VIGILANT Installation User Guide

1.0 Introduction

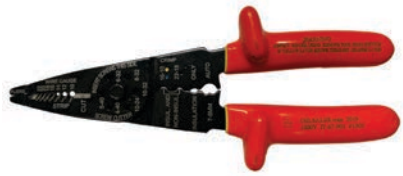
This guide is part of a document series on how to install, start-up, commission, and utilize the VIGILANT battery monitoring system. The specific steps outlined cover the physical installation of the system. Due to the large variation of battery types compatible with the VIGILANT, this guide will cover general installation steps that apply to the most common batteries. Eagle Eye can provide battery-specific drawings at a cost - contact the sales representative to inquire about this.

Document version: v01

Date updated: May 30, 2024

2.0 Required Tools

Installation of the VIGILANT requires specific tools to complete successfully. Additional tools may be required for specific mounting and installation of the system which are not listed. It's recommended to have general electrician tools for the installation of the system.

Tool	Description	Make/Model	Picture
Wire stripper (16-18 AWG)	Adjust wire lengths and strip total voltage cable	No specific model	
Precision flathead screwdriver (2mm head)	Terminate wires at monitor	No specific model	
Hex driver (1.5mm)	Adjust cable clamp piercing screw into charger cable	No specific model	
Cable boring tool	Bore hole in charger cable for connection of cable clamp	No specific model	
RJ12 cable crimper	Crimp RJ12 cables for sensor communications	Klein Tools / VDV226-011-SEN	

Tool	Description	Make/Model	Picture
IDC crimp die	Crimp IDC connectors to sensing harness wires	TE Connectivity / 58247-1	
Crimp die handle	Attach to IDC crimp die	TE Connectivity / 58074-1	
Insulated torque wrench	Torque clamps to 5 in-lbs. (M3 for J-Clamp, M4 for C-Clamp)	VIG-TOOL-TORQ-5-M3, VIG-TOOL-TORQ-5-M4	
Digital multi-meter	Verify voltages and continuity of various parts of the system	No specific model	
Battery resistance tester	Cross reference VIGILANT resistance & voltage readings for verification	Eagle Eye IBEX or similar	

3.0 Review BOM

Prior to starting installation it's important to review the included BOM and ensure all components are included.

3.1 Package BOM

A printed BOM (bill of material) is included with each VIGILANT system. Below is an example of what a typical BOM looks like for a 60-cell system.

EAGLE EYE POWER SOLUTIONS

Date	March 20, 2023
Customer / PO	Example Customer
Site	Example Site
Model	EE-V-60C-E
Serial Number	MV556677

BILL OF MATERIALS

Eagle Eye Power Solutions, LLC
6306 Eastwood Court
Mequon, WI 53092

Item #	Part #	Description	Qty.	Check
1	VIG-MON-MV-02-00 (Version: 1.3.10)	Medium Voltage Monitor Kit, includes: - Medium Voltage Monitor (90-300V) - Cable Clamp Set - Ambient Temperature Sensor Vigilant Sensor Kit (for +1 Sensor)	1	☒
2	VIG-SEN-01-00 (Batch: 6443-01)	Vigilant Sensor Kit, includes: - Vigilant Sensor - Mounting Cradle - (2) IDC Connectors - RJ12 Communications Cable (12", 305mm) - Cradle Sticker (in leaflet)	60	☒
3	VIG-TAB-01	Tab Connector Pair with 3.3ft (1m) Cable Harness, includes: - Positive Tab Connector (red) - Negative Tab Connectors (2 black)	60	☒
4	VIG-TERM-TAB-01	Special Positive Terminal Tab Harness	1	☒
5	VIG-CLM-01	Medium FASTON C-Clamp (16.6 - 28.1mm), includes: - Positive Clamp (single tab) - Negative Clamp (double tab)	60	☒
6	ELS-03-00-A (Batch: 4818-01)	ELM-Sensor Kit, includes: - ELM Sensor - Mounting Cradle - Connector Cable (12", 305mm)	60	☒

3.2 Identify Components

Use the table below to identify the VIGILANT components and ensure everything was included. Refer to **Appendix A** for more detailed information about the main components.

Part Number	Description	Picture
VIG-MON-LV-02	Monitor for Low Voltage (18-72VDC) - ***Includes****: DIN rail, DIN rail clips, ambient sensor, +1 VIGILANT sensor, cable clamps, manual*	
VIG-MON-MV-02	Monitor for Medium Voltage (100-365VDC) - ***Includes****: DIN rail, DIN rail clips, ambient sensor, +1 VIGILANT sensor, cable clamps, manual*	*Similar to VIG-MON-LV-02*

Part Number	Description	Picture
VIG-MON-HV-02	Monitor for High Voltage (300-600VDC) - ***Includes**: DIN rail, DIN rail clips, ambient sensor, +1 VIGILANT sensor, cable clamps, manual*	*Similar to VIG-MON-LV-02*
VIG-AMB-SEN	Ambient Temperature Sensor	
VIG-CBL-CLP-POS-02	Positive Charger Cable Clamp - ***Includes**: 3-way jelly crimp, inline fuse, backplate, 2x cable ties*	
VIG-CBL-CLP-NEG-02	Negative Charger Cable Clamp - ***Includes**: 3-way jelly crimp, inline fuse, backplate, 2x cable ties*	
VIG-SEN-01	VIGILANT Sensor - ***Includes:** (2) IDC connectors, mounting cradle, 12" RJ12 cable*, isolation sticker	

Part Number	Description	Picture
VIG-TAB-01	Positive & Negative Tab Harness Set	
VIG-TERM-TAB-01	Special Terminal Tab Harness	
ELS-03-00-A	Electrolyte Level Sensor (Optional) - ***Includes:*** *Mounting cradle, connector cable*	
VIG-CLS-ST-02	Small steel C-Clamp with single tab for square posts	
VIG-CLM-ST-02	Medium steel C-Clamp with single tab for square posts	
VIG-CLL-ST-02	Large steel C-Clamp with single tab for square posts	

Part Number	Description	Picture
VIG-CLJ-01	Steel J-Clamp for round posts *(may include insulator depending on battery type)*	
VIG-CLLS-01	Steel long-legged clamp for round posts	
VIG-TAB-M8	M8 Tab Washer	
VIG-TAB-M10	M10 Tab Washer	
VIG-TAB-M12	M12 Tab Washer	
VIG-TAB-M10-BENT	Bent Brass M10 Tab Washer for BAE Cells	
VIG-STO-M8X22	M8x22 Bolt with Threaded Tap	

Part Number	Description	Picture
VIG-STO-M10X22	M10x22 Bolt with Threaded Tap	
VIG-STO-HW	M8/M10x22 Standoff Bolt Hardware Kit - **Includes:** (3) 45 angle tab washer, (3) M6 bolts**	*Not pictured*
VIG-CBL-CLPM-01	Positive Cable Clamp for Inter-tier Connections -**Includes**: Backplate, 2x cable ties	

4.0 Installation Preparation

The following steps should be reviewed before installing any VIGILANT components on the battery.

4.1 Pre-Install Battery Checks

Perform pre-installation checks on the battery system that is receiving VIGILANT installation:

1. Check for unintentional grounds.
2. Verify float voltage matches manufacturer recommendations and the charger output.
3. Test the battery with a portable resistance tester to record the cell/unit voltages, internal resistances, and connection resistances.
4. Analyze data to ensure the VIGILANT should/can be installed properly/safely.
    - ***Example:*** *A battery with an open cell, very high resistance, or extreme physical defects should not have a VIGILANT installed on it.*

4.2 Battery Preparation

Successful operation of the VIGILANT requires certain parts of the battery system to be cleaned and prepped:

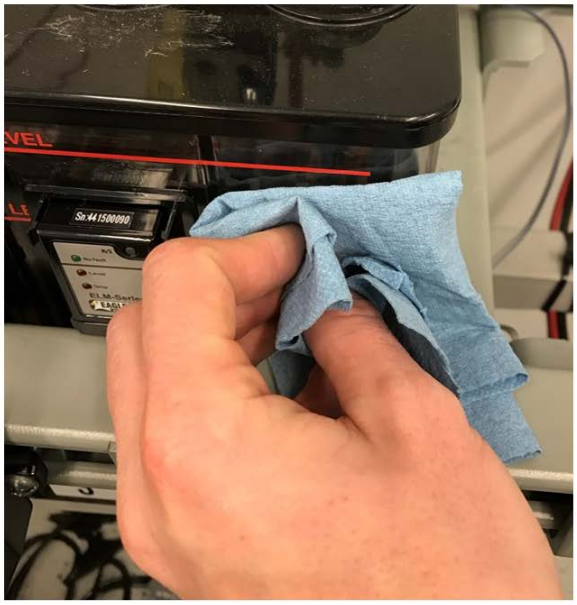
1. Clean any excessive corrosion off the battery terminals and jars.
2. Remove excessive grease from the terminals if present. Grease can affect the resistance measurement accuracy.

3. If mounting the VIGILANT cradles on the battery rack with adhesive, ensure the rack strut is cleaned thoroughly.

4.3 ELM Sensor Preparation

This step only applies if installing the ELM sensors on flooded batteries. The front of the battery jar must be cleaned to ensure the ELM sticks to the battery long-term.

