Detroit Hoist Lidar Travel Limit System

Detroit Hoist & Crane LLC, Co.
6650 Sterling Drive North, Sterling Height Michigan 48312
+1 586-268-2600

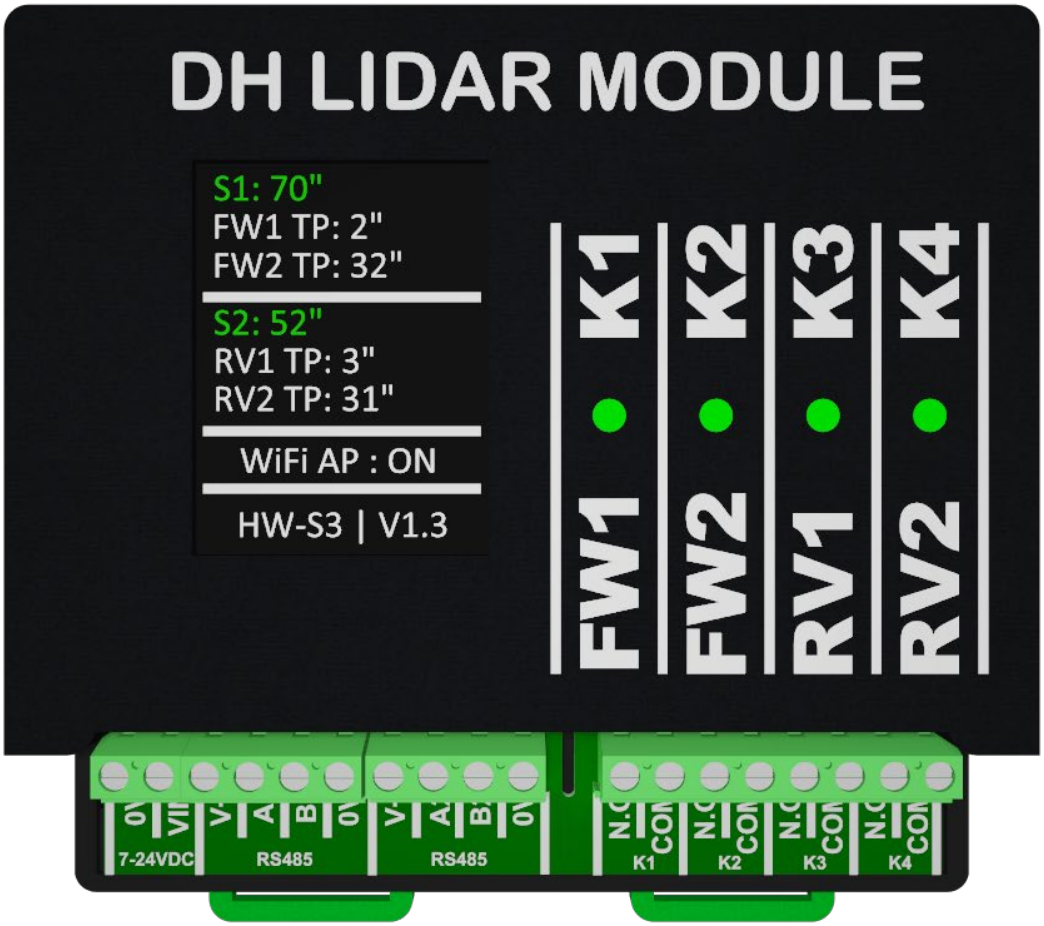


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BASIC SPECIFICATIONS

For specifications that are not listed please contact Detroit Hoist for further information.

- Class 2 low voltage limited energy circuit 7-24vdc (24vdc typical 200mA max) diode reverse polarity protected.
- Operating temperature 20°F to 122°F.
- (4) relays using N.O contacts. (2) relays for each direction slow and stop trip points.
- LED indicators for each relay status.
- ESP32 based microcontroller using self-hosted webserver (no application or internet required).
- 2.0” 320x240 IPS TFT display for module read out.
- WPA2 password protected Wi-Fi access point to securely allow wireless programming and adjustments to the system. No app to download, just connect to the Wi-Fi access point of the module and view the data and program the trip points from your browser.
- Wi-Fi toggle switch to allow disabling of the Wi-Fi radio and access point after initial programming.
- 35mm x 7.5mm x 2mm DIN rail compatible.
- (2) LiDAR sensors IP65 rated sensing range 40m max. (spot size dependent)
- Class 1 (IEC60825) 850nm wavelength, VCSEL light source.
- LiDAR sensor distance accuracy +/- 1% (5m-40m) | +/- 5cm (0.1m – 5m) based on 90% reflectivity surface (white object).
- Ambient light immunity 100Klux, FOV 3°, frame rate 100Hz.
- Modbus RS485 communication protocol between sensor and controller to provide highly robust, standard industrial communication protocol designed for harsh environments, offering noise immunity through differential signaling and supporting long distances up to 1200 meters.
- Normally open relay logic is designed to break directional + slow down connections in the event of sensor communication timeout and power off.

GENERAL OVERVIEW

The LiDAR travel limit system was created to provide a cost effective non mechanical travel limit system that can be programmed and adjusted wirelessly based on the LiDAR concept. LiDAR stands for light detection and ranging. The sensor works by using a class 1 eye safe laser to send light pulses out and measures the time it takes for the light to reflect back to the sensor to determine the distance, this is known as time of flight.

Using spot plates mounted to the runway end stops the system acts as travel limits to slow and stop before the runway end stops. If additional hoists are mounted to the same beam or bridge the system will act as anti-collision and travel limits.

The system uses a self-hosted web application for wireless configuration of limits and system. The system allows each sensor to be bypassed independently if a sensor fails or the system needs to be bypassed for certain situations.

LIDAR SENSOR SAFETY / WARNINGS

The Benewake TF02 is rated as a Class 1 eye-safe laser product under IEC/EN 60825 standards. Warnings on such sensors are standard legal and safety precautions, but normal operation poses no risk to human eyes. Avoid Magnification: Never look directly into the operational lens through magnifying glasses, microscopes, or camera lenses.

LIDAR SENSOR INSTALLATION

The lidar sensors must be in line with the spot plates for reliable accuracy and operation. The spot plates must be non-reflective matte type finish and should be white in color for optimal performance. When using the lidar system as anti-collision the opposing sensors need to be offset so the sensors don't shine into each other. The sensors have a 3° field of view so ensure the 3° FOV from the maximum separation distance does not overlap the lens of the opposing sensor. You can take the maximum distance the opposing sensors would have and multiply it by 0.03 to get a safe offset distance. Typically, on hoists that have trolley trucks the opposing sensor would be mounted to the opposite trolley truck and on bridge trucks the same would apply.

Example: 480" between opposing sensors (480 x 0.03) = 14.4" offset

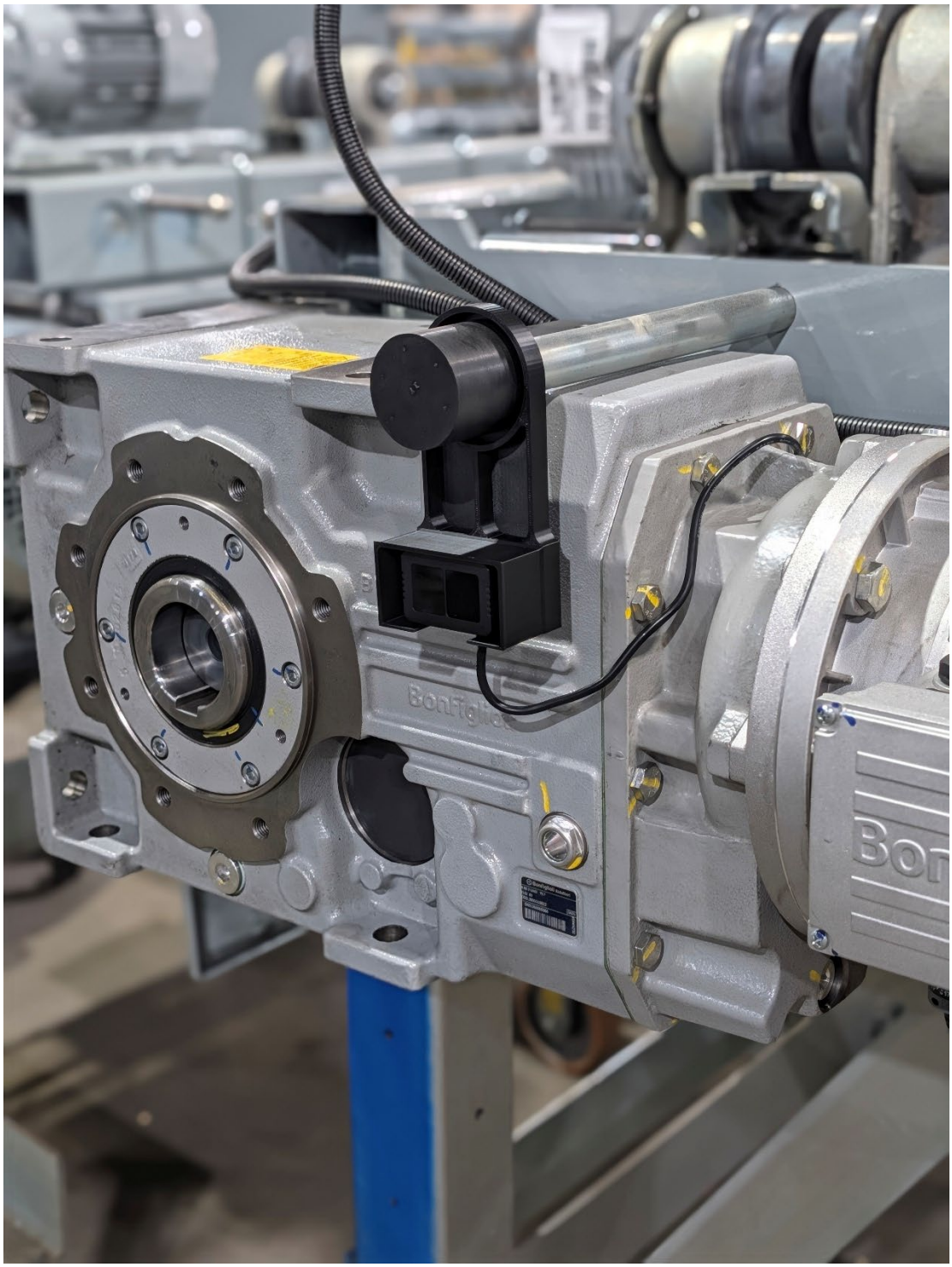
SPOT SIZE REQUIREMENTS

The detection angle of TF02-i is 3°. At different distances, the size of light spot, namely the edge length of the detection range, is different. Side length of the detection range at different distances (the detection range is a square), as shown below. Use the chart below to determine the required spot plate size based on the required range detection distance. Spot plates need to be installed in line with the sensor.

