Train Detection and Warning System User Manual

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1 Introduction

This document describes the operation of the Train Detection and Warning System (TDWS). The Train Detection and Warning System is a modular system designed for rural railroad crossings. Each module is designed to be self-contained. Each module is also designed to be solar powered. Each module should have a PCB with the appropriate components, a solar charge controller, a 12V 50Ah battery, and 12V 100W solar panel.

Figure 1 shows the PCB and all the possible components on it. Please note, the magnetometer will not be on the PCB in any of the modules, it is in the picture for ease of recognition. Also note that not every module contains all pictured components.

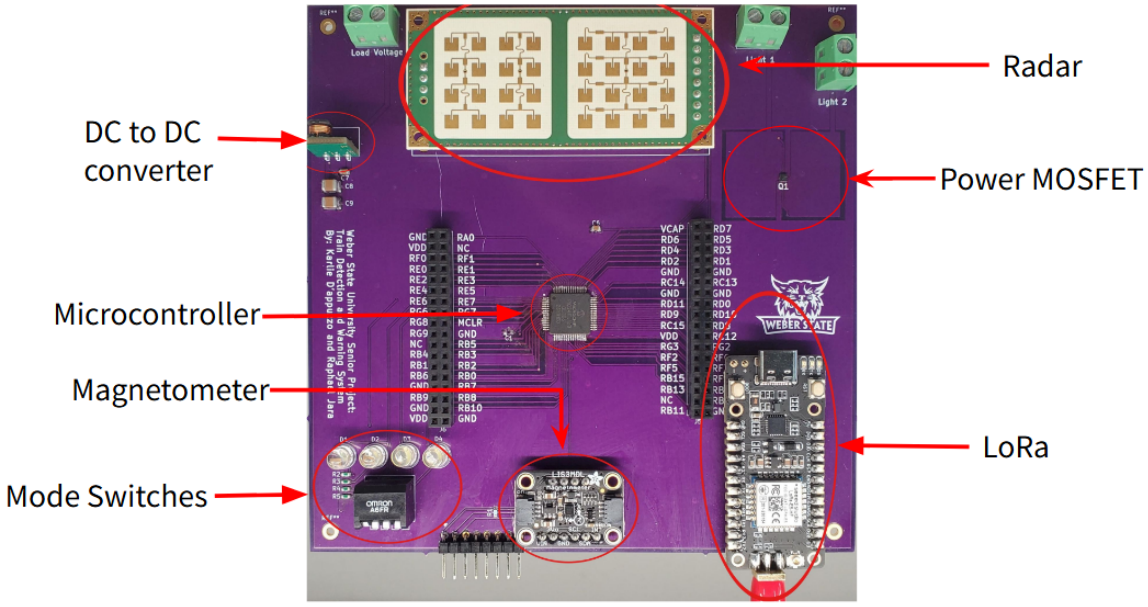


Figure 1: Picture of the TDWS PCB showing what all components look like.

2 Warning Module

For the Warning Module, the PCB should have the magnetometer as the sensor. It should have a power MOSFET on it. Please reference Figure 1 for what the components look like when on the PCB. Please note that the magnetometer while part of this module, is separate from the PCB.

2.1 Connecting the Warning Module

Grab the cable that splices the PCB positive voltage wire and the anodes of the two crossing lights into 1 wire. Insert the cable into the positive terminal of the load output of the charge controller denoted by the light bulb symbol and tighten the screw terminal until the cable is taught. Please refer to Figure 2 anytime the document refers to the charge controller. If the voltage wire of the PCB is not connected, place the end of the wire into the load voltage block connector into the terminal denoted with the "+" symbol and screw the terminal until the wire is taught.

The black wires of the lights, or the cathodes, connect to the block connectors on the PCB labeled "Light 1" and "Light 2" in each terminal labeled "+" and each terminal is screwed until the wire is taught. We acknowledge the confusion of connecting a black wire to a positively labeled terminal, but this is the necessary implementation in order for the system to work. If you would like to know why this is the case, please consider looking at the technical documentation for this project, particularly the "Issues with PCB"

section. Connect the negative terminal of the load output of the charge controller to the block connector on the PCB labeled "Load Voltage" in the terminal labeled "-" and screw the terminal till the wire is taught.