- For strong adhesion of the ELM sensor cradles to the battery jar, any residues must be cleaned off.
- There are 2 preferred solutions to clean the front of the battery jars:
    - I70% Denatured rubbing alcohol - Works for most battery types and does not harm the jar.
    - CRC PF Precision Cleaner (P/N: 03190 (US)) - A more thorough cleaner which can remove some of the anti-adhesive properties of some battery jar labels (EnerSys specifically).
- For either cleaning solution, clean each jar first, then go through again with a dry rag and buffer the jars.



5.0 Identify Placement of Components

This section outlines best practices for placement of the components on the battery. It's important to plan out the placement of each component before installing them on the battery. Specific steps on how to mount the components mentioned here will covered later in the guide.

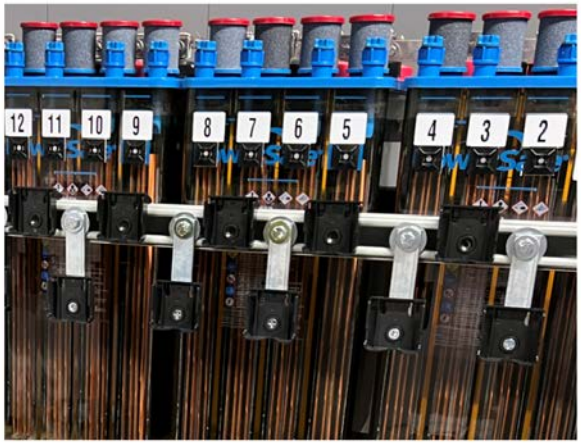
5.1 VIGILANT Monitor Placement

- The monitor dimensions are: 10W x 8.3H x 3.2D in. (255W x 210H x 80D mm).
- Each monitor includes a DIN rail with clips for mounting, ensure the surface for mounting the monitor can accommodate the DIN rail securely.
- The monitor should generally be placed as close to the battery mains as possible, either on the wall or directly on the battery rack. Below are 2 examples of each mounting option:

- The monitor should not be mounted more than 25 ft. (7.6m) from the battery.
- The monitor should not be mounted on the ceiling or at an angle.
- RJ12 communications cable will need to be cut to length and ran from the monitor to the first and last VIGILANT sensor on the battery, be mindful of these cable runs.

5.2 VIGILANT Sensor Placement

- The sensor dimensions are: 2H x 2W x 1D in. (50H x 50W x 25D mm)
- Sensors should be mounted as close to each cell as possible.
- There needs to be at least 2" (50mm) above and below the sensor. If 2 sensors are mounted side-by-side, there should be at least 3" between them.
    - If space does not allow this, contact Eagle Eye regarding drop down hardware that staggers the height of every other sensor.



- Each sensor includes a mounting cradle. Understanding the mounting options should be considered when determining sensor placement:
    - **Hardware mount**: Sensor cradles have a hole in the middle for a bolt or screw. This is the preferred mounting method *(see left image below)*. This can be used on channel strut or DIN rail with DIN rail clips.
    - **Adhesive mount**: Sensor cradles can be mounted using the adhesive backing. This should only be considered when hardware mounting is not possible *(see right image below)*.


Spring Nut Mounted
(preferred)


Adhesive Mounted

- In considering sensor placement, understand the cable length limitations:
    - **Tab Harnesses**: Each harness is 3.3 ft (100 cm) long, do not place sensors more than this distance from the battery terminals.
    - **RJ12 Cable**: Each sensor includes a 12 in. (305 mm) RJ12 cable for sensor to sensor communications. Keep this in mind when spacing out sensors.
    - **ELM Cable**: The cable from the VIGILANT sensor the ELM is 12" (305 mm) long. The ELM sensor is mounted on the front of the jar.
- Placement for Flooded/VLA battery systems:
    - It's recommended to mount the sensor inline with each cell, so that the sensor is in front of the cell.

- On smaller battery systems, it may be difficult to fit sensors right next to each other. In this case consider the drop down bracket.

VLA Mounted on Rack

- Placement for front facing sealed/VRLA systems:
  - Sensors are typically mounted on the side or top of the battery bank. Keep in mind cable length limitations for each sensor. For example, if mounting sensors on the top of the battery bank, ensure the 3.3 ft (100 cm) harness for that sensor can reach cells at the bottom of the battery bank.

VRLA Front Mounted

VRLA Side Mounted

5.3 ELM Sensor Placement

- The placement of ELM Sensors requires more attention to detail than the other components. **For the sensors to measure electrolyte level accurately, they must be mounted exactly as this guide outlines.** These steps will be detailed in a later section.
- ELM sensors include a cradle which is mounted to the front of the battery jar. When planning placement of the ELM sensors, ensure there is adequate space above and below the minimum line on the jar for the cradle to mount.
    - If there is not enough room for the cradle, standalone adhesives are included to mount the ELM sensor directly on the jar without the cradle.

- Below are common issues that can get in the way of ELM sensor placement:
    - Battery labels: Sensors must be placed in a spot with no stickers or obstructions behind the sensor.
    - Battery number stickers: For smaller jars, sometimes the battery number stickers are in the way of the only clear area on the jar. They must be moved.
    - Battery racking: Especially in seismic zones, the battery racking can get in the way of the sensors. It will need to be moved or the sensors might need to be mounted on the back of the cells. Contact Eagle Eye if this is an issue.
    - Minimum line close to top of jar. In this scenario the ELM might need to be mounted without the cradle.
- ELM sensors connect to the VIGILANT sensors with the provided 12" ribbon cable. Ensure the VIGILANT sensors are close enough to where the ELM sensors will be mounted to account for this.

6.0 Mount Components

Once the placement of components has been determined, it's time to install them on or around the battery.

6.1 VIGILANT Monitor Mounting

The following steps outline how to install the VIGILANT Monitor. These steps assume the placement has been determined based on Section 5.1.

Parts Needed

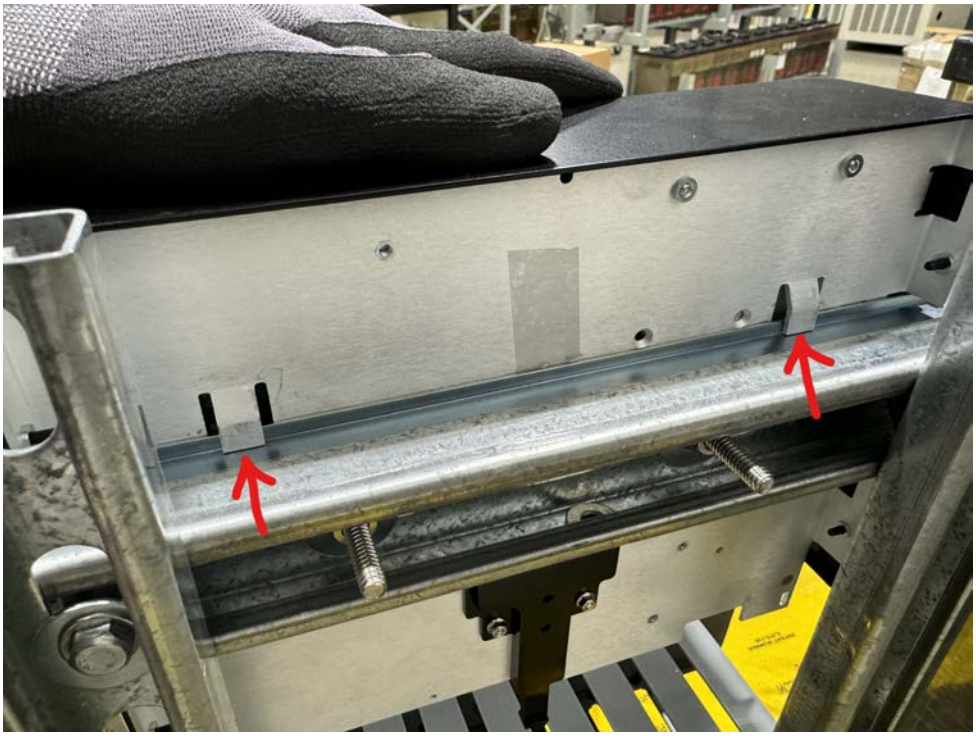
Part	Use	Where to Find
VIGILANT Monitor	Main controller for data collection and storage, plus some general measurements	Packaged in monitor box
DIN Rail	For mounting Monitor	Packed in monitor box
DIN Rail Stops	For keeping the monitor secured on the DIN rail	Packed in monitor box
Ambient Sensor	Measures ambient temperature	Packaged in monitor box
14AWG Stranded Ground Wire	Ground monitor	Not included

Installation Steps

1. Remove the 2 front covers from the monitor by loosening the screws. Back the screws out as far as you can without completely unscrewing them, then pull the covers out.

