles moving toward the sensor (Departure de-selected) or away from the sensor (Departure selected). By default, all Departure checkboxes are de-selected.

The sensor can track up to 64 vehicles, and if there are more than 64 vehicles in the detection area, it will prioritize tracking to the closest 64 vehicles. While all Departure Detection checkboxes disabled, the number of targets is filtered to the closest 64 vehicles moving toward the sensor. If any zones' Departure checkbox is selected, the sensor will track vehicles bi-directionally, and will prioritize the tracked vehicles as the closest 64 moving vehicles independent of travel direction.

This checkbox is common in Wrong Way installations when the sensor is mounted at the intersection and is providing Wrong Way detection for the approach where the correct flow of traffic is coming toward the intersection and sensor, and the wrong-way vehicles are driving away from the intersection. Having bi-directional tracking can also be assist in bicycle detection applications where bicyclists move sporadically (i.e. make "Figure-8's or ride side-to-side) when they come to an intersection.

5.3.7   Zone Description

Each zone has an 8-character description field (upper and lowercase letters or numbers only) that allows the user to describe the zone's function. This typically is used to designate any designations from city plans, phase designation, and/or lane designation.

5.3.8   Vehicle Count

The TC-CK1-VMS keeps a running total of the number of vehicles that pass through a zone that meets all activation criteria. The Vehicle Count column provides a read-out of the number of vehicles that met all activation criteria for each zone. The TC-CK1-VMS System can record up to 65,354 vehicles per zone. Once the number of vehicles exceed this number, the vehicle count number resets back to 0.

To manually clear the vehicle count, press the "Clear Vehicle Count" that is below the Target Setup Table.

5.4   Settings Tab

The Settings Tab contains more advanced settings customizations. These settings can be viewed by clicking the "Settings" button to the right of the Sensor Information fields. To close the Settings Tab menu, click the "Settings" button again. It will also be automatically close if a setting change is saved with its respective button.
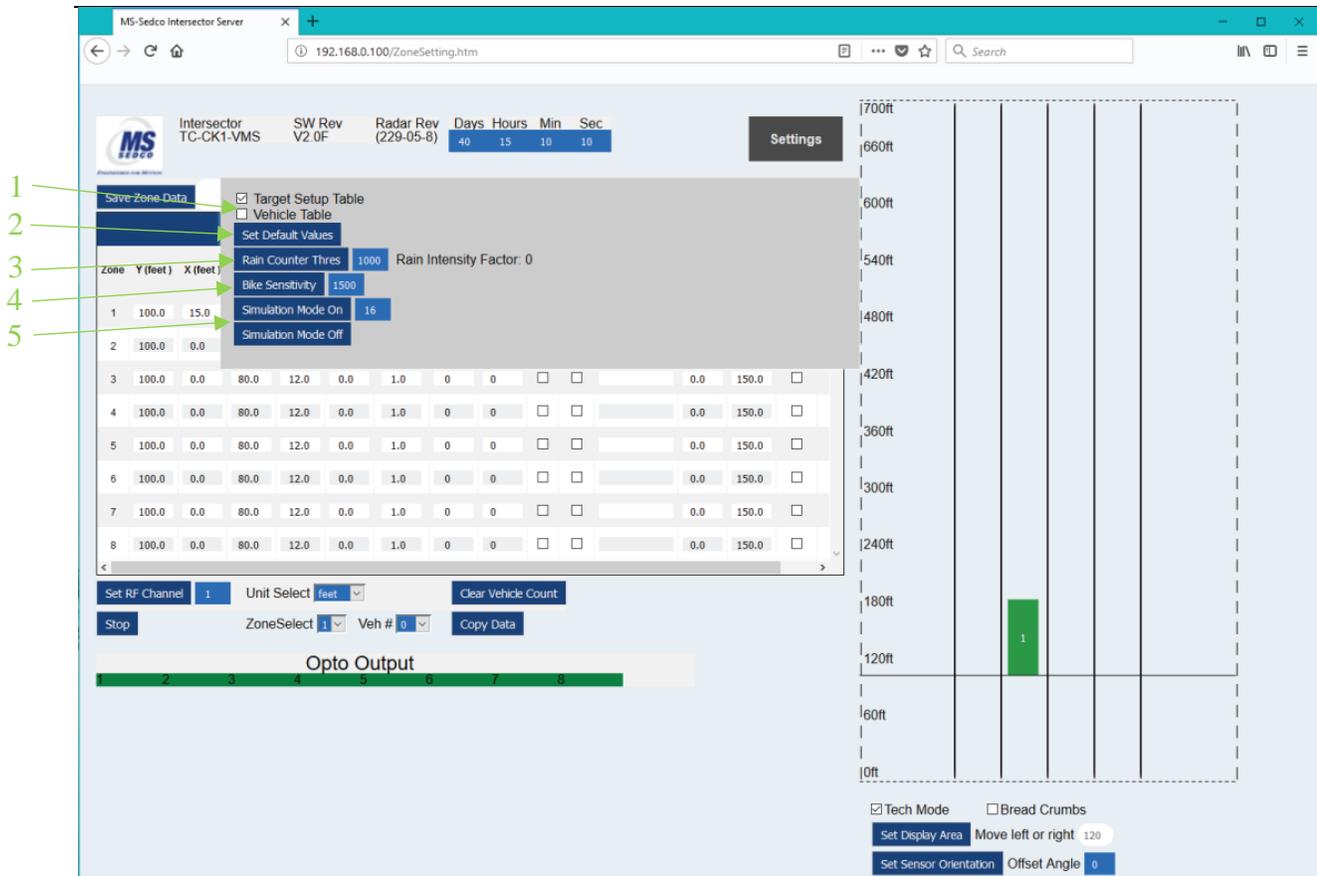
Figure 30: Settings Tab