Ranging Distance (m)	1	2	3	5	7	10	20	30	40
Spot Size (cm)	5	10	16	26	37	52	105	156	208

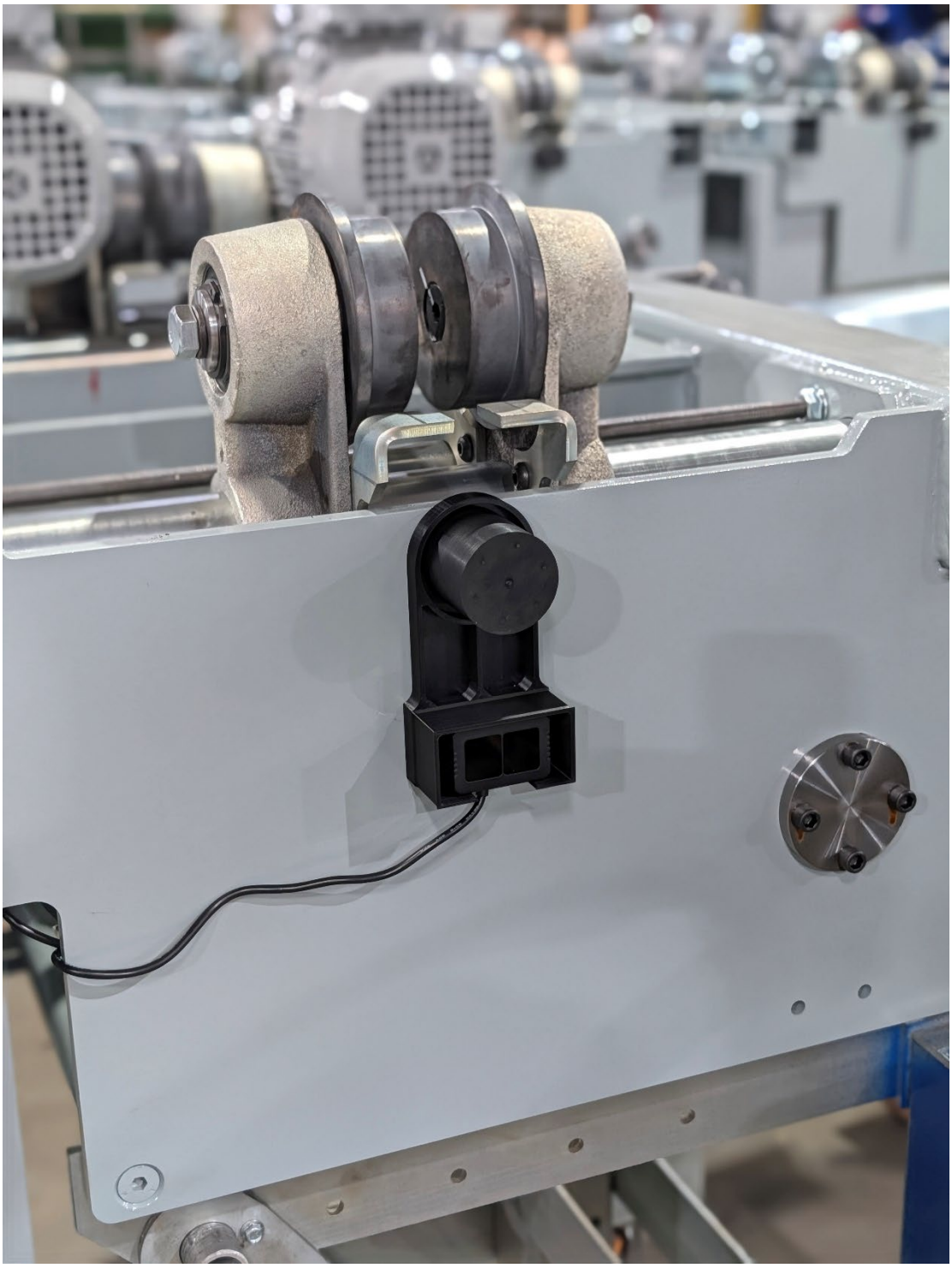
INSTALL EXAMPLE MONORAIL HOIST (GB SIDE)

The image below is a reference to how the monorail lidar bracket is mounted. The bracket is mounted between the bumper and bumper extension on the drive side. On the idler side the bracket is mounted between the bumper and frame, see the next page for reference.



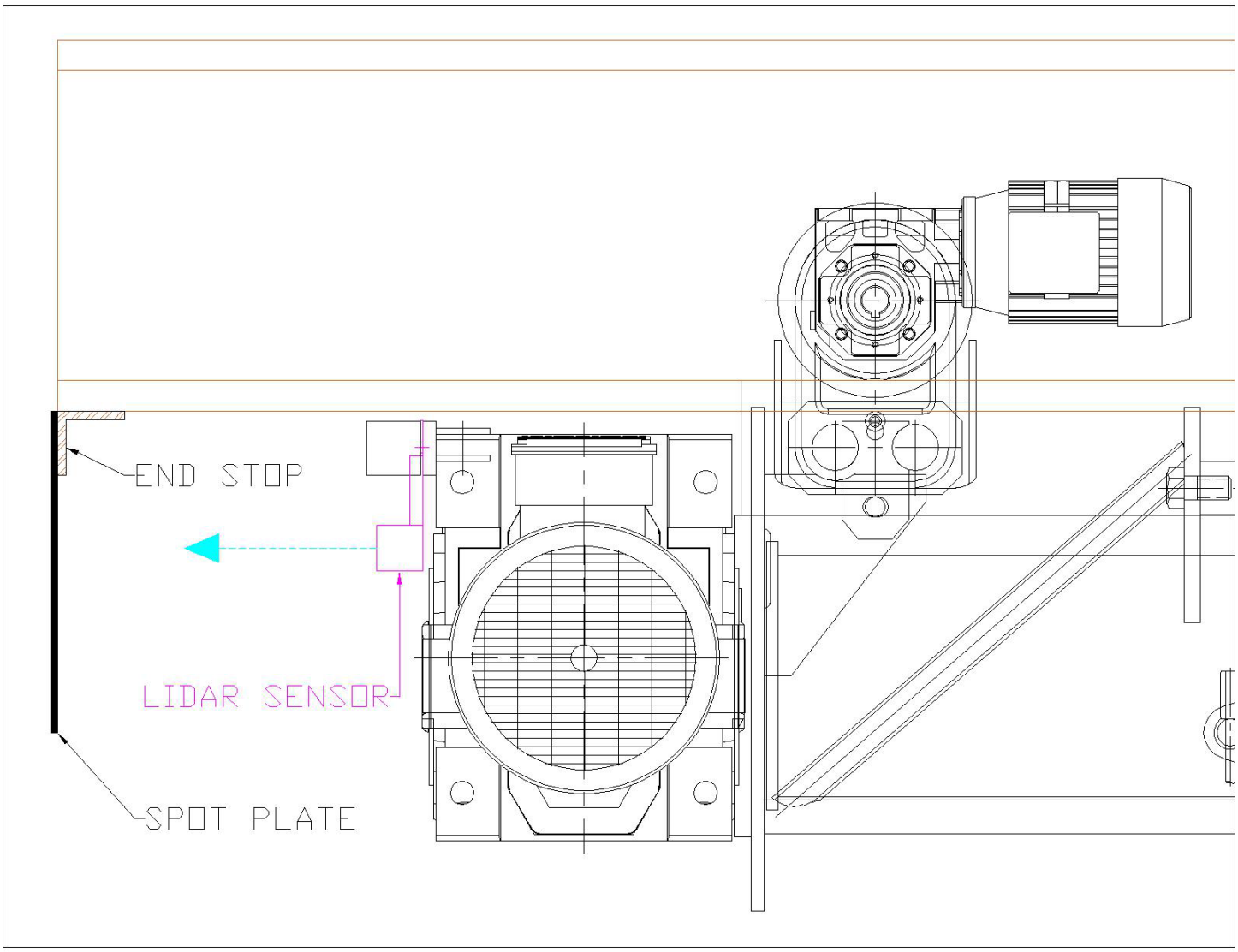
INSTALL EXAMPLE MONORAIL HOIST (IDLE SIDE)

The image below is a reference to how the monorail lidar bracket is mounted. The bracket is mounted between the bumper and frame.