2. Mount the DIN rail to determined location (hardware not included).

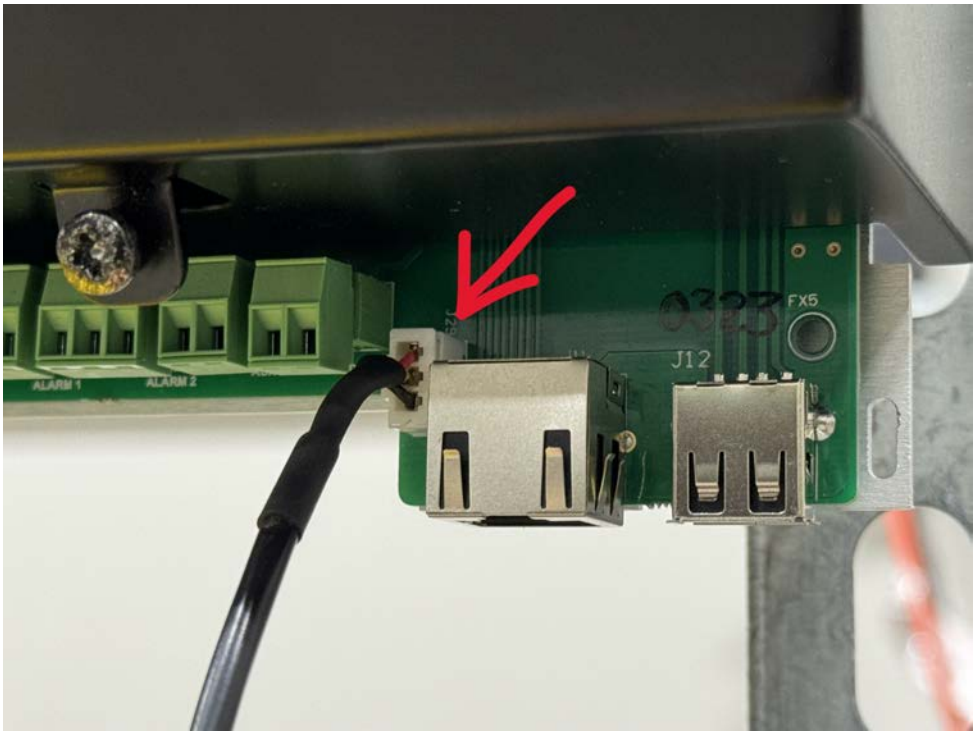
3. Slide the monitor over the DIN rail, aligning the tabs on the back with the top of the DIN rail. Ensure the tabs are seated all the way down on the DIN rail.



4. Push the DIN rail clip up to secure the monitor then hold the monitor with both hands and shake it gently to confirm it's mounted securely.

5. Install the DIN Rail Stops on each side of the monitor. Ensure the stop is pushed all the way in before tightening so that both ends grip the DIN rail.

6. Plug the ambient temperature sensor into the port shown below.



7. Secure the sensor near the monitor using cable ties.
8. Put the 2 front covers back on the monitor, then put the screws in all the way.

6.1.1 Grounding the Monitor

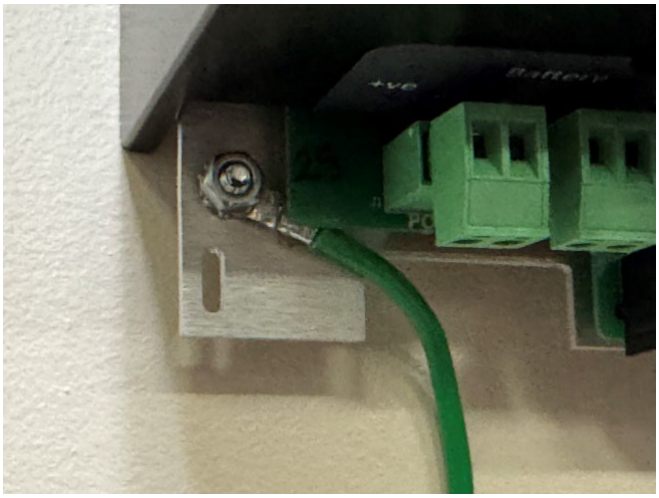
After mounting the monitor, it's required to ground it. In an electrical environment, to comply with the National Electrical Code all non-current carrying metal shall be bonded together to a common ground point. Simply fastening the monitor to a grounded metal structure is not an acceptable method.

For grounding the monitor, 14AWG stranded green wire is to be used. Crimping should be done with a crimp tool that is sized appropriately for the wire. The wire should then be grounded to the appropriate location. If possible, this will be determined during the site survey process.

Steps to Ground

1. Crimp the ground wire to the lug on the monitor.

2. Fasten the lug to the monitor. The wire will need to route behind the power and sense input plugs. Route the wire as shown below:



3. From the monitor, route the wire to the ground point on-site. Fasten the wire to the grounding the point.
    - If a specific ground point was not determined during the site survey, the monitor can be grounded to the same point as the grounding lug on the battery rack. If unsure, contact Eagle Eye.

6.2 VIGILANT Sensor Mounting

The following steps outline out to mount the VIGILANT Sensors . These steps assume the placement has been determined based on Section 5.2.

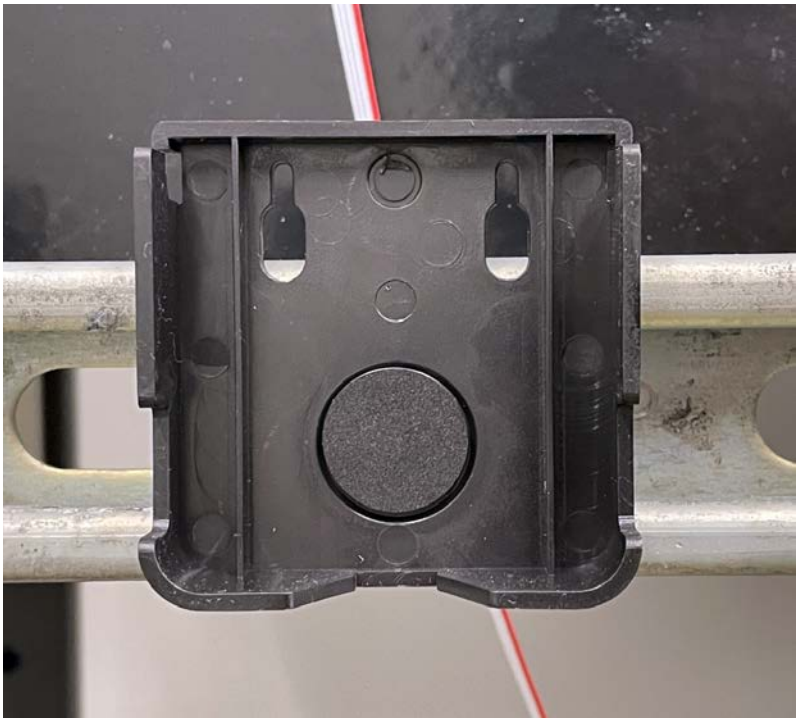
Parts Needed

Part	Use	Where to Find
VIGILANT Sensor	Measures each battery cell	In sensor box (12 per box)
Sensor Cradle	For mounting each sensor	Wrapped with each individual sensor
ICD Connectors	For tab harness connection to sensor	Plugged into each sensor
RJ12 Comms. Cable	For monitor to sensor & to sensor communications	Bundled in each sensor box (12 per box)
ELM Ribbon Cable	Connection to ELM sensors (if used)	Bundled in each ELM sensor box (30 per box)
Black Dot Stickers	For covering cradle mounting hardware	Inside the leaflet included with each sensor box

Installation Steps

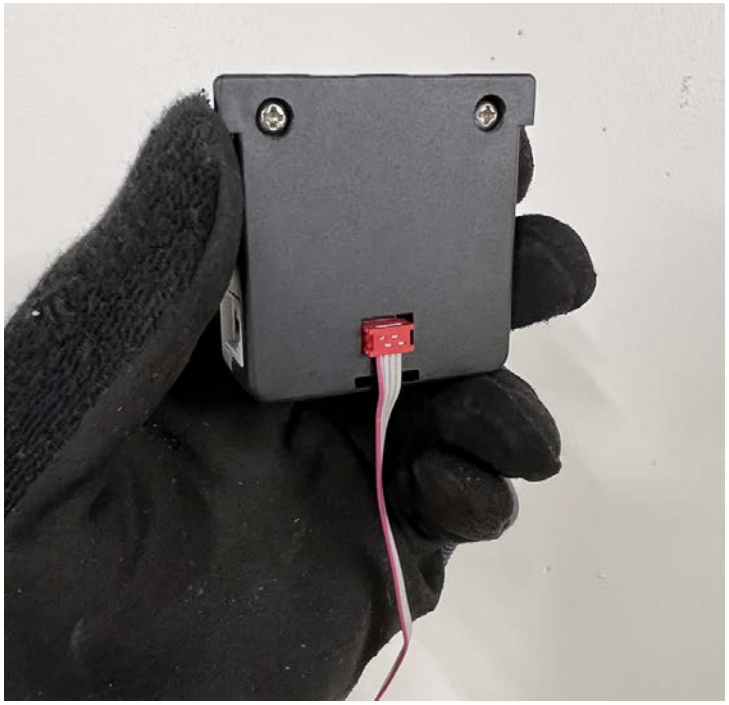
1. Mount the cradles as determined from Step 5.2:

- **Hardware mount:** Screw each cradle into the battery rack, wall or surface they are mounting on. After secured, place a black dot sticker over the hardware on each cradle.