1. **TC-CK1-VMS Portal Page Declutter Options:** Checkboxes to declutter the Target Setup Table and Vehicle Table. When the checkbox is selected, the fields associated with that group are visible. When the checkbox is deselected, the fields associated with that group are hidden from view.
2. **Set Default Values:** The "Set Default Values" return all values customizable on the TC-CK1-VMS Portal Page back to their default values. Note that this does not change the Ethernet network settings or failsafe timers if those were changed from their default values.
3. **Rain Failsafe Feature:** Rain customization options for sensitivity to going into recall with rain.
4. **Bike Classification Feature:** Customization option to fine-tune the sensor's bike / car classification threshold.
5. **Simulation Mode:** Mode to run the sensor with a simulated vehicle profile instead of live radar data.

5.4.1 TC-CK1-VMS Portal Page Declutter Options

To reduce clutter on the TC-CK1-VMS Portal Page, the TC-CK1-VMS unit provides the ability to toggle the view of the Target Setup Table and Vehicle Table. By default, the Target Setup Table is visible, and the Vehicle Table is hidden.

The following fields are always visible, independent of the Target Setup Table and Vehicle Table declutter options:

- Model number
- Both sensor software version numbers
- Operation Timer
- TC-CK1-VMS Description Field with save button
- Upload and Download TC-CK1-VMS Settings buttons
- Settings Tab selection
- Opto Output visual display
- TC-CK1-VMS Grid View and customization options
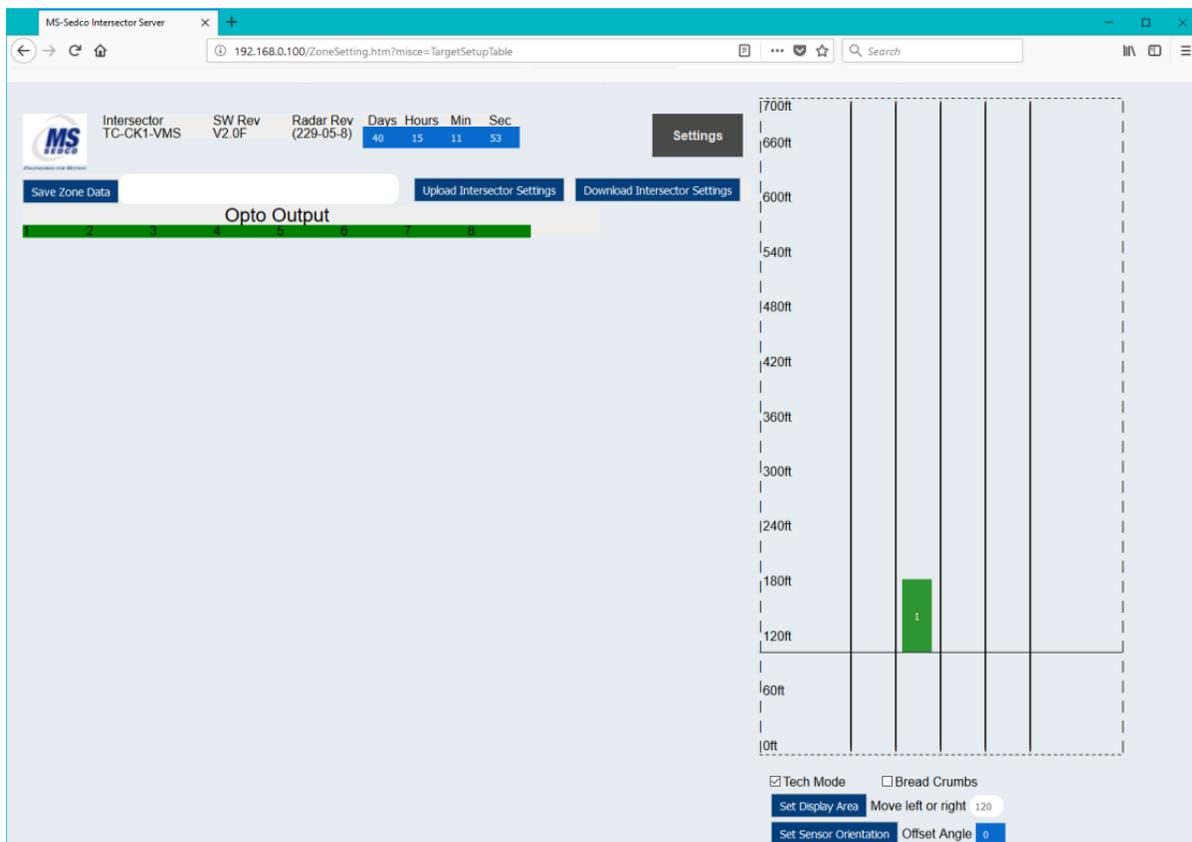
Figure 31: Target Setup Table and Vehicle Table Declutter View