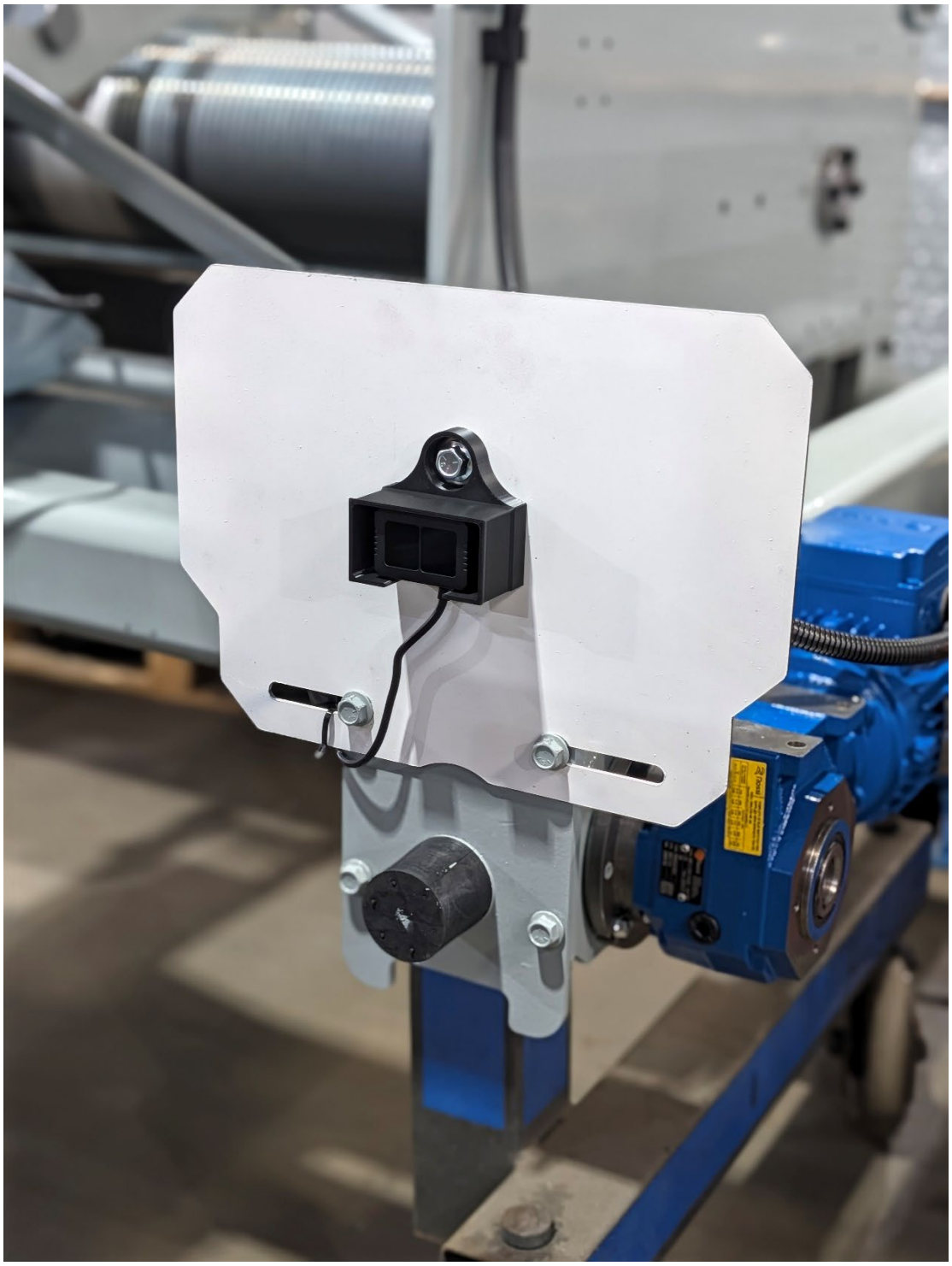
INSTALL EXAMPLE MONORAIL HOIST (COMPLETE)

The image below shows how a complete system would be installed on a single monorail hoist on a bridge. The spots plates would be installed in front or behind the end stops at each end of the beam. The lidar sensors would mount in line with the spot plates.



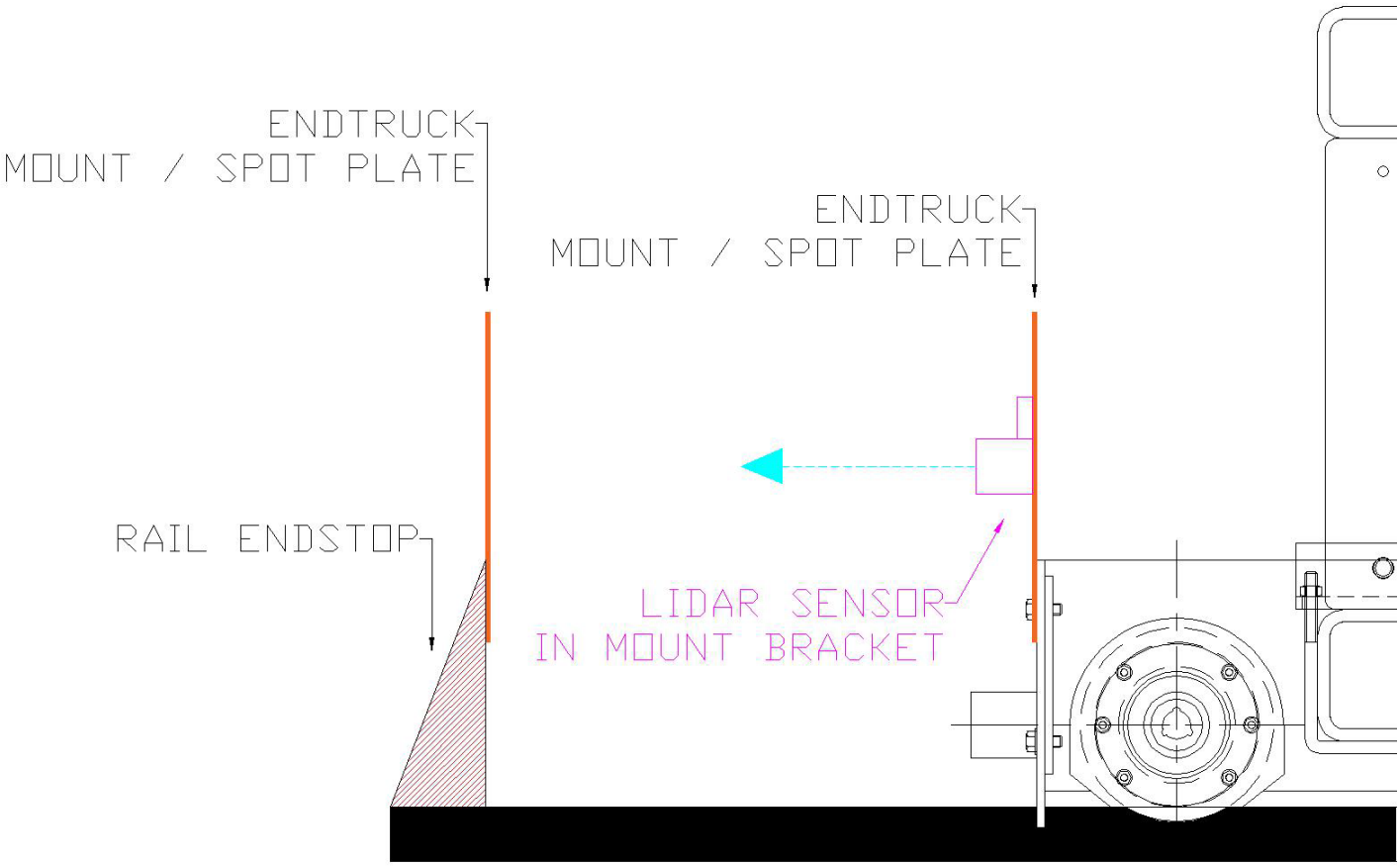
INSTALL EXAMPLE TOP RUNNING HOIST (TRUCK)

The image below shows how the sensor would be mounted to a top running double girder hoist. The spot / mount plate reuses the existing top bolts to mount the plate to the truck, and the sensor bracket mounts to the spot / mount plate using a 3/8-16 x 3/4 bolt, 3/8 x 1” OD washer and a serrated nut. The second sensor would mount to the other side facing the opposite direction.



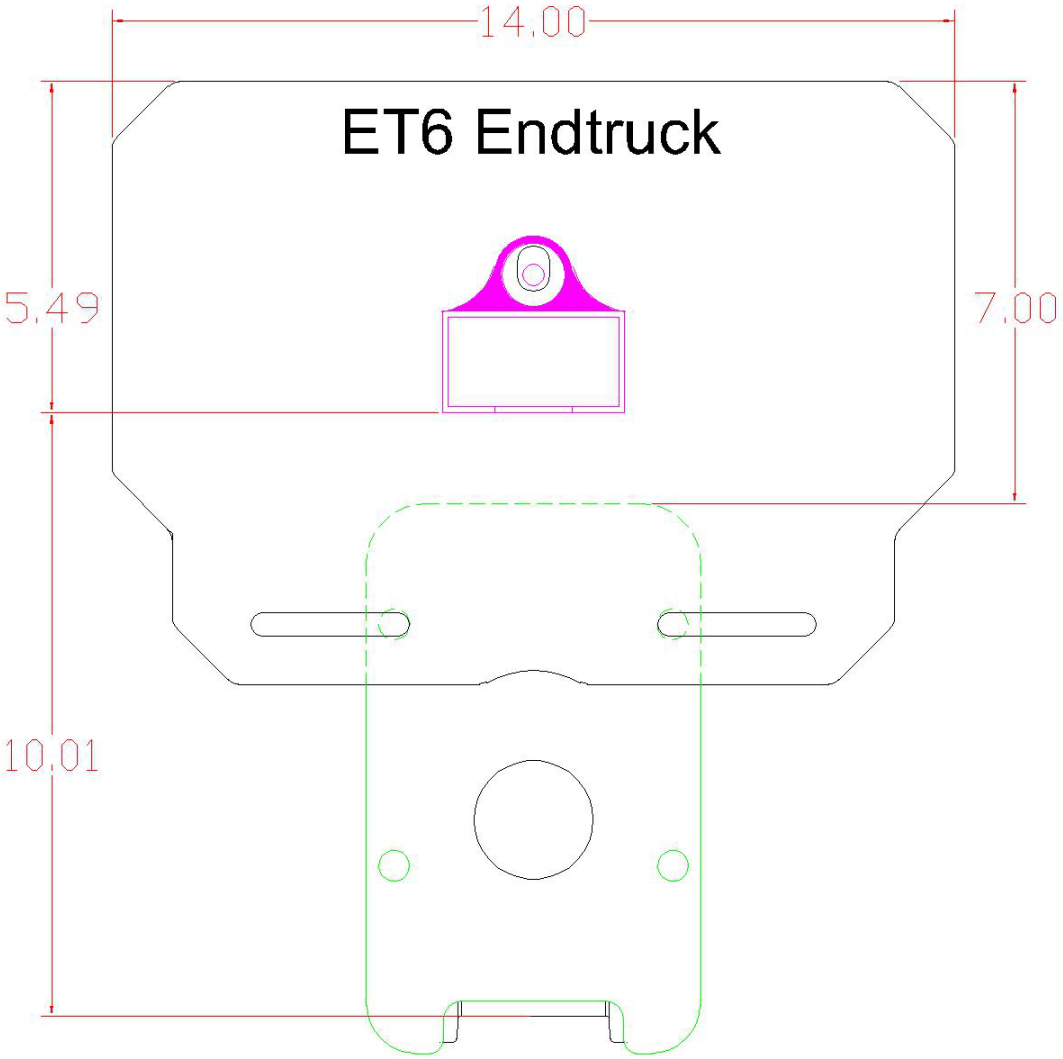
INSTALL EXAMPLE TOP RUNNING HOIST (COMPLETE)

The image below shows how a system would be installed on a single top running hoist on a bridge. The spots plates would be installed in front or behind the end stops. The lidar sensors would mount to the endtruck mount / spot plate. The endtruck mount / spot plate would be mounted to the face of the endtruck bumper plate using the existing bolts.