The solar panel has 2 connections, the positive and negative wires of the output voltage. Route the solar panel cables into the enclosure and under the mesh of the enclosure. Pull the cables though the mesh once the wires get near the charge controller. Connect the positive solar panel cable to the positive terminal of the solar panel input of the charge controller denoted with a solar panel and screw the terminal until the cable is taught. Repeat for the negative solar panel cable and negative terminal.

Once these connections have been made, you're ready to connect the 12V battery to your system's charge controller. You do this by placing the cables to your battery in the terminals of the charge controller's input voltage, denoted with a battery symbol, making sure to match the negative and positive terminals together. After you place them, screw each terminal till the wires are taught.

2.2 Installing the enclosure

Using the bracket described in the technical manual, align the two $\frac{13}{64}$in diameter holes to the predrilled holes on the top of the enclosure and screw in a M5 $\frac{3}{8}$in length screw through both holes. Once the enclosure is affixed to the bracket, place the bracket onto the tripod, routing the stud of the tripod through the $\frac{25}{64}$in hole in the bracket and tighten the wingnut of the tripod on the tripod stud. Then, with the lights facing the same way as the enclosure door, place the T-slot bar with the lights over the holes near the wingnut of the tripod until the center of the T-slot bar is aligned with the wingnut. Then, slide 2 T-nuts through the T-slot bar, on the side of the bracket, and align the holes of the T-nuts with the holes of the bracket. Through the underside of the bracket, use two M4 T-slot bolts to tighten the bar to the bracket.

3 Detection Module

For the Detection Module, the PCB should have the Radar as the sensor. It should **not** have a magnetometer or power MOSFET on it. Please reference Figure 1 for what the components look like when on the PCB.

3.1 Connecting the Detection Module

The detection module wiring is less complex than that of the warning module in that it has no warning lights, and thus the PCB's positive and negative "Load Voltage" terminals can connect straight into the output load voltage terminals of the charge controller, denoted with the light bulb symbol. The solar panel is also simply connected to the input solar panel terminals of the charge controller, denoted with the solar panel symbol. Once the previous two terminals are connected and screwed into place, you are ready to connect the battery into the charge controller's input voltage terminals, denoted with the battery symbol. Be sure to tighten connections with a flat-head screwdriver.

3.2 Installing the enclosure

The steps to installing the bracket to the enclosure of the detection module are similar to the steps of installing the warning module, however, you skip anything to do with the T-slot bar with the lights because the detection module has no lights. Please refer to the steps of installing the warning module Section 2.2 to install the detection module.

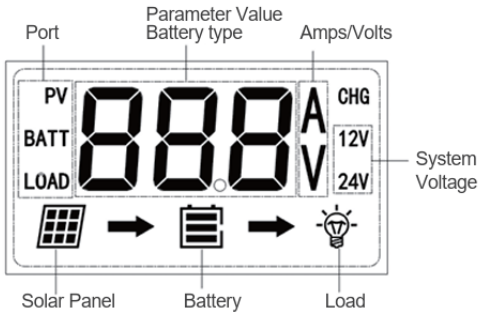
3.3 Positioning of the Detection Module.

With the side of the door to the enclosure facing away from the warning module, place the detection module parallel to the area where the moving object will pass it. Place the module 6ft away from the area where the moving object will go through.

4 Turning on the Modules

All modules should have the a solar charge controller. The solar charge controller is shown in Figure 2. After connecting all devices as described in sections 2.1 and 3.1, the screen of the charge controller should have a cycling display. For more information about how to operate the charge controller refer to the WND10-Manual included in the documentation files. Figure 3 from the manual shows what the screen should look like when on and what each indicator means. The most important indicator is wether the load is active. To turn on/off the load press the enter button once. If turning on, it will take a few seconds. Once the load is on the charge controller will show the load active indicator, and the LEDs next to the mode switches (reference Figure 1) on the PCB should be on.