The following settings are grouped with the Target Setup Table in the declutter option:

- Target Setup Table
- Set RF Channel button and text entry field
- Unit selection
- Clear Vehicle Count
- Stop live traffic view
- Copy feature of vehicle information to zone parameters

The Vehicle Table option controls whether the vehicle table is shown or hidden. See the Vehicle Table section for a summary of information the Vehicle Table provides.

The figure below provides a view with the Target Setup Table decluttered and the Vehicle Table is visible.
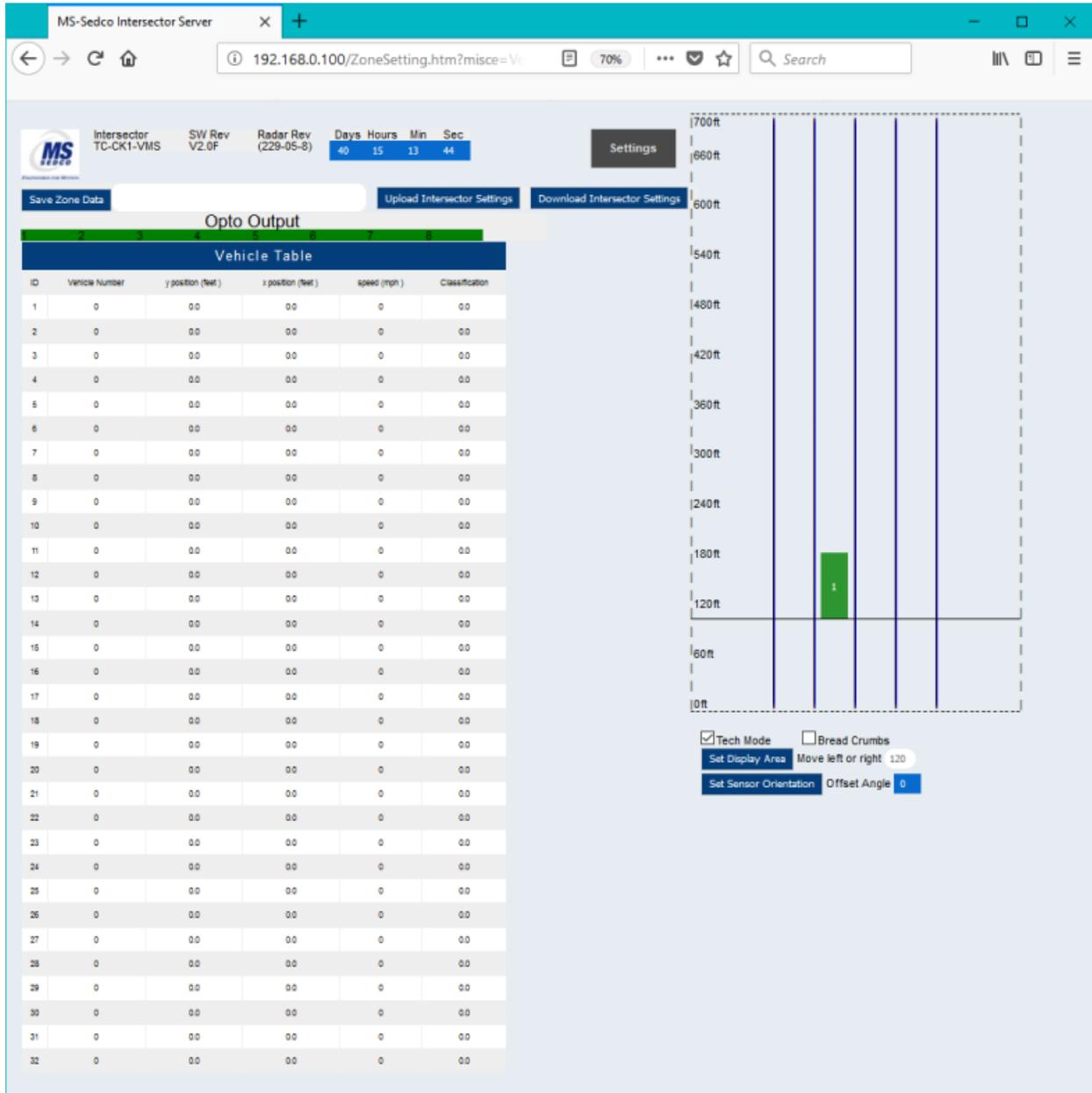
Figure 32: Vehicle Table Visible and Target Setup Table Decluttered