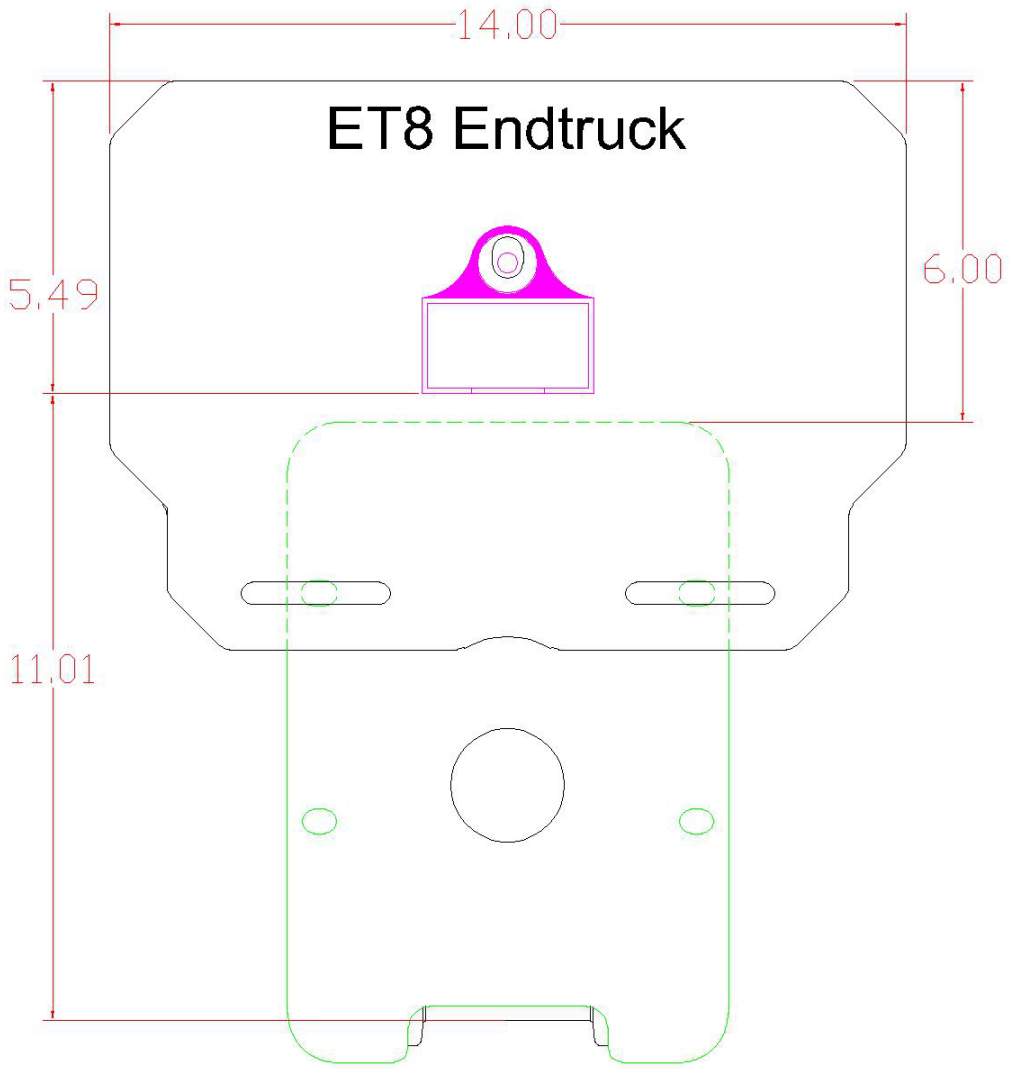


MOUNT PLATE (ENDTRUCK / BRIDGE TRUCK ET6)

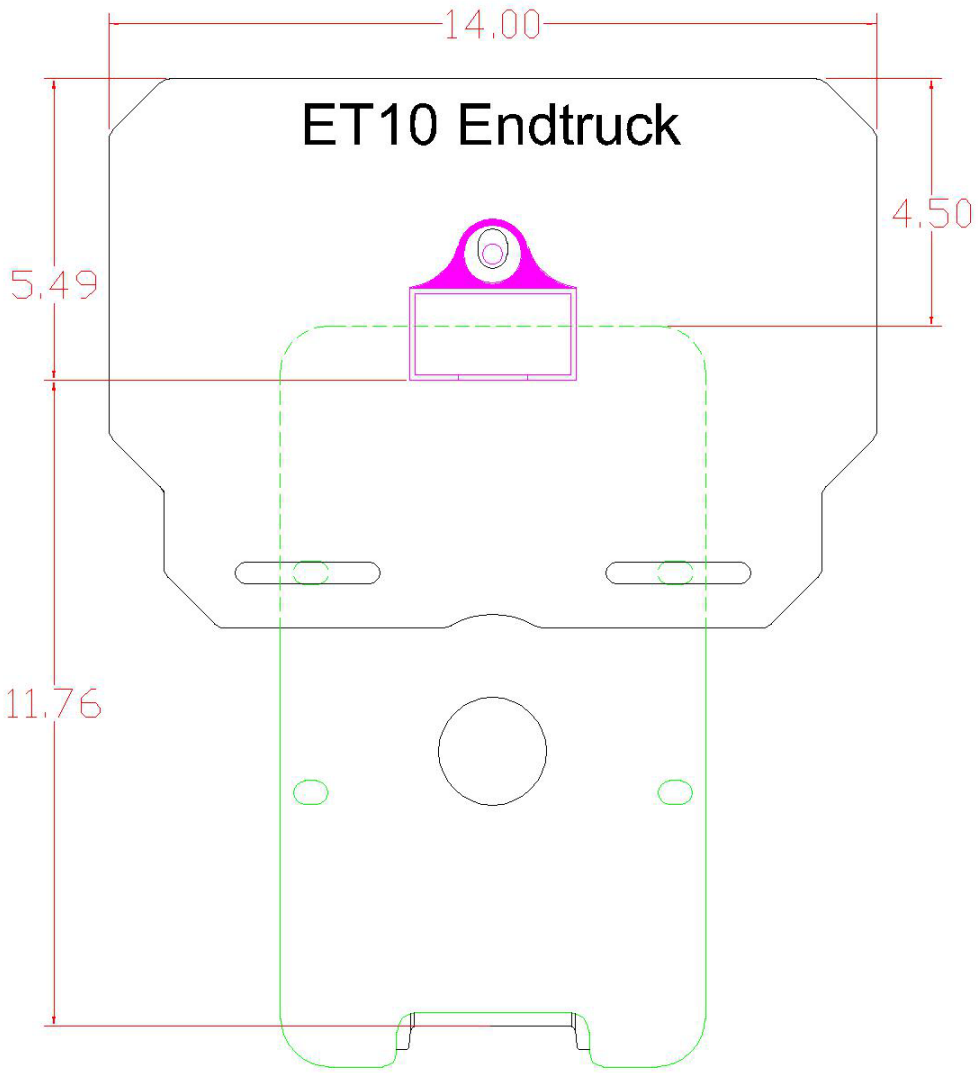
The lidar bracket is shown in magenta. On endtruck models ET6 through ET10 the lidar bracket will be mounted to the spot / mount plate using a 3/8-16 x 3/4 bolt with an oversize 3/8 washer and a 3/8-16 serrated nut. The spot / mount plate mounts to the endtruck reusing the existing 2 top bolts for the bumper end plate.



MOUNT PLATE (ENDTRUCK / BRIDGE TRUCK ET8)

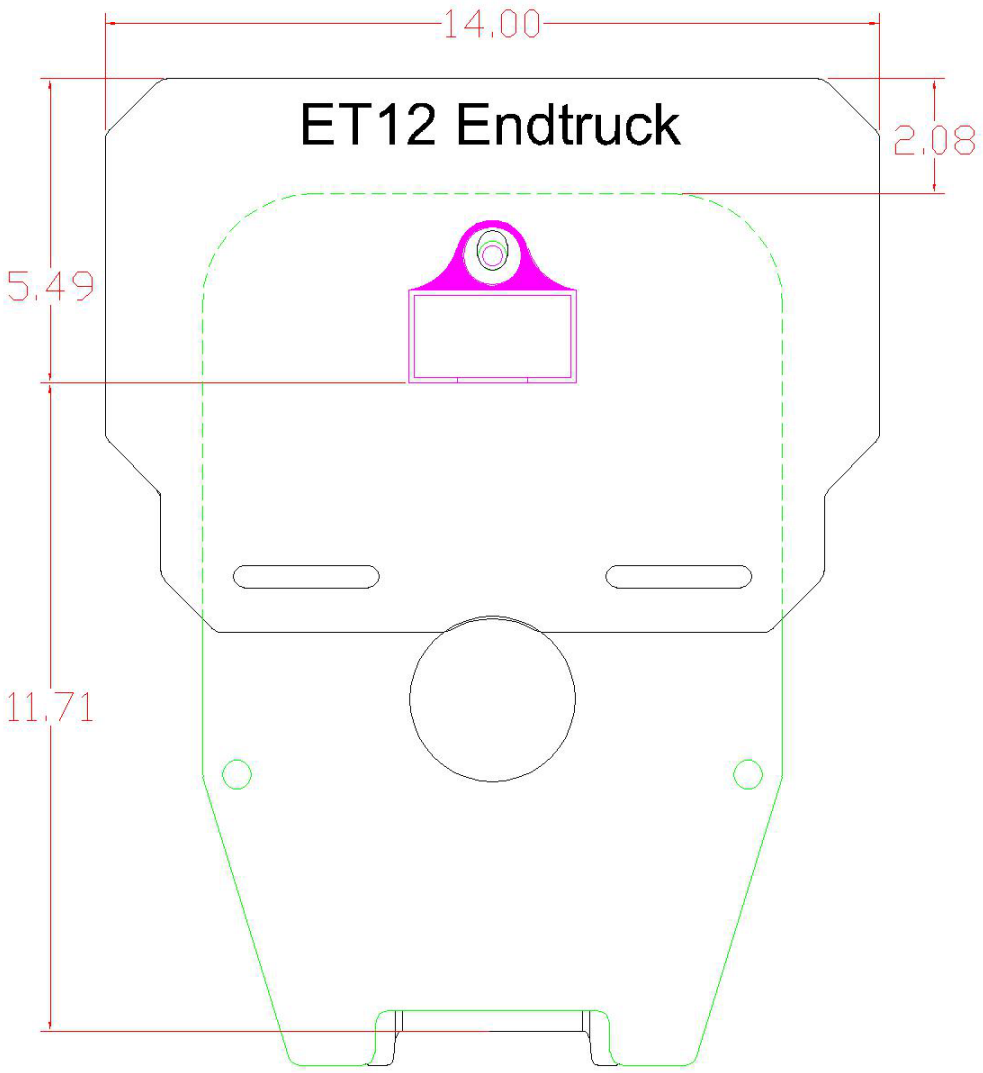


MOUNT PLATE (ENDTRUCK / BRIDGE TRUCK ET10)



MOUNT PLATE (ENDTRUCK / BRIDGE TRUCK ET12)

On the ET12 endtruck the spot / mount plate and the lidar bracket reuse the top 1/2-13 bolt from the endtruck bumper end plate and an 1/2 washer that sits on the front of the lidar bracket.