- **Adhesive mount:** Attach the top cradle piece to the main cradle. Remove both adhesive backings and stick the cradle the cleaned surface. Ensure both adhesives make good contact.
    - **NOTE:** If using the adhesive, it's required to clean the surface of the battery cell. Follow the same steps outlined in the ELM cleaning section

2. If using ELM Sensors, attach the ribbon cable to the back of each VIGILANT sensor, this will be needed for the ELM installation steps (Section 4.3).



3. Slide the VIGILANT sensor into the cradle, there is no locking mechanism.

4. Connect the RJ12 comms cable to each sensor; plug the cable in so that it's on the side of the sensor facing the most negative post of the string. **Do not** plug the other side of the cable into the next sensor, leave them hanging.
    - Some battery systems require longer comms cable runs between rack tiers or steps, that step will be addressed in the coming steps.
5. When completed, all sensors should be in the cradles with the included comms cables attached, and ELM cables attached if applicable.

6.3 ELM Sensor Mounting

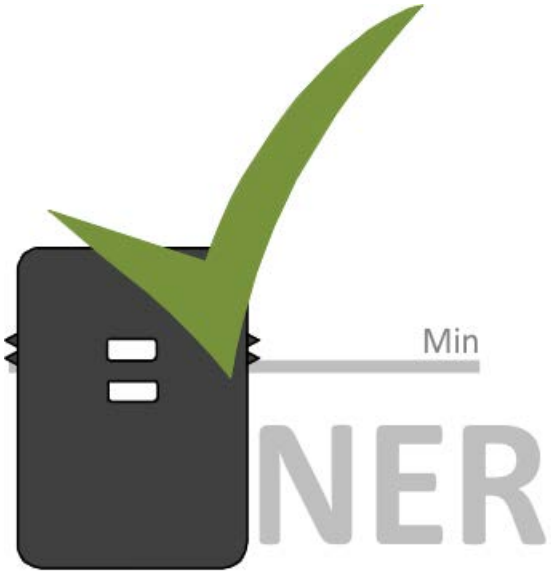
The following steps outline out to mount the ELM Sensors . These steps assume the placement has been determined based on Section 5.3.

Parts Needed

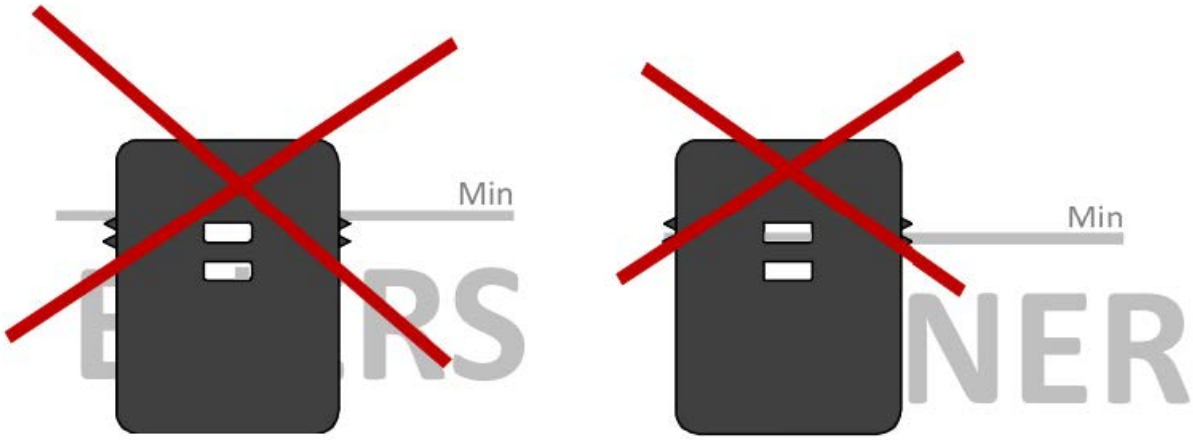
Part	Use	Where to Find
ELM Sensor	Measures electrolyte level	In ELM Sensor box (30 per box)
ELM Cradle	For mounting ELM sensor to jar	Wrapped with each ELM sensor
ELM Ribbon Cable	Connects ELM sensor to VIGILANT sensor	Bundled in ELM Sensor box (30 per box)
ELM Template	Confirm ELM sensors will not be obstructed	n/a

Installation Steps

1. General placement of the sensors should have been determined during Section 5.3. If in the way, battery labels and/or racking should have been moved or adjusted to accommodate the sensors.
2. The cradle has 2 pointed arrows on each side - line up the point of the bottom arrow to the top of the minimum line.



4. Check again that there is nothing printed on the battery jar between the arrow sets, including parts of the battery label.
5. Make sure the minimum line is not in-between the arrows on the cradle.



6. Once the mounting position is determined, remove the adhesive and firmly press the cradle onto the battery jar. If available, use the ELM applicator tool to press the cradle on using an up and down rocking motion.
7. Repeat the steps above for all sensor cradles.
8. After the cradles are mounted, slide the sensor into the cradle and click it into place.
9. On the front of the ELM, remove the cover by squeezing both sides.

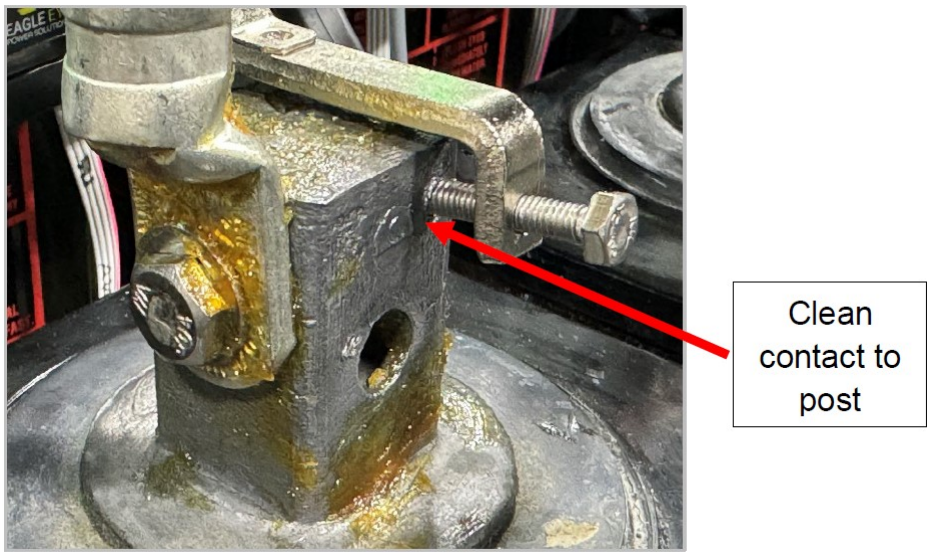
6. Plug in the ELM ribbon cable to either port (it does not matter which).
7. Put the cover back on the sensor.
8. Go through all sensors again and firmly press the cradles on to the battery jar to ensure maximum adhesion.
9. When complete, all ELM sensors should be securely mounted with the covers in place and ribbon cables connected to the VIGILANT sensors.

6.4 Connection Hardware Mounting

The VIGILANT has various connection hardware options depending on the battery type. Combinations of different types of connectors can be used to achieve the optimal connection for the VIGILANT.

6.4.1 Battery Terminal Preparation

Before installing any hardware to the battery terminals, ensure they are clean of corrosion and/or excessive grease where the clamp and/or tab washer makes contact (on both sides).