5.4.2 Rain Failsafe Feature

The TC-CK1-VMS provides a feature that can put the TC-CK1-VMS System into recall during a heavy rainfall that exceeds the sensor's rated rainfall limit. The following items are used for this feature:

- *Rain Intensity Factor:* Continuously calculated value based on the number of rain drops within the first 10-feet of the radar's field of view and a measurement of the rain drops
- *Rain Counter Threshold:* Maximum Rain Intensity Factor allowed before the TC-CK1-VMS System goes into rain failsafe
  - *Range:* 1 to 5000
  - *Default:* 1000
  - *Disable Feature:* 5000
- *Rain Flag:* Visual notification (bold blue text: "RAIN") on the TC-CK1-VMS Portal Page to the right of the Opto Output visual indicators to notify the user that the TC-CK1-VMS System is currently in Rain failsafe recall.

The TC-CK1-VMS System continuously calculates the Rain Intensity Factor and compares it to the Rain Counter Threshold. If the Rain Intensity Factor exceeds the Rain Counter Threshold, the TC-CK1-VMS System is put in failsafe recall until the Rain Intensity Factor drops below the Rain Counter Threshold for 5 minutes. While the system is in failsafe recall, all outputs on the connected TCIB card(s) are activated and the TC-CK1-VMS Portal Page displays the Rain Flag.

The Rain Counter Threshold can be adjusted by editing the text field next to the "Rain Counter Thres" button on the Settings Tab. To save, press the "Rain Counter Thres" button. The Rain Intensity Factor readout can be found to the right of the Rain Counter Threshold edit fields in the Settings Tab.

As depicted in the graph below, the Rain Intensity Factor correlates to the rain storm's rainfall rate; typically, as the rainfall rate increases, the Rain Intensity Factor also increases. By default, the Rain Counter Threshold is set to 1000, which is typical for a heavy rainfall rate. While rainfall rate is the primary metric to determine the Rain Intensity Factor, blowing wind may also affect the Rain Intensity Factor. To increase rain sensitivity, decrease the Rain Counter Threshold. To decrease rain sensitivity, increase the Rain Counter Threshold. Rain Counter Threshold entry ranges from 1 to 5000. To disable the Rain feature, set the Rain Counter Threshold to 5000.

Rain Intensity Factor Correlated to Rainfall Rate
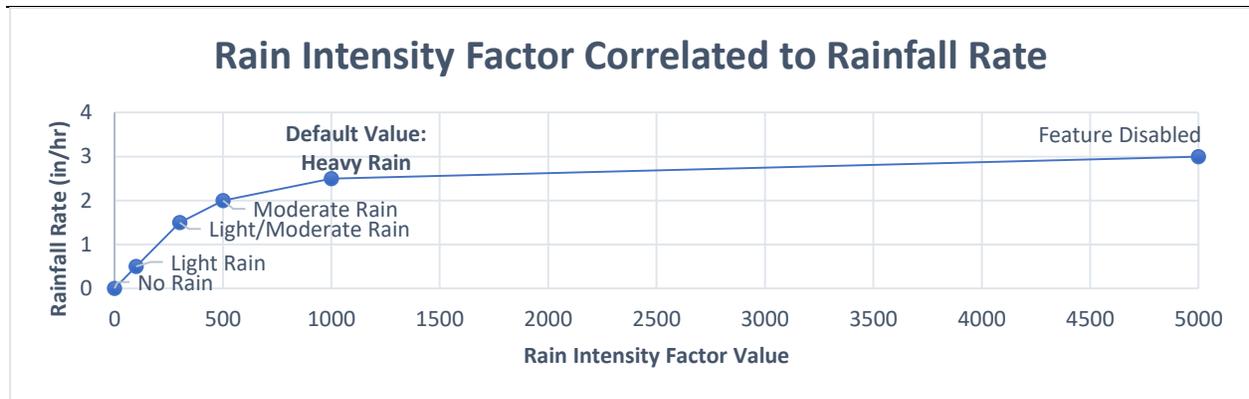
Figure 33: Rain Intensity Factor to Rainfall Rate Graph