SENSOR WIRE COLOR CODE & PIN OUT

The sensors are terminated using M12 screw connectors and extended using shielded cable. Reference the chat below for the wire color codes and connector pin out. The shield should be terminated with the black wire to the 0V terminal on the module or an equipment ground. Connect sensor 1 to A1 & B1 and sensor 2 to A2 & B2.

Lidar Sensor		**M12 Fitting**		**Cable Ext.**	**Module Term**
Red Wire	24V	PIN 1		Red Wire	V+
Black Wire	0V	PIN 2		Black Wire	0V
Green Wire	Data + (A)	PIN 3		Green Wire	A1, A2
Yellow Wire	Data – (B)	PIN 4	PIN 4	White Wire	B1, B2
N/A	N/A	PIN 5		Shield	GND / 0V

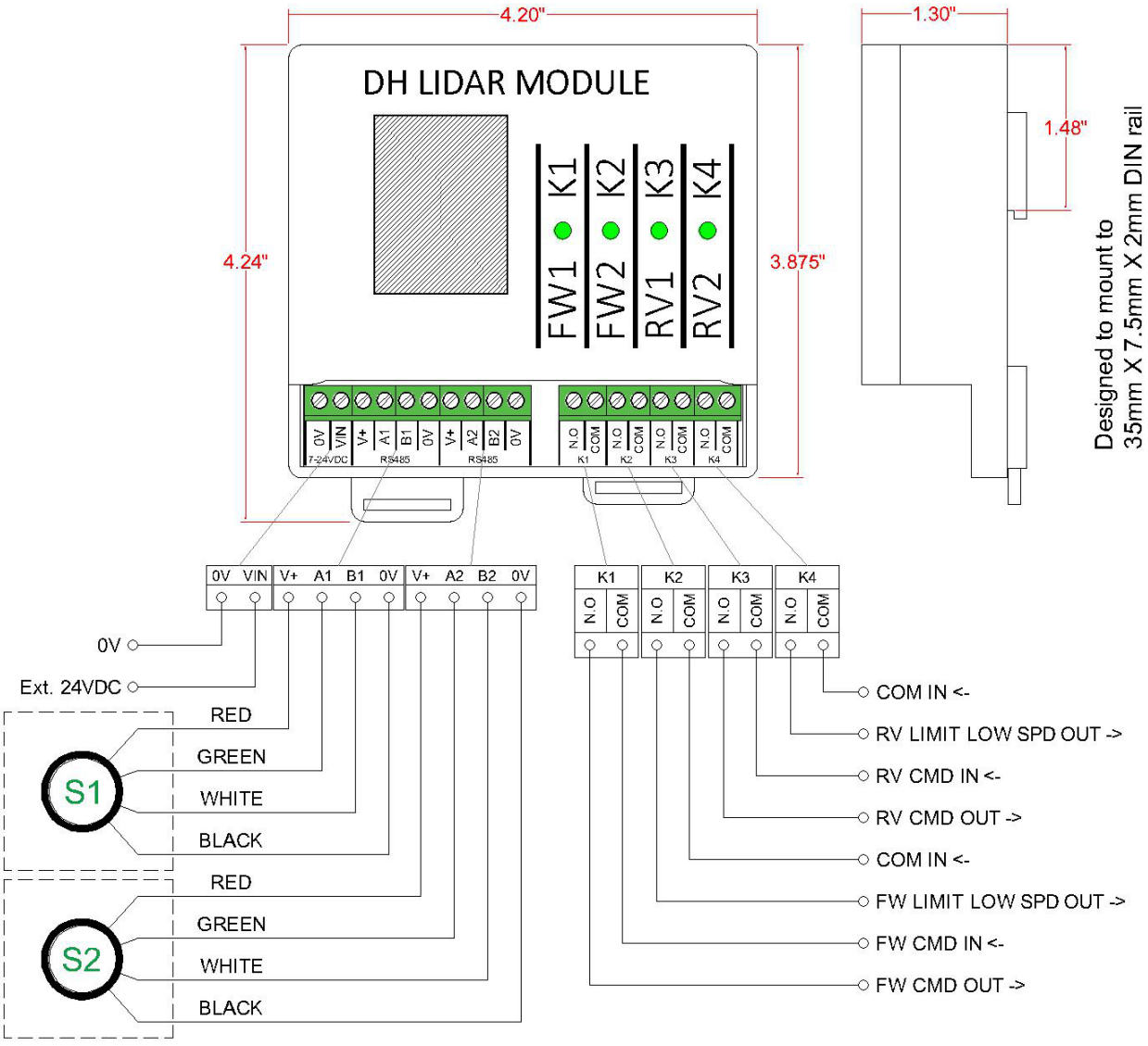




MODULE WIRING OVERVIEW

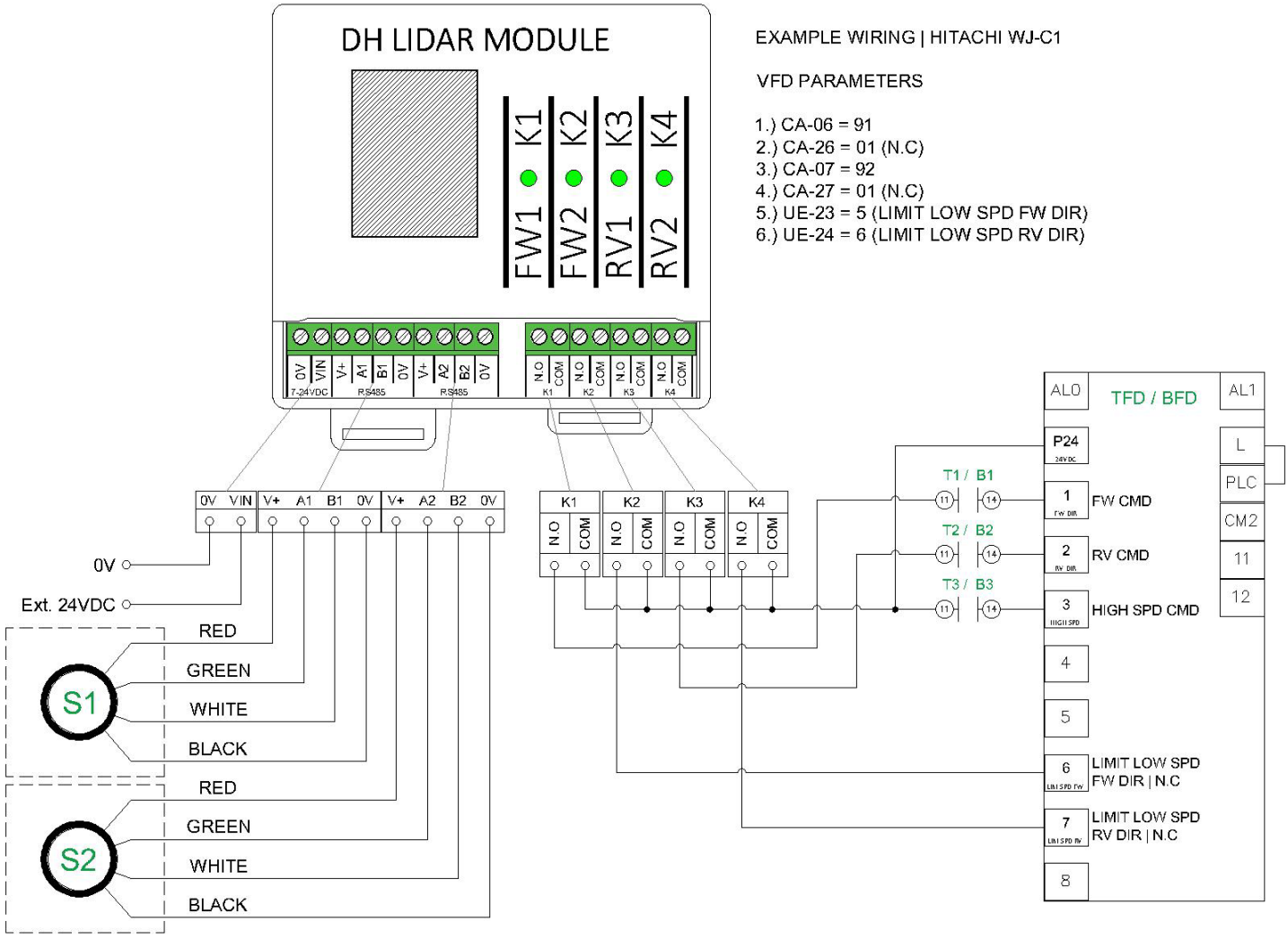
The module requires an external 24vdc power supply for the module and lidar sensors. An isolated class 2 power supply is required for UL508A compliance. The module relays are set up to use the N.O contacts of the relays to prevent motion until the system is ready. The VFD digital inputs assigned to limit to low speed need to be set for N.C.

Terminal	Function
0V	0-volt reference for 24vdc
VIN	300mA minimum external 24vdc supply input
V+	24vdc supply output to lidar sensors
A1, A2	RS485 data+ positive signal for the lidar sensors
B1, B2	RS485 data- negative signal for the lidar sensors
K1 Relay	Directional relay for sensor 1. Used to break the FW command for stopping.
K2 Relay	Slow down relay for sensor 1. Used to break the FW slow down.
K3 Relay	Directional relay for sensor 2. Used to break the RV dir command for stopping.