6.4.2 Square-Post Clamp Installation

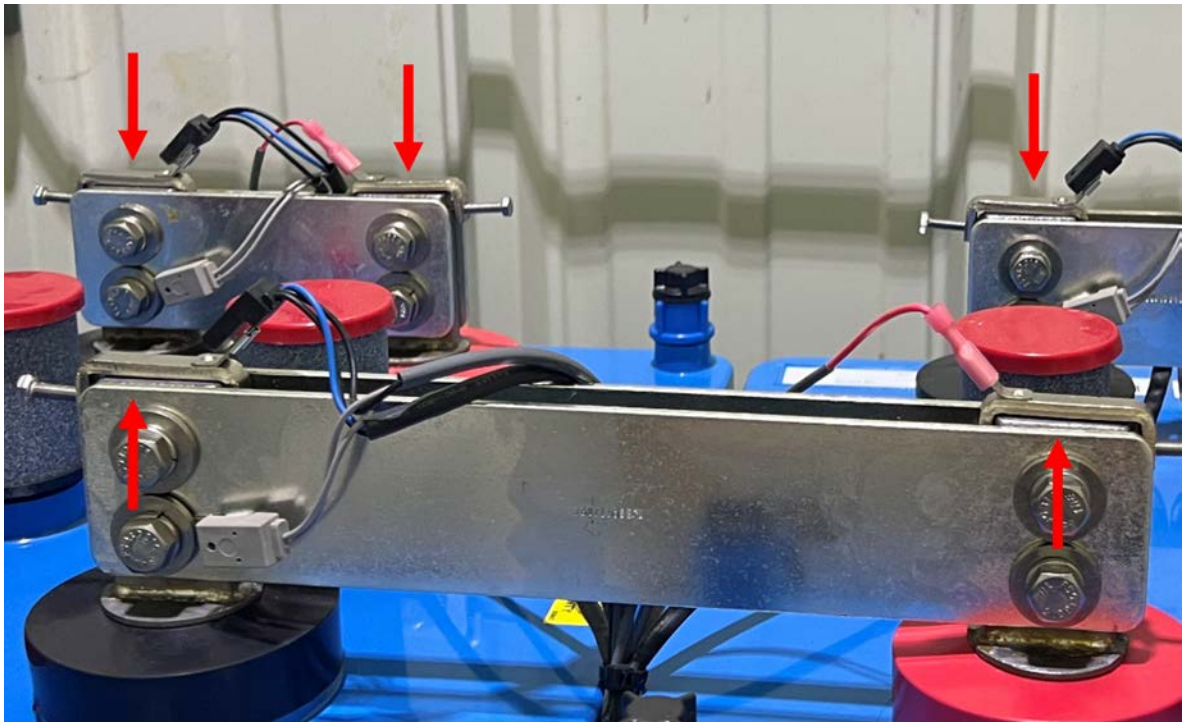
The C-Clamp is a steel clamp designed to be installed on exposed square post battery terminals with a tab washer.

- **C-Clamp** - Used for the sense lead connections only (black and red). A single clamp is installed on the post of every cell.

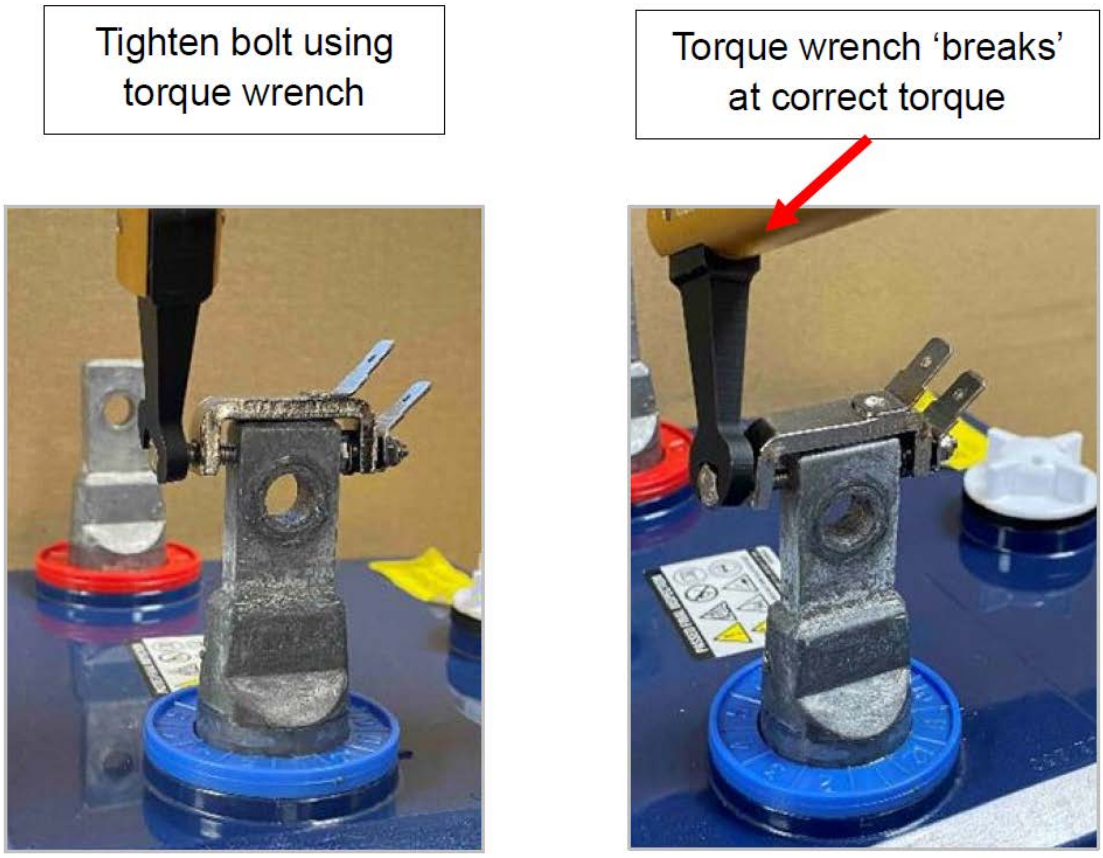
Ideally, the clamps should be installed using an Eagle Eye approved torque wrench. If not available, the instructions for not using a torque tool must be followed. Each method of installation will be covered below.

1. Place each clamp on the battery terminals and ensure they are consistently facing the same direction per each row of batteries. The adjustment screw should be facing a direction that is accessible with the tool used to tighten.

- **IMPORTANT: When placing the clamp on the post, be sure the clamp does not make contact with the bus bar.**



2. Hand tighten the adjustment screw on all the clamps and ensure the clamp is pushed down on the top of the most as much as possible.
3. **If Using Torque Tool -**
    - With the clamp hand tightened, continue to tighten the adjustment screw with the torque tool until the tool 'breaks'.
    - Push down on the top of the clamp while tightening.



4. **If NOT Using Torque Tool -**
    - With the clamp hand tightened, mark a small dot on each adjustment screw bolt head.
    - Using an insulated wrench, turn the bolt ONE full turn while pushing the top of the clamp down on the post.
    - Observe the marked bolt head for accuracy.

NOTE: If the clamp 'rides up' the post excessively, it means the clamp is too large for the post. Refer to table below for ideal clamp sizing per post size.

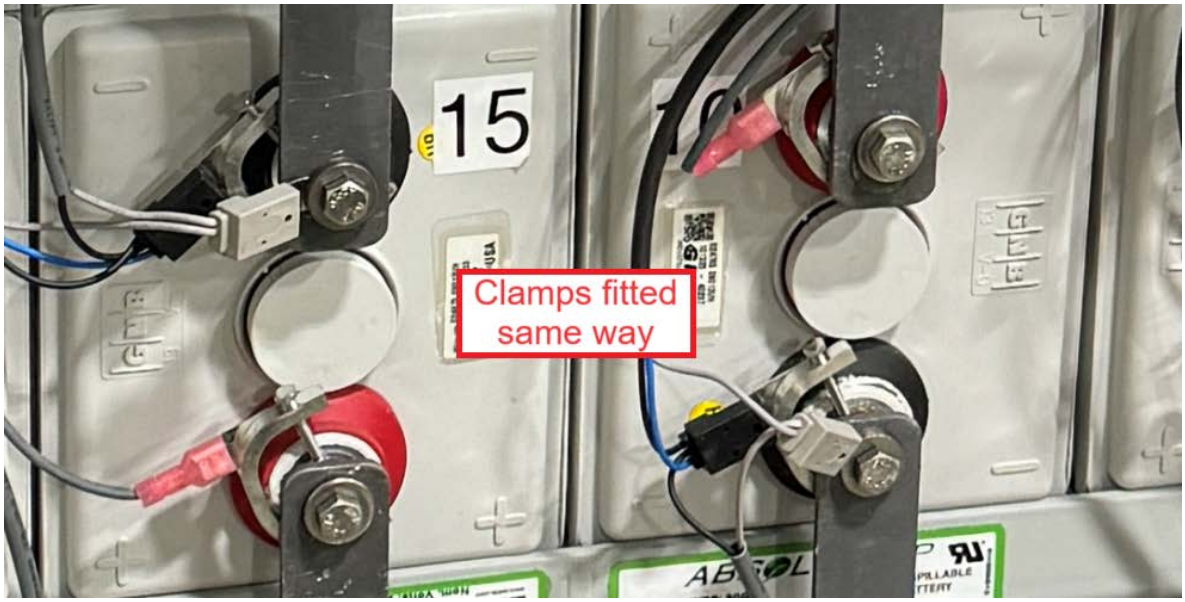
Clamp Type	Gape Range Tab
Small C clamps	17 – 23mm
Medium C clamps	18 – 32mm
Large C clamps	31 – 45mm

When completed, the clamps should be consistently installed across the battery.

6.4.3 Round-Post Clamp Installation

If the battery has round posts the C-Clamp is not used. Instead, either a J-Clamp or Long-Legged Clamp is used.

1. Follow the steps above for cleaning the post and **ensuring the clamp does not make contact with the bus bar**. The J-Clamp can be fitted with an isolation sticker if the gap is too tight to comfortably fit the clamp without it making contact with the bus bar.
2. The clamp should be installed on each post in the same orientation. The orientation chosen should ensure the adjustment screw is accessible and that clamp does not make contact with the bus bar.