5.4.3   Bike Classification Sensitivity Adjustment

Another advanced feature found in the Settings Tab is the Bike Classification Sensitivity adjustment. This adjustment allows the user to customize how sensitive the TC-CK1-VMS is for classifying vehicles as either bikes or cars. In some installations, the TC-CK1-VMS may be more likely to incorrectly classify cars as bicycle traffic, or vice versa. If cars are being misclassified as bikes, decrease the Bike Sensitivity value. If bicycles are being misclassified as cars, increase the Bike Sensitivity value. Note that if a vehicle's speed exceeds 18.7 mph anytime during the life of that vehicle ID, it will always be classified as a car.

The adjustment range of this field is between 0 and 5000, and the default setting is 1500. Typically, a setting of 300 would accurately classify cars coming from an angle (driveways, roundabouts, etc), or where bike-only zones are not required. A setting between 1250 and 2000 will offer better accuracy in bike-friendly areas with long, straight approaches.

Note that while the Bike Sensitivity setting can assist in correctly classifying bike or cars, the sensor mounting is crucial. For best results for bike classification, the TC-CK1-VMS should be installed with a mounting height between 16 and 20 feet, an offset angle between 0 and ±10 degrees, and an additional tilt angle of approximately 3 degrees downward (to a maximum of -9 degrees) relative to the slope of the road.

5.4.4   Simulation Mode

The final feature available in the Settings Tab is the Simulation Mode. Simulation Mode allows the user to run a pre-existing scenario stored in the radar head rather than live traffic. This primarily used to test output mappings, product demonstration, and training on software setup.

To run a simulated scenario, put a simulation number into the text entry field in the Settings Tab and press the "Simulation Mode On" button. Simulation number 16 is the default simulation mode.

To turn off Simulation Mode and return to live data, press the "Simulation Mode Off" button in the Settings Tab.

5.5 Vehicle Table

The Vehicle Table is another advanced feature available in the TC-CK1-VMS Portal Page. To view it, check the box next to "Vehicle Table" in the Settings Tab. The Vehicle Table provides a list of the closest vehicles, up to 32, being tracked by the sensor. If no "Departure" checkboxes are selected in the Target Setup Table, all vehicles listed will correlate to vehicles moving towards the radar. If any "Departure" checkboxes are selected, the vehicles listed can correlate to vehicles either approaching or departing with respect to the sensor.

The Vehicle Table has 6 read-only columns to describe each vehicle.

ID	Vehicle Number	y position (feet)	x position (feet)	speed (mph)	Classification
1	0	0.0	0.0	0	0.0
2	0	0.0	0.0	0	0.0
3	0	0.0	0.0	0	0.0
4	0	0.0	0.0	0	0.0
5	0	0.0	0.0	0	0.0
6	0	0.0	0.0	0	0.0
7	0	0.0	0.0	0	0.0
8	0	0.0	0.0	0	0.0
9	0	0.0	0.0	0	0.0
10	0	0.0	0.0	0	0.0
11	0	0.0	0.0	0	0.0
12	0	0.0	0.0	0	0.0
13	0	0.0	0.0	0	0.0
14	0	0.0	0.0	0	0.0
15	0	0.0	0.0	0	0.0
16	0	0.0	0.0	0	0.0
17	0	0.0	0.0	0	0.0
18	0	0.0	0.0	0	0.0
19	0	0.0	0.0	0	0.0
20	0	0.0	0.0	0	0.0
21	0	0.0	0.0	0	0.0
22	0	0.0	0.0	0	0.0
23	0	0.0	0.0	0	0.0
24	0	0.0	0.0	0	0.0
25	0	0.0	0.0	0	0.0
26	0	0.0	0.0	0	0.0
27	0	0.0	0.0	0	0.0
28	0	0.0	0.0	0	0.0
29	0	0.0	0.0	0	0.0
30	0	0.0	0.0	0	0.0
31	0	0.0	0.0	0	0.0
32	0	0.0	0.0	0	0.0

Figure 34: Vehicle Table

- ***ID:*** The vehicle's relative number as seen by the sensor. This value is helpful to determine how many vehicles are displayed instantaneously.
- ***Vehicle Number:*** The tracking number assigned by the radar. This value can be used to copy the vehicle's position to a zone's X and Y position. See the Zone Location and Activation Parameters section of this document for additional details.
- ***Y position:*** Vertical coordinate of where the vehicle is relative to the sensor, or how close or far the vehicle is from the sensor.
- ***X position:*** Horizontal coordinate of where the vehicle is relative to the senor, or how far the vehicle is to the left or right of the sensor. Negative x-values correlate to vehicles to the left of sensor's boresight. Positive x-values correlate to vehicles to the right of the sensor's boresight.
- ***Speed:*** How fast the vehicle is moving, as measured by the sensor.
- ***Classification:*** A numerical value corresponding to the vehicle's size as determined by the radar.