TYPICAL WIRING EXAMPLE

The image below shows a typical wiring schematic of the lidar system integrated within a Detroit Hoist trolley or bridge using a Hitachi WJ-C1 VFD programmed with the Detroit Hoist firmware. Note the list of parameters that are to be changed.



MODULE DISPLAY

The module has a 2.0” TFT color display that provides real time information about the sensor’s status, distance readings, trip points, Wi-Fi switch status, hardware version, and firmware version.

S1 : 69”	<- Sensor 1 reading
FW1 TP: 2”	<- Sensor 1 stop trip point distance
FW2 TP: 32”	<- Sensor 1 slow trip point distance
S2 : 84”	<- Sensor 2 reading
RV1 TP: 2”	<- Sensor 2 stop trip point distance
RV2 TP: 30”	<- Sensor 2 slow trip point distance
WiFi AP: ON	<- Wi-Fi switch status
HW-S3 | V1.3	<- Hardware (S3) | Firmware V1.3

Figure 1 - Module Display

WIFI SWITCH

To use the self-hosted webserver access point, the Wi-Fi switch must be in the ON position. The device does not require the Wi-Fi to be on for normal operation only for configuration. The Wi-Fi switch is located on the top right of the module enclosure. The status of the switch will be display on the 2.0” color display. The Wi-Fi switch is shown below highlighted in orange.

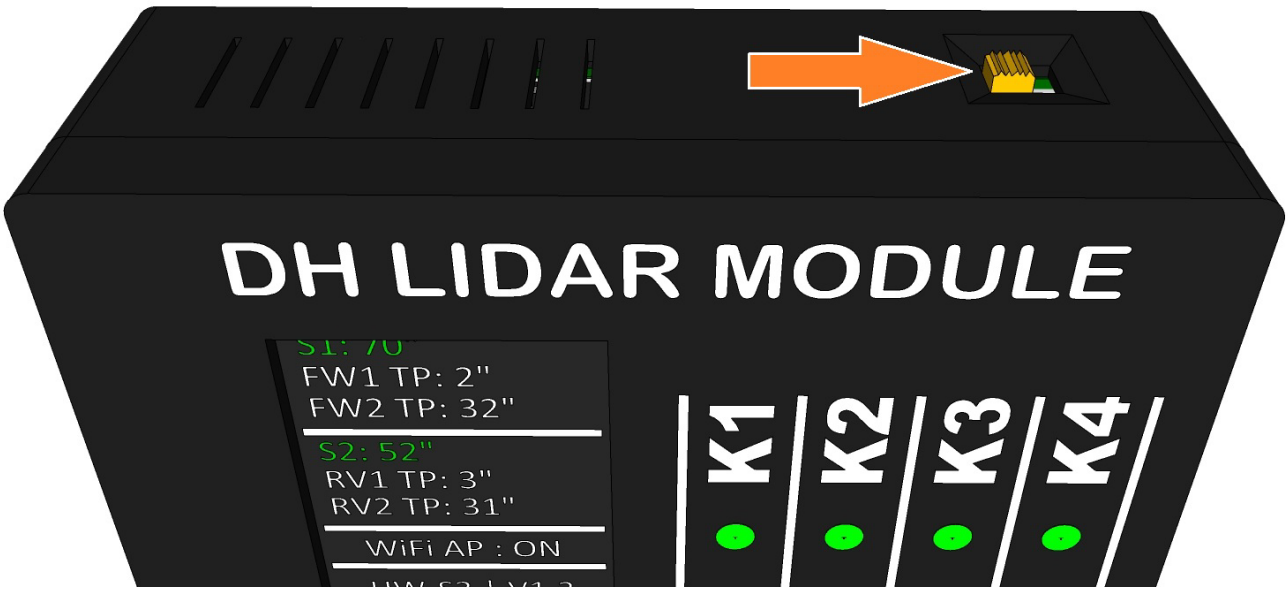


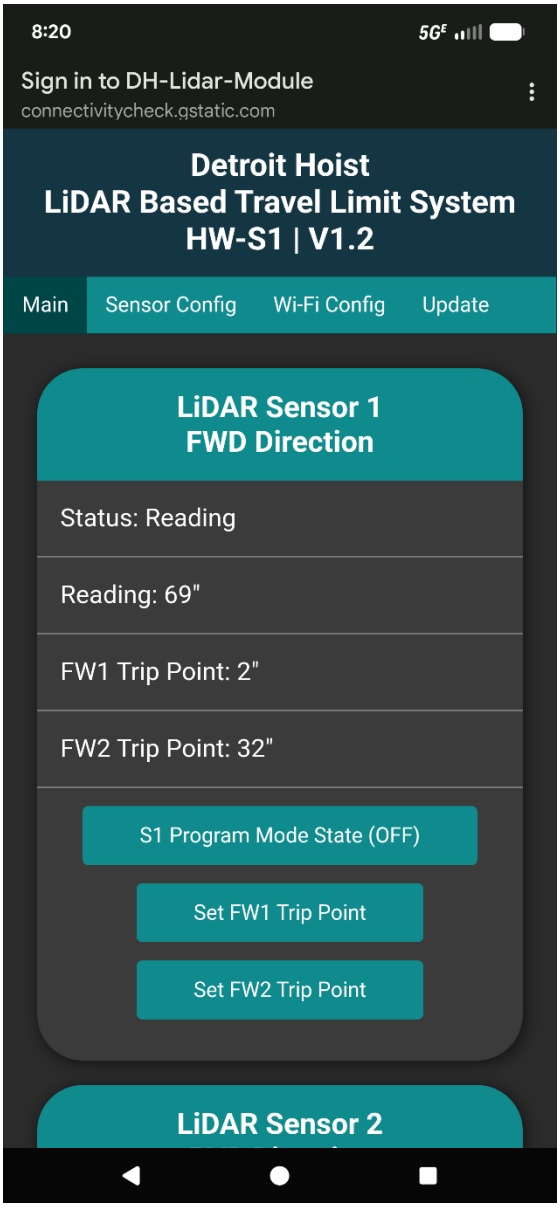
Figure 2 - Hardware HW-S3 Wi-Fi Switch

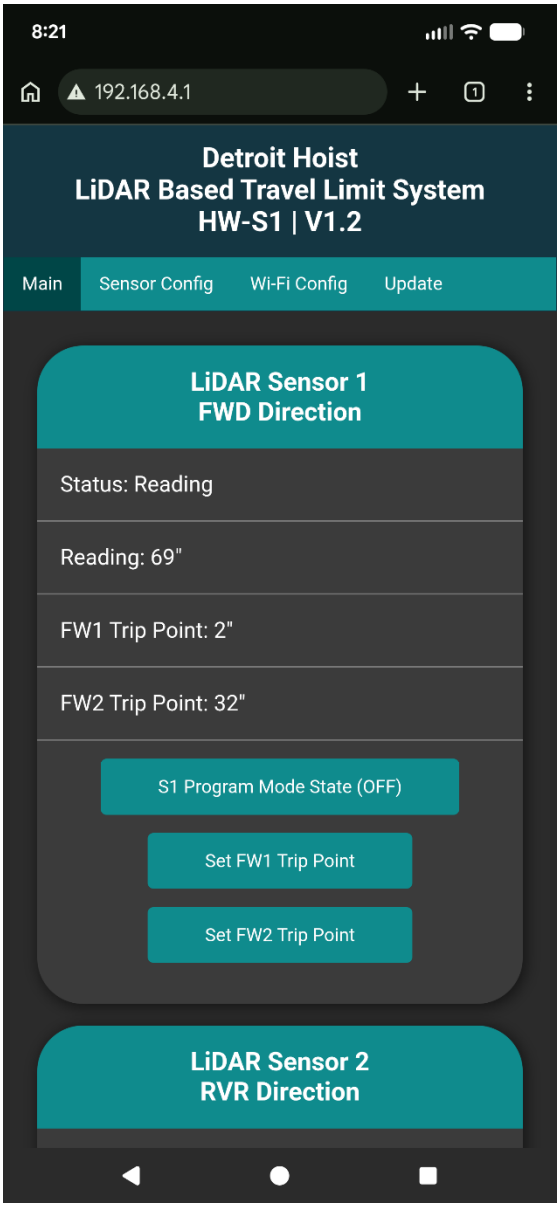
CONNECTING TO MODULES WEBPAGE

The module has a built-in webserver that doesn't require any outside internet connection. Using a phone, tablet, or computer you can connect directly to the modules Wi-Fi network to configure the modules settings and update the firmware.

Search for available Wi-Fi networks using your device and select the lidar modules network name and enter the password. The default Wi-Fi network name and password will be as shown below. Once connected the captive portal will open at the main tab of the webpage interface. If your mobile device does not support captive portals, then once connected open a browser tab and in the URL type 192.168.4.1 and enter.

Default Wi-Fi Network Name	Default Password
DH_Lidar_xxxxxxxxxx	Xcal@!!187





PROGRAMMING THE LIMITS

Follow the process below to set the forward and reverse trip points.

Step 1	Connect to the modules Wi-Fi network using a mobile device or PC. Once on the webpage interface navigate to the “Main” tab if not already there.
Step 2	Press the “**(S1) Program Mode State**” button if setting the FW1 & FW2 limits. Press the “**(S2) Program Mode State**” button if setting the RV1 & RV2 limits. It will show (ON) indicating program mode is on.
Step 3	In the direction that is being programmed run the trolley or bridge to the desired distance in which to start slowing down.
Step 4	Press the “**Set (FW2) Trip Point**” button to store the slow down distance if setting the FW2 limits. Press the “**Set (RV2) Trip Point**” button to store the slow down distance if setting the RV2 limits.
Step 5	In the direction that is being programmed run the trolley or bridge to the desired distance at which to stop.
Step 6	Press the “**Set (FW1) Trip Point**” button to store the stop distance if setting the FW1 limits. Press the “**Set (RV1) Trip Point**” button to store the stop distance if setting the RV1 limits.
Step 7	Press the “**(S1) Program Mode State**” button if setting the FW1 & FW2 limits. Press the “**(S2) Program Mode State**” button if setting the RV1 & RV2 limits.