3. Fit the clamp using the same steps outlined above by either using the torque tool or manual adjustment.

J-Clamp fitted

Long-legged clamp

6.4.4 Tab Washer Installation

A variety of tab washer options are available for the VIGILANT system. Tab washers can be used in combination with post clamps to achieve optimal connection to many battery types. In some scenarios, only tab washers must be used, typically when the battery does not have an exposed post. This section will outline common scenarios for installing tab washers.

WARNING: *Tab washer installation often requires de-energizing the battery and removal of battery hardware. This guide* ***does not*** *cover all the steps required on the battery system to fit tab washers. It simply explains what the options are and how they should be distributed on the battery. Be sure to follow safety and procedural steps for work on the specific battery.*

Tab Washer Dos and Don'ts

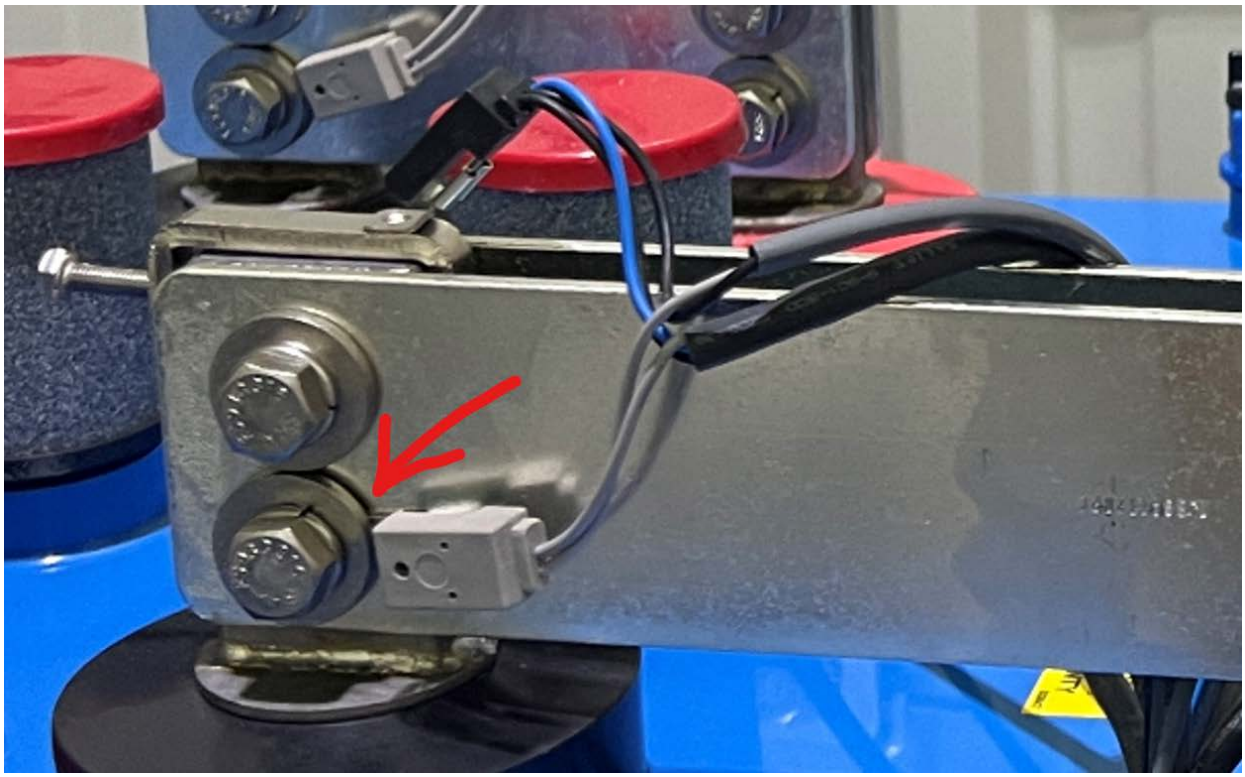
Regardless of which method below is used for tab washers, there are some general dos and don'ts when it comes to installing tab washers.

- Don't install tab washers between the bus bar and the post.
- Do face all tab washers in the same direction, generally toward the Vigilant sensors.
- Don't fit tab washers that are too large for the bolt.
- Do torque the connection with the tab washer to the battery specified torque value.

6.4.4.1 Tab Washer with Post Clamps

If the battery has an exposed post, the optimal connection is 2 clamps on each post for the sense leads, and a tab washer on the negative post for the pulse lead. Refer to section 6.4.2 above for how to install the clamps on the posts.

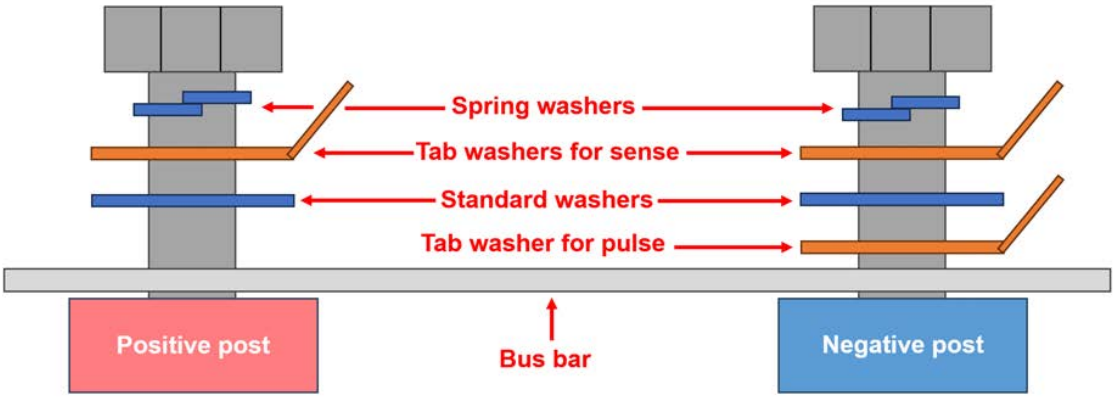
1. Install one tab washer on every negative post. Ideally the tab washer should be on the bolt head side like shown below.
2. Install one tab washer on the positive post of the last cell/unit (at the negative end of the string) in the same way as the negative posts.



6.4.4.2 Tab Washer Only

If the battery does not have an exposed post, then tab washers must be used for all connection points. The placement of the tab washers becomes important as there will be a pulse and a sense tab washer on every negative post and the last positive post.

1. Install 2 tab washers on every negative post. One of the tab washers should be between the bus bar and standard washer for the battery hardware. The other washer should be between the standard washer and the bolt head. If a spring washer was installed, place it between the standard washer and spring washer.



2. Install 1 tab washer on every positive post except on the last positive post, install 2 tab washers (at the negative end of the string). The washer should be between the bus bar and standard washer for all except the last positive which should be installed the same way as on negative posts.

6.4.5 Standoff Bolt Installation

Some battery systems require the addition of a standoff bolt to accommodate the VIGILANT connections to the battery. Use of the standoff bolt can follow similar installation practices mentioned above by either installing a single tab washer on the negative, or only tab washers on both posts.

Standoff Bolt with Post Clamps

If the battery has an exposed post, the optimal connection would be 2 clamps on each post for the sense leads, and a standoff bolt on the negative post for the pulse lead.

1. Install a standoff bolt on every negative post.
2. Install a standoff bolt on the positive post of the last cell/unit (at the negative end of the string).
3. Install a single tab on every standoff bolt installed.

Standoff Bolt Only

In some scenarios, only standoff bolts will be used without any clamps. **NOTE:** This method may lead to erroneous strap resistance readings.

1. Install a standoff bolt on every positive and negative post.
2. On every negative post install 2 tab connects.
3. On every positive post install 1 tab connect, except on the last cell install 2 tabs on the positive.

7.0 Install Cable Clamps

Each VIGILANT Monitor includes a set of cable clamps which are installed on the battery charger cables. These clamps power the monitor (if not using the 24V input), measure the charger float voltage, and provide terminal connection resistance measurement points.

Parts & Tools Needed

Part/Tool	Use	Where to Find
Positive Cable Clamp	Positive battery connection	In monitor box

Part/Tool	Use	Where to Find
Negative Cable Clamp	Negative battery connection	In monitor box
Cable Clamp Support Brackets w/Cable Ties	Support cable clamp on charger cable	In monitor box
3-Way Jelly Crimp	Crimp inline fuse from clamp to voltage cable	Packaged with each clamp
DC Power Cables	Power the monitor from the battery	Not provided
Total Voltage Cables	Sense the battery voltage	Not provided
Inline Fuses	Fused connection between battery and monitor	Packaged with each clamp
Cable Boring Tool	Bore holes in charger cable to install cable clamp	Not provided
Hex Driver	Screw cable clamp into charger cable	Not provided

7.1 Install Clamps to Charger Cables

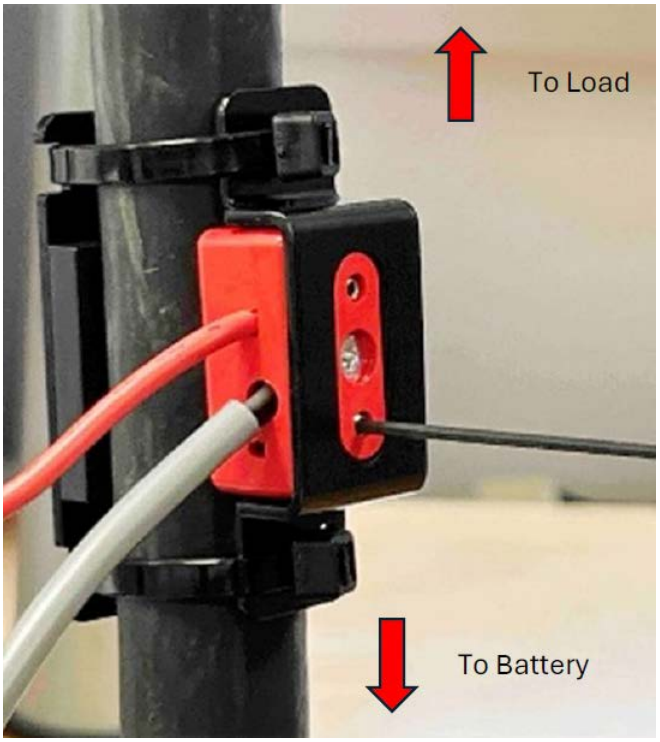
The steps to install both the positive and negative cable clamp are generally the same.