6   TC-CK1-VMS Grid View

The TC-CK1-VMS System offers a Grid View on the TC-CK1-VMS Portal Page. This view overlays zones relative location and sizes with a graphical representation of vehicles.
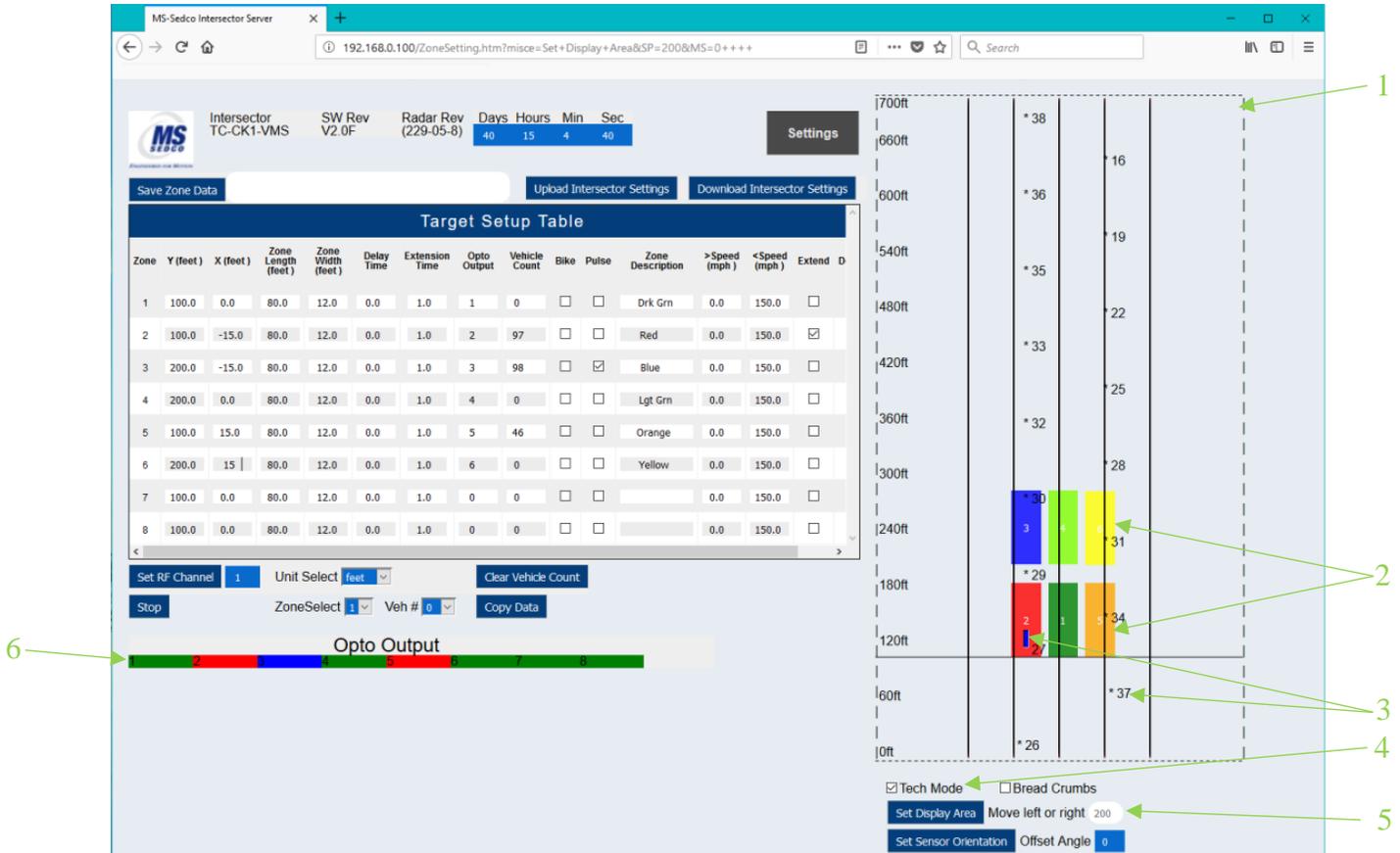
Figure 35: TC-CK1-VMS Grid View

1. ***TC-CK1-VMS Grid View Base:*** Background of the TC-CK1-VMS Grid View that is always on the TC-CK1-VMS Portal Page.
2. ***Zone Rendering Overlay:*** Graphical representation of each zone overlaid to scale on the TC-CK1-VMS Grid View base.
3. ***Vehicle Rendering:*** Graphical representation of each vehicle overlaid in each respective coordinate on the TC-CK1-VMS Grid View base.
4. ***Tech Mode Feature:*** Toggle whether the zone or vehicle renderings are "on top".
5. ***Set Display Area Feature:*** Shift the graphical representation of zones and vehicles left or right in the TC-CK1-VMS Grid View base.
6. ***Opto Output Display:*** Visual representation of output activation on the TC-CK1-VMS Portal Page.