Figure 2: Picture of the soalar charge controller.



Icon or Value	State	Description
	Steady on	Solar Panels Charging Battery
	3 Bars Flashing	Battery Voltage (16.1V+)
	3 Bars	Battery Voltage (12.9V- 16.0V)
	2 Bars	Battery Voltage (12.5-12.8V)
	1 Bar	Battery Voltage (11.6-12.4V)
	No Bars	Battery Voltage (11.5V and below)
	No Bars Flashing	Battery Voltage (10.9V and below)
	Steady on	Load is On

Figure 3: Picture of the soalar charge controller screen.

5 Mode Selection

Once the module has been powered on the mode selection switches can be set to run the desired mode. The possible modes are shown in Table 1. The modes are selected by changing the switches to the combination for each respective mode. For more information on the testing modes please reference the TDWS documentation file.

Switch 1: LED D1	**Switch 2: LED D2**	**Switch 3: LED D3**	**Switch 4: LED D4**	**Mode**
0	0	0	0	Main Module
1	0	0	0	Detection Module 1: People Tracking
0	1	0	0	Detection Module 2: People Tracking
1	1	0	0	Detection Module 1: Car Tracking
0	0	1	0	Detection Module 2: Car Tracking
1	0	1	0	Detection Module 1: Train Tracking
0	1	1	0	Detection Module 2: Train Tracking
1	1	1	0	LoRa Reciever Testing
0	0	0	1	Radar Testing
1	0	0	1	Magnetometer Testing
0	1	0	1	LoRa Transmit Testing
1	1	0	1	Light Testing
0	0	1	1	Magnetometer Detection Testing
1	0	1	1	Unimplemented: Defaults to Main Module
0	1	1	1	Unimplemented: Defaults to Main Module
1	1	1	1	Main Module

Table 1: Software modes from switch values.

5.1 Main Module Mode

The Main Module mode is the mode that the warning module primarily operates in. To select this mode, set the switches according to Table 1. In this mode the warning module waits for a message from the detection module. Once it receives a message that indicates that the detection module saw something, the warning module begins flashing the attached lights. The lights will stay on until a large enough magnetic field passes directly by it. This magnetic field could be caused by magnet (if testing the module) or by a car that passes close enough, or a train (it's intended use case).

5.2 Detection Module 1 and 2

Detection Module 1 and 2 operate the exact same. However the major difference is the device ID. If you have 2 detection modules, one should be set as Detection Module 1 and the other should be set to Detection Module 2. Each detection module can be configured to track either people, cars, or trains. The Detection Module has a radar that is capable of being configured for the specified targets.

People Tracking

In this detection mode, the detection module can detect people running towards the module. For more detailed information please refer to the TDWS documentation.

Car Tracking

In this detection mode, the detection module can detect cars traveling towards it at low speeds i.e. between 10-25 mph. For more detailed information please refer to the TDWS documentation.

Train Tracking

In this detection mode, the detection module can detect trains traveling towards it at higher speeds i.e. between 40-90 mph.

5.3 Module Reset

Once the appropriate mode has been selected, the module will then need to be reset, depending on the module the reset process is slightly different. Resetting the module allows for the switches to select the mode.

Detection Module Reset

The detection module reset is simple. Locate the reset button located on the breadboard, push and hold the reset button for approximately 5 seconds. The module should reset and detect the desired targets.

Main Module Reset

The main module reset is slightly more complex. Locate the reset button on the breadboard, also locate the reset button on the LoRa module (refer to Figure 1 for the LoRa module). Press and hold the breadboard reset button, and while holding the breadboard reset button, press and hold the LoRa reset button for approximately 5 seconds. After releasing the LoRa reset button wait approximately 5 seconds before releasing the breadboard reset button. The module should then be able to receive messages and flash the lights. This is complex and not intended but this is how it works until future development can improve this process.