NOTE: Time should be taken to follow the steps below and ensure the clamp is secured to the cable properly. Improperly installed clamps can provide accurate results during commissioning but drift over time leading to false alarms.

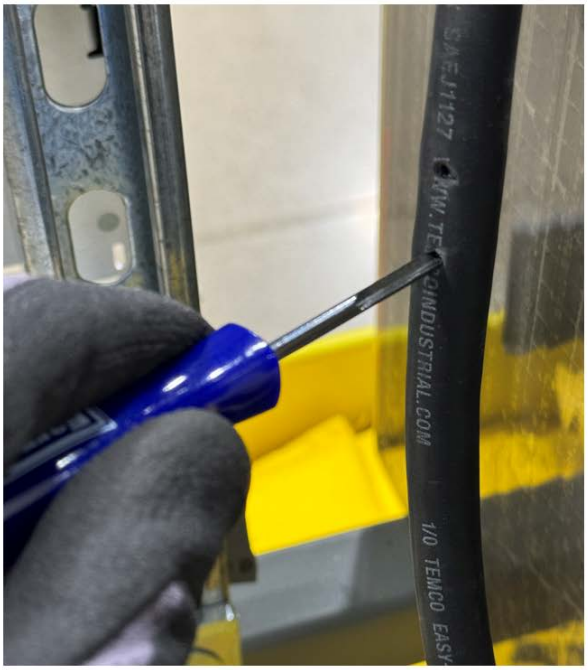
1. Remove the clamps and parts from the bags and ensure everything is included. Note the positive clamp has a red plastic mold and the negative clamp a black mold. Not pictured are the cable ties and support brackets which will be explained.

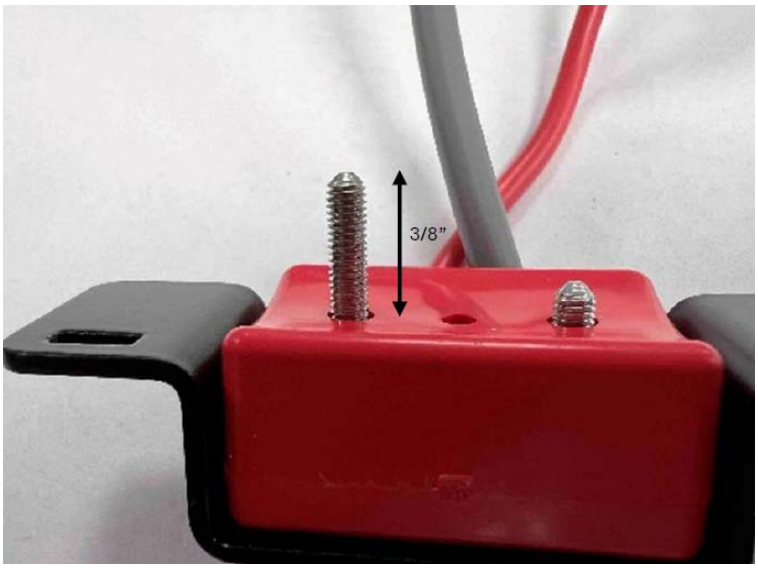
2. Determine where on the charger cable the clamps will be installed, take into consideration the following:
    - The clamps should be as close to the battery terminals as possible. They are also limited by the length of wire attached (3.3ft).

- Do not install the clamps on a bend in the cable as it will lead to erroneous results.
- If there are multiple charger cables, choose a location that allows the clamp to be installed so that the backplate is also accessible.
- The clamp should be oriented so that the thick red cable (3mm diameter) is facing the load (away from the batteries).

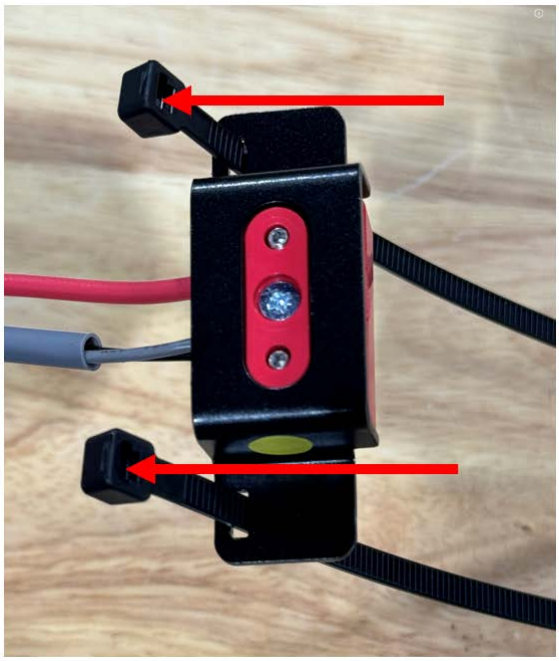


3. Once the clamp location is determined, holes will need to be marked and bored out on the cable:
    - Either place the clamp on the cable and use the 'grub' screws to mark the holes, or use a marker.
    - With the holes marked, use the boring tool or equivalent to bore out holes in the cable insulation until the copper is visible.
        - The size of the bit should not exceed 2mm (5/64").
        - Do not use the grub screws to bore the holes.
        - The grub screw should not penetrate the cable more than 9mm (3/8") from the base of the mold.

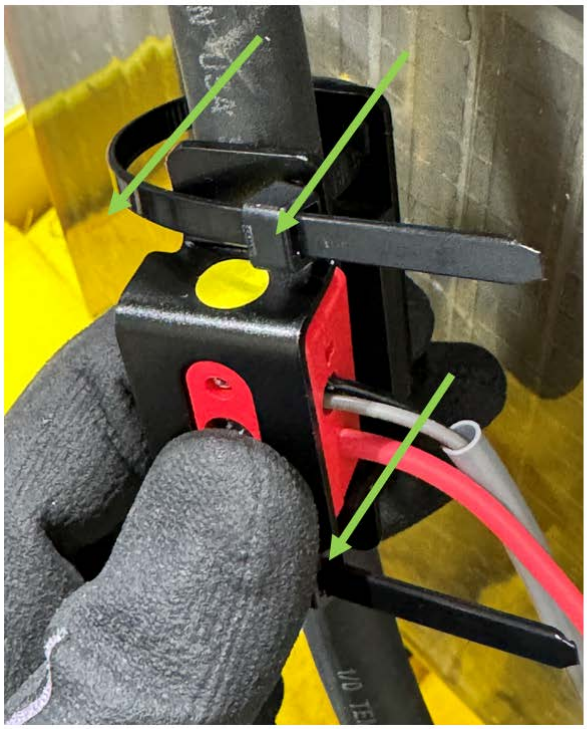




4. With the holes bored, the clamps are ready to be secured to the cables.
    - **WARNING: It's recommended to tape the ends of the sense wires on the clamp prior to attaching it. Once the grub screws make contact with the cable the sense wires will be live.**
5. Locate the support backing plate for each clamp.
    - Start by inserting the cable ties into the holes on the clamp main body. Note the position of the cable tie heads, the cable should feed into the head from the wire side of the clamp.
    - Next, slide the backplate into the cable ties.

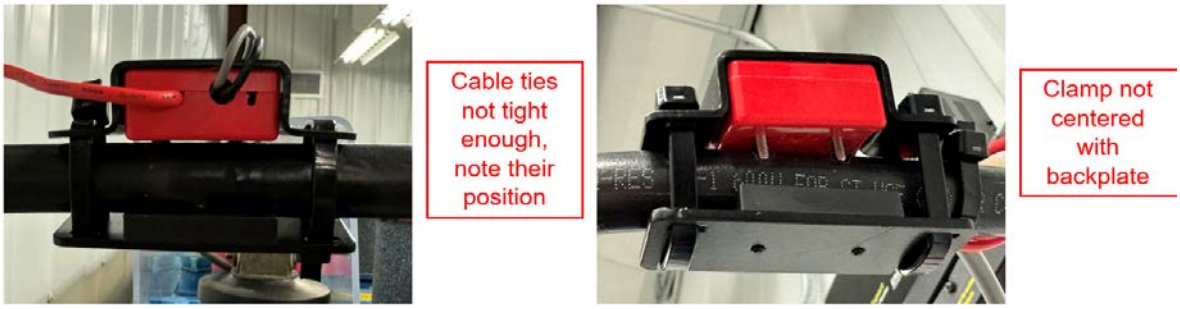


6. Position the body of the clamp and the backplate on opposite sides of the cable. Make sure the red power cable is facing toward the load (away from the batteries).
    - Ensure that the two grub screws are located in the two holes previously bored. It can help to screw the clamp in just a bit to hold in place.
    - Feed the cable ties around the back of the support bracket and through the head. As you tighten the cable ties, ensure the clamp and bracket are aligned so that the bracket is evenly positioned behind the clamp. Use the corners of the clamp and bracket to visually align them.