6.1   Grid View Markings

The TC-CK1-VMS Grid View denotes the scale with a periodic Y-value scale running from the bottom to the top of the Grid View. When English units are selected, this scale ranges from 0 to

700 feet in increments of 60 feet with the exception from 660' to 700', which is drawn to scale, but is only 40' tall. When Metric units are selected, this scale ranges from 0 to 213 meters in increments of 20 meters with the exception from 200m to 213m, which is drawn to scale, but is only 13m tall.

The Grid View also provides vertical lines spaced approximately 20-feet apart. These lines do not designate specific x-values, they are meant to be guide lines for setting the sensor's Offset Angle such that vehicles move as straight as possible through the region(s) of interest.

A horizontal line is rendered along Zone 1's Y-value. This line is meant to represent a stop bar if the sensor is used in stop bar applications. This line is for graphical scale reference only, and does not affect TC-CK1-VMS performance. If the application does not require a stop bar zone, this horizontal line's display can be disregarded.

6.2   Zone Rendering

Zones are overlaid to scale on top of the TC-CK1-VMS Grid View. The zone's graphical representation is designated with its Zone Number from the Target Setup Table in the center of the zone in white text. Changes to a zone's location or size can be previewed in the TC-CK1-VMS Grid View.

Zones are color coded on the Grid View to show activation status, as well as other pertinent information about activation type and criteria.

- *Dark Green:* Zones with non-zero Opto Outputs set to activate for approaching vehicles that are not currently activating their Opto Output.
- *Red:* Zones with non-zero Opto Outputs set to activate for approaching vehicles that are currently activating their Opto Output, and are not set to "Pulse" mode.
- *Blue:* Zones with non-zero Opto Outputs that are set to "Pulse" mode that have a vehicle that activated the zone passing through it.
- *Light Green:* Zones with non-zero Opto Outputs set to activate for departing vehicles that are currently not activating their Opto Output.
- *Orange:* Zones with non-zero Opto Outputs set to activate for departing vehicles that are currently activating their Opto Output.
- *Yellow:* Zones that have unsaved changes in the Target Setup Table.

6.3   Vehicle Rendering

Vehicles being tracked by the radar are also overlaid on the TC-CK1-VMS Grid View. Their relative location is denoted on the Grid View with an asterisk symbol (*). If a vehicle that is not classified as a bike is in a zone with its "Extend" checkbox selected, the vehicle symbol changes from an asterisk to a blue bar that starts at the vehicle's X and Y coordinates and extends 12-feet back.

The number next to the vehicle symbol correlates to its Vehicle Number, which allows the user to either set a zone's X and Y values based on its position, or to find it in the Vehicle Table. For vehicles classified as cars, this number will not have any background. For vehicles classified as

bikes or "unknown" (typical for vehicles that have traveled less than 60' after being picked up from the radar), this number will have a blue background.

The TC-CK1-VMS also can hide vehicle symbols while they are on top of zones through the "Tech Mode" feature. When "Tech Mode" is enabled, vehicles are overlaid on top of zones; when "Tech Mode" is disabled, zones are overlaid on top of vehicles. Enabled Tech Mode helps when doing initial setup while disabled Tech Mode helps monitoring zone activations without any clutter of overlaid vehicles. By default, Tech Mode is enabled.

6.4 Set Display Area

The TC-CK1-VMS Grid View can also be shifted left or right depending on where zones and vehicles are with respect to the sensor. Increasing the number next to the text "Move left or right" below the Grid View will shift all object renderings right. Decreasing this number will shift all object renderings left. Clicking the "Set Display Area" button saves changes to the text entry field.