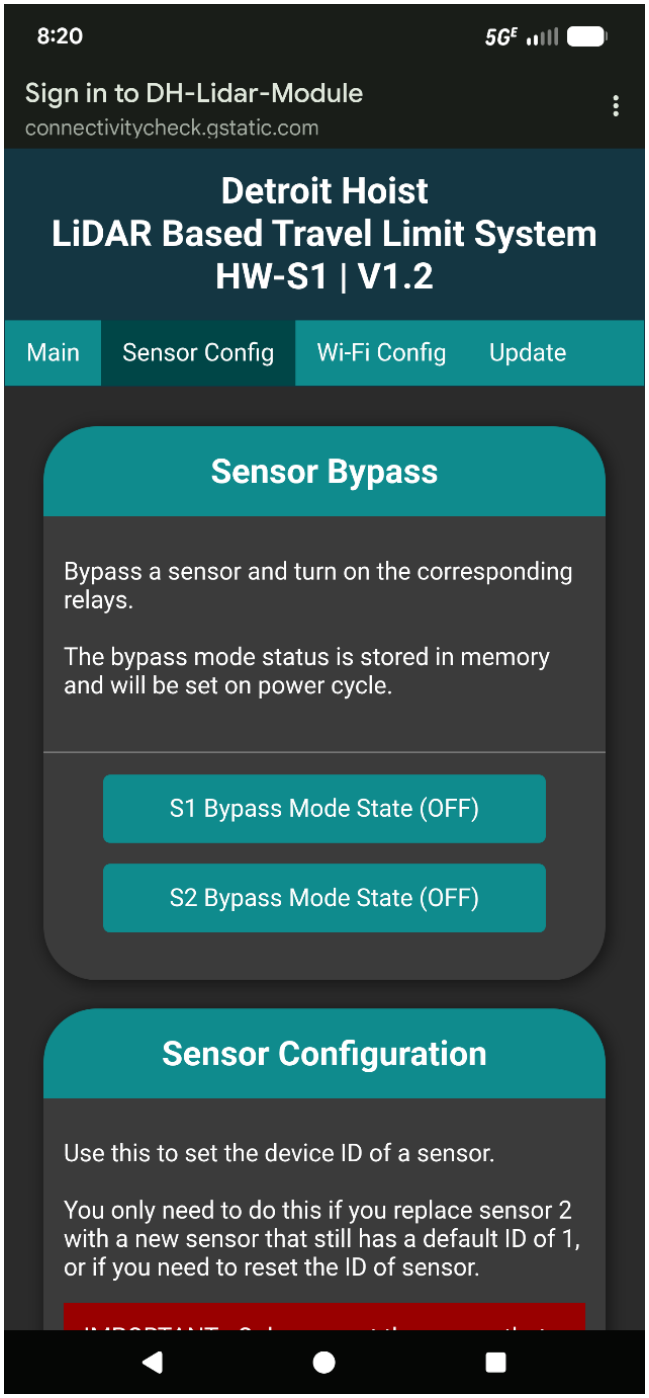
	It will show (OFF) indicating program mode is off.
Step 8	In the direction that is being programmed verify that the limits are working correctly and adjust if needed.

SENSOR BYPASS

If a sensor is not working correctly, damaged, or not performing within the environment you can bypass the specific sensor. The bypass status is stored in memory, so it is not required to bypass the sensor each time it is used. To bypass a sensor, you must use the modules web interface and navigate to the “Sensor Config” tab. The modules display will indicate if the sensor is in bypass mode.

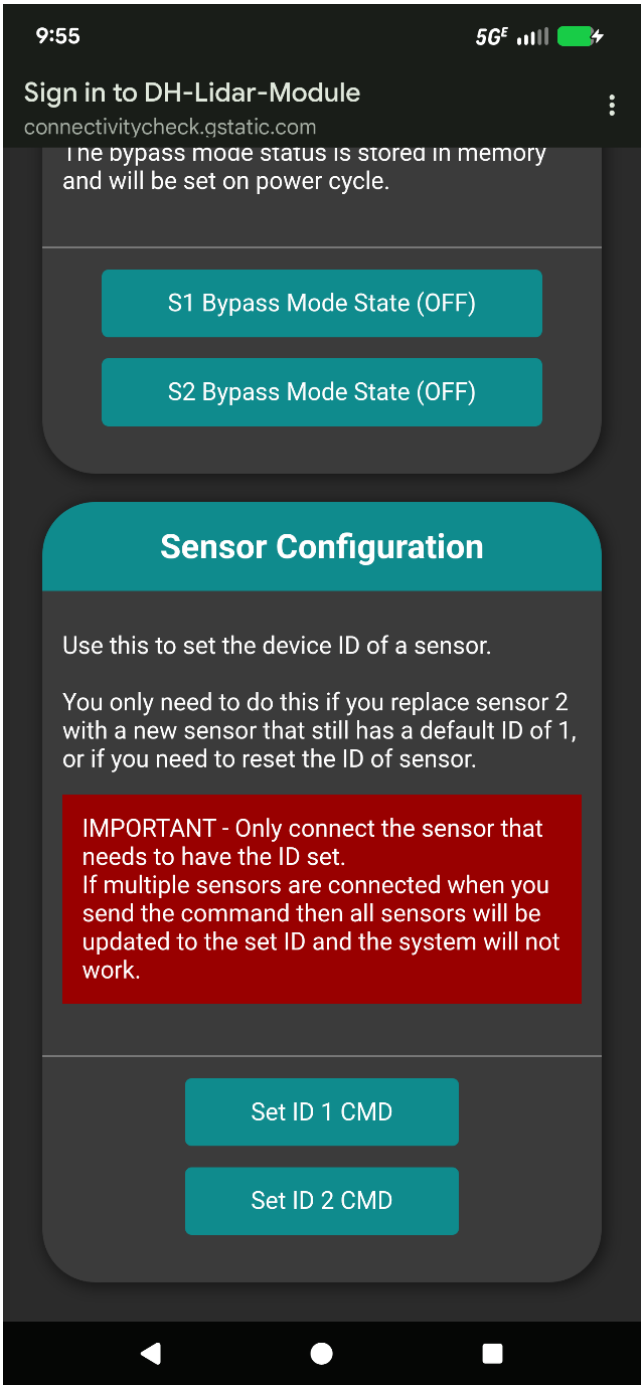
To bypass sensor 1, press the “S1 Bypass Mode State” button. The state of the sensor is shown in the button (OFF) / (ON).

To bypass sensor 2, press the “S2 Bypass Mode State” button. The state of the sensor is shown in the button (OFF) / (ON).



SENSOR ID CONFIGURATION

Each sensor must have a separate device id. Sensor 1 will have a device id of 1 and sensor 2 will have a device id of 2. In the case of replacing sensor 1 nothing is required since the default device id is 1. If replacing sensor 2 you would need to set the device id to 2. You can use the modules web interface to set the device id to 2, be sure to only have the sensor connected that needs to have the device id changed.

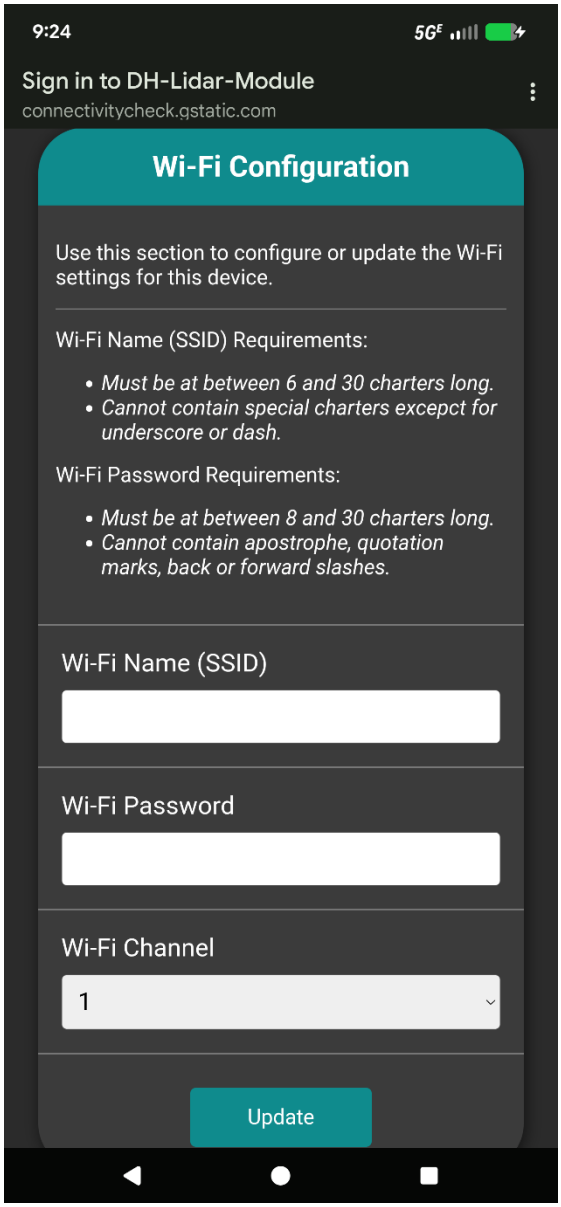


Wi-Fi CONFIGURATION

You can rename the Wi-Fi network and change the password. If multiple systems are installed changing the Wi-Fi name to a unique name that helps identify the system to the specific hoist or crane is suggested. The Wi-Fi channel number can be changed if multiple systems are nearby or other wireless networks are on the same channel.