6.5 Opto Outputs

The TC-CK1-VMS Portal Page also provides a readout graphic to display the activation status of each Opto Output. The bar found between the Target Setup Table group and Vehicle Table has a box for each possible output. Each box is designated with its Output Number corresponding to the left side of the box. The following is the color code of the boxes:

- *Dark Green:* Opto Output that are not currently activated
- *Red:* Opto Output that is activated and is not set to "Pulse" mode
- *Blue:* Opto Output, set to "Pulse" mode, with at least 1 active vehicle still in the zone

Note that these graphical representations correspond only to zone activations. If the TCIB is not in a recall or failsafe state, these will correspond to the outputs on the TCIB(s). There are 4 possible scenarios where the TCIB would register activations that would not be displayed on the web page:

1. *Power-up Failsafe:* The TC-CK1-VMS System has an initial power-up failsafe timer that keeps all outputs active while the sensor powers up and calibrates. By default, this timer is set to 120 seconds (2 minutes). This can be changed through the serial terminal of the TCIB.
2. *Network Communication Error:* If the TC-CK1-VMS is connected to a TCIB's "SETUP" port and the TCIB's "LAPTOP" port does not connect to the "OPERATIONAL" port through an Ethernet switch, the TCIB will not be able to get data from the TC-CK1-VMS and will therefore stay in recall until it can get sensor information through the "OPERATIONAL" port.
3. *Rain Failsafe:* If the Rain Failsafe Feature is activated, the TCIB will go into a failsafe mode until all the conditions to come out of Rain Failsafe have been met. The user can see if this condition is active on the TC-CK1-VMS Portal Page. If the Rain Failsafe Feature is active, "RAIN" will be displayed to the right of the Opto Output boxes in bold blue letters.

4. ***Sensor Error:*** If the sensor has a critical internal failure that prevents it from operating properly, it will go into recall until the unit is serviced. The user can see if this condition is active on the TC-CK1-VMS Portal Page. If the TC-CK1-VMS is in Sensor Error, "Sensor Error" will be displayed under the model number in the Sensor Information section of the portal page in bold red letters.

7   Download and Upload TC-CK1-VMS Settings

The TC-CK1-VMS has features to download and upload the user-customizable settings.
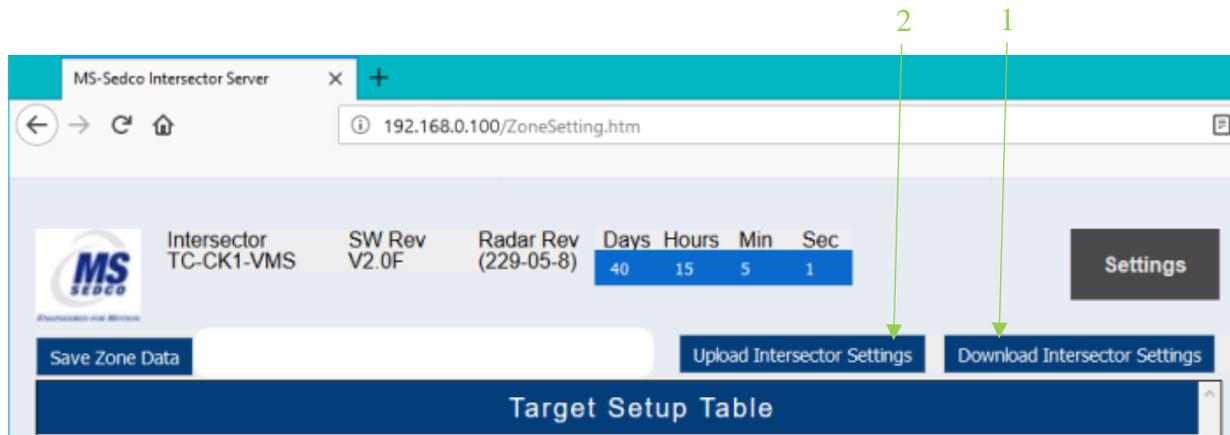
Figure 36: Download and Upload TC-CK1-VMS Settings

7.1   Download TC-CK1-VMS Settings

Once the TC-CK1-VMS System is set up and has the desired performance, it is recommended that the user save the settings in the event something happens to the TC-CK1-VMS unit. The Download TC-CK1-VMS Settings feature allows the user the ability to store VMS TC-CK1-VMS setup and zone settings configurations. When the Download TC-CK1-VMS Settings is selected, a text file containing the current values from the TC-CK1-VMS Portal Page will be downloaded to the computer.

The interface to Download TC-CK1-VMS Settings will depend upon the web browser being used and their applicable settings.

7.2   Upload TC-CK1-VMS Settings

The Upload TC-CK1-VMS Settings feature allows the user the ability to retrieve VMS TC-CK1-VMS setup and zone settings configurations previously saved. Selecting the Upload TC-CK1-VMS Settings allows the user to navigate to a location that contains previously saved files using the browser window that appears based on web browser settings. Selecting a file and clicking "OK" will upload the saved values into the TC-CK1-VMS Portal Page.

Only previously saved TC-CK1-VMS files should be used to upload to a TC-CK1-VMS. Using a TC-CK1-SBE file will cause the unit to not behave correctly.