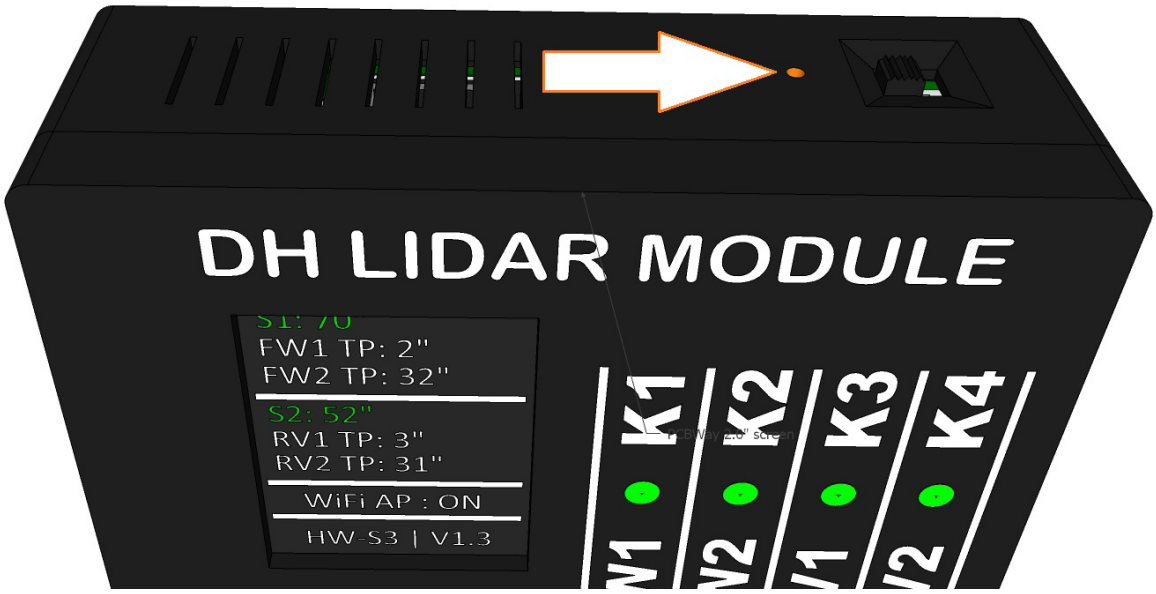
After making any changes to the network name, password, or channel the module will reboot to apply the changes.

Default Wi-Fi Network Name	Default Password
DH_Lidar_xxxxxxxxxxxx	Xcal@!!187



RESTORE DEFAULT Wi-Fi CONFIGURATION

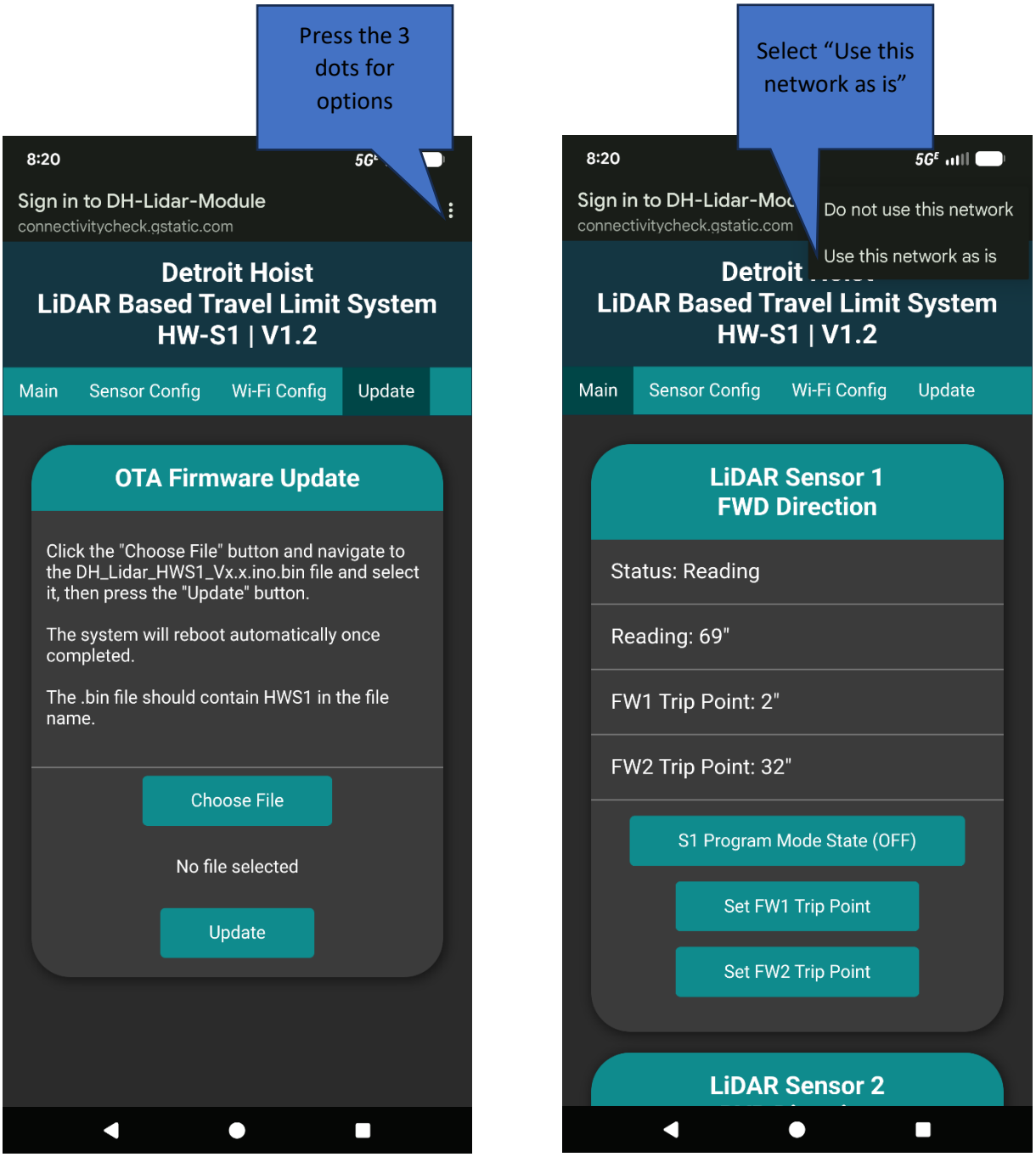
To restore the factory Wi-Fi network name, password, and channel press and hold the factory default button for 10 seconds and the device will reboot. The Wi-Fi default button is highlighted in the image below for reference. The hole is next to the Wi-Fi switch.

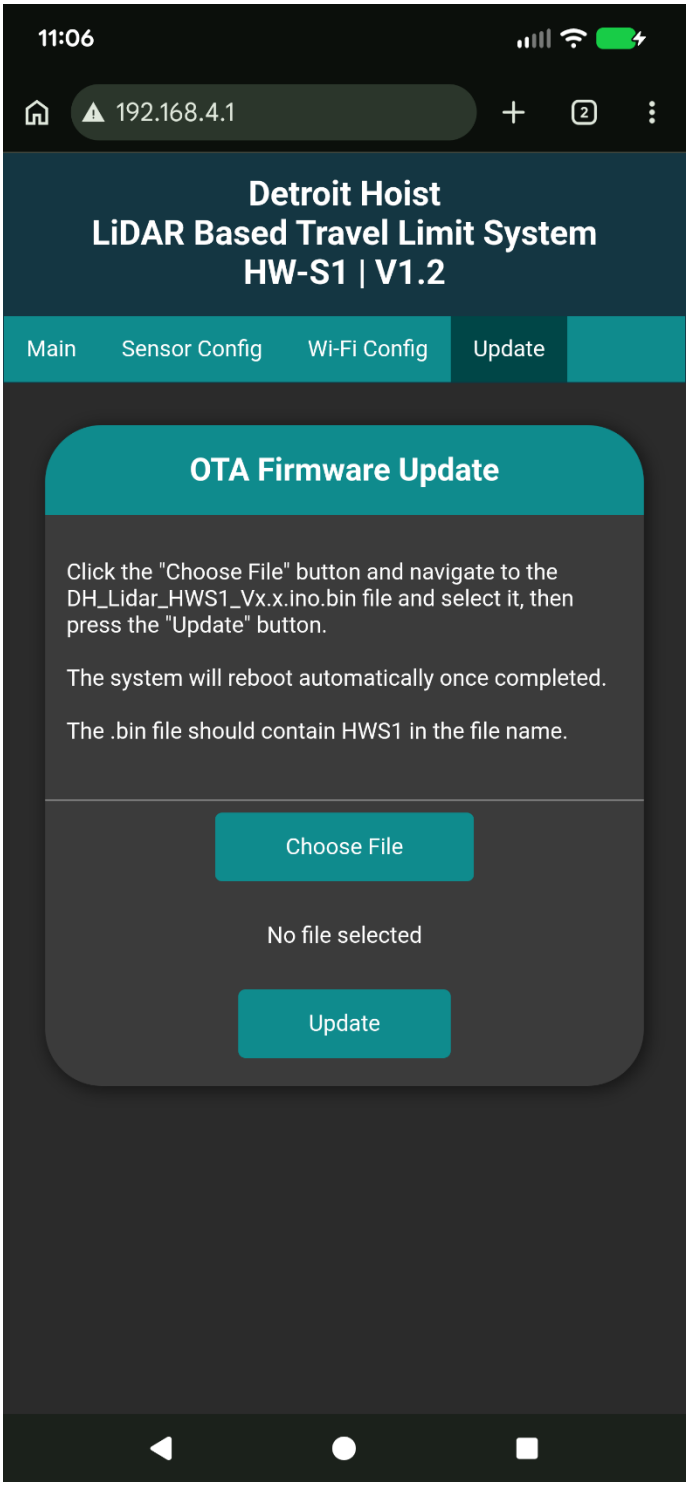


FIRMWARE UPDATE (OTA)

If a firmware update is available, you can update the firmware through the web interface. Navigate to the “Update” tab and click the choose file and locate the firmware file for the hardware version you have (HWS1 or HWS3) and then press the “Update” button. Once the update is complete the device will reboot. The hardware version is shown at the top of the web interface as well as on the modules display.

NOTE – The “Choose File” may not work while connected in captive mode on Android devices. Select “Use this network as is” and then open your web browser and in the URL bar type in 192.168.4.1 and press enter. Then go to the “Update” tab and “Choose File” then press the “Update” button.




11:06
192.168.4.1
Detroit Hoist
LiDAR Based Travel Limit System
HW-S1 | V1.2
Main
Sensor Config
Wi-Fi Config
Update
OTA Firmware Update
Click the "Choose File" button and navigate to the DH_Lidar_HWS1_Vx.x.ino.bin file and select it, then press the "Update" button.
The system will reboot automatically once completed.
The .bin file should contain HWS1 in the file name.
Choose File
No file selected
Update

LIDAR SENSOR MAINTENANCE

To provide the best accuracy from the sensors it is recommended to periodically clean the sensors lens and the white plate that the sensor range off from. Use a damp cloth to wipe the sensors lens. **DO NOT USE any solvents or alcohol to clean the lens of the sensor.**