7. Pull the cables ties as tight as possible - it works best to have the cable tie head flush with the clamp bracket as shown below. Tighten the grub screws into the cable and cut the excess zip tie.

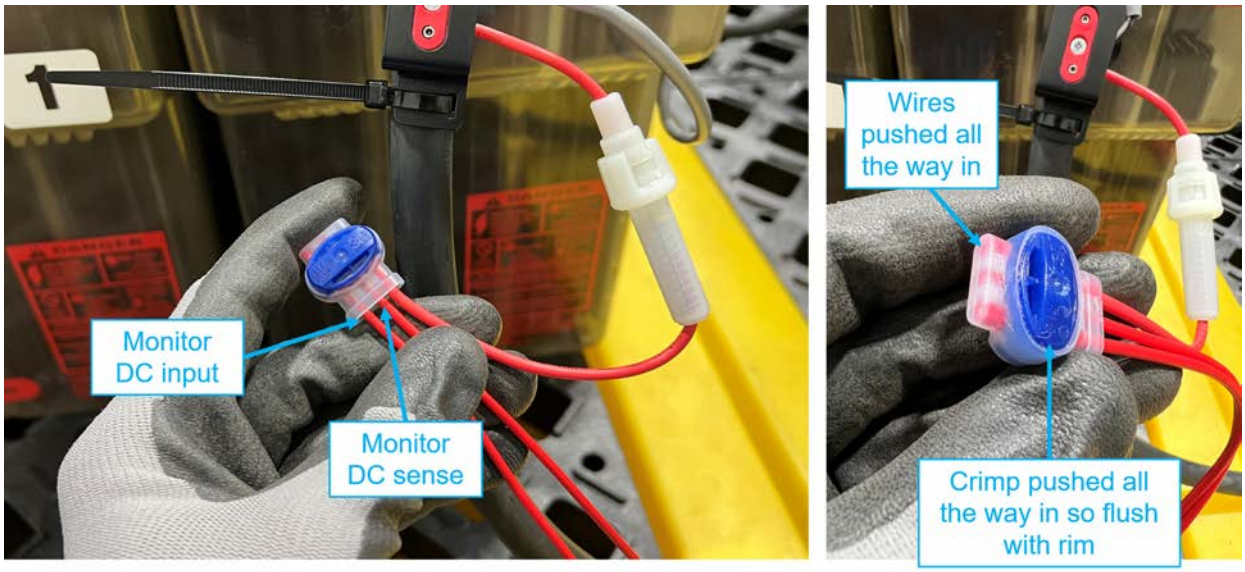
- **NOTE:** The clamp won't always look perfectly aligned. The most important visual cue is to ensure you cannot see the grub screws between the clamp and cable.



7.2 Connect Power & Sense Wires

The red in-line fused wire off each clamp connects back to the monitor. If powering the monitor from the battery, there will be (2) wires per each clamp back to the monitor. The steps below assume this is true.

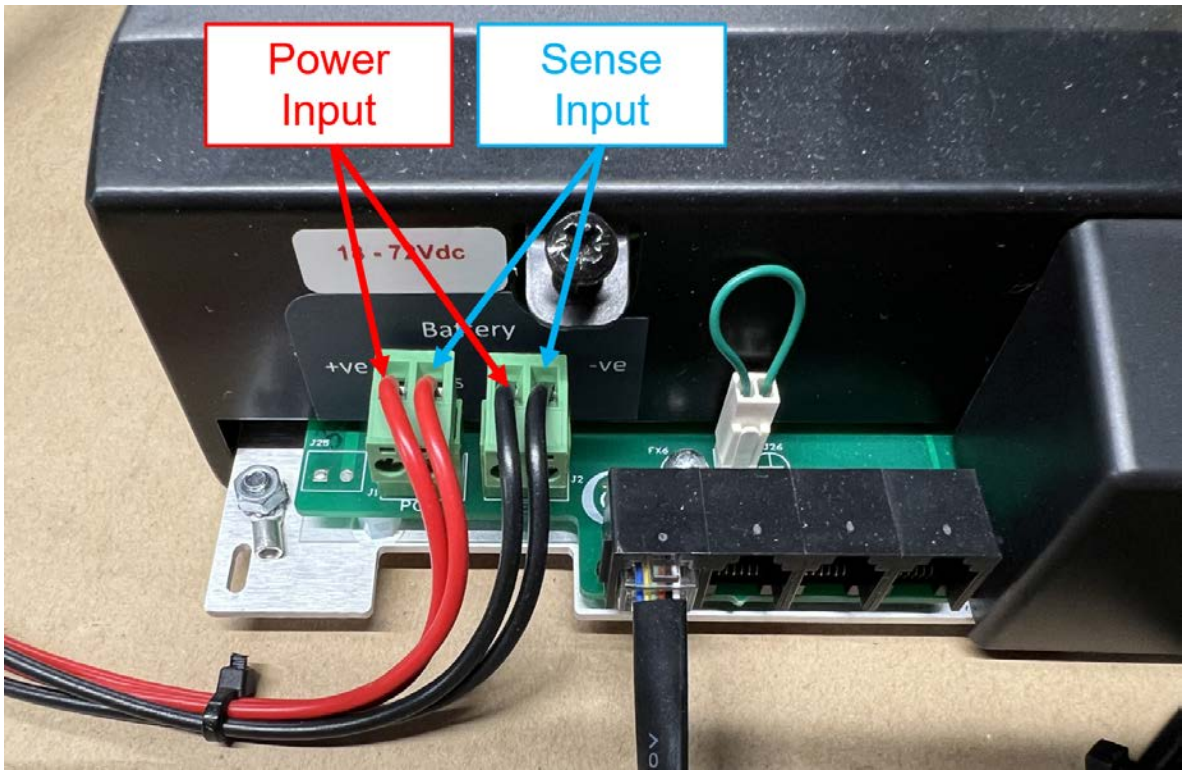
1. Measure out and cut all wiring needed between the cable clamps and the monitor. Both the positive and negative clamp require (2) separate wires back to the monitor, (4) wires in total.
2. Start with the positive cable clamp. Insert the (2) monitor wires into the 3-way jelly crimp and then insert the in-line fused wire as shown below. Using pliers, squeeze the crimp together until it's firmly closed. It may need to be pressed down in several places to ensure a good connection.
    - **WARNING: Remove the fuse from the fuse holder before proceeding.**



3. Secure the wiring to the battery and to the monitor to the charger cable. Ensure the fuse holder is openly accessible as the fuse will be installed later. The fitted cable clamp should look like the below when done.

4. Repeat the same steps for the negative cable clamp and wiring.

5. Route both sets of wires back to the monitor. Wires should be managed and secured so that they are not loose, excessively long, or coiled up.
6. Remove the left bottom cover from the monitor and then remove the Molex connectors.
7. Strip back 1/4" of wire to terminate each set into the Molex connectors. If powering the monitor from the battery, terminate both wires at either input of the Molex. If powering from the 24V supply, be sure to plug the sense into the correct input.
    - Sense input: On each Molex, the voltage sensing input is right-hand pin of the socket.
    - Power input: On each Molex, the power input is the left-hand pin of the socket.



***WARNING**: Verify the voltages with a multimeter before connecting.*

8. Plug the connectors into the proper ports to ensure they connect without stress on the wire.
9. Insert the inline fuses into the fuse holders.
10. Finally, remove the Molex connectors for now until later steps to protect the monitor.

8.0 Install Tab Harnesses

The tab harnesses connect each VIGILANT Sensor to the connection hardware on the cell.

Parts & Tools Needed

Part/Tool	Use	Where to Find
Positive Tab Harness	Connect sensor to connection hardware	In harness box (12 per box)

Part/Tool	Use	Where to Find
Negative Tab Harness	Connect sensor to connection hardware	In harness box (12 per box)
Special Terminal Tab Harness	Connect +1 sensor to connection hardware	Packaged in main box
IDC Connectors	Terminate harness wires to sensor	Connected to sensors in package
IDC Crimp Tool	Crimp harness wires to sensor IDC	Not provided
Wire Stripper	Adjust wire length	Not provided

8.1 Understanding the Harnesses

Each tab harness comes as a set with a positive and negative harness. The parts of the tab harness are described below. The type of wires and connectors will be referenced throughout this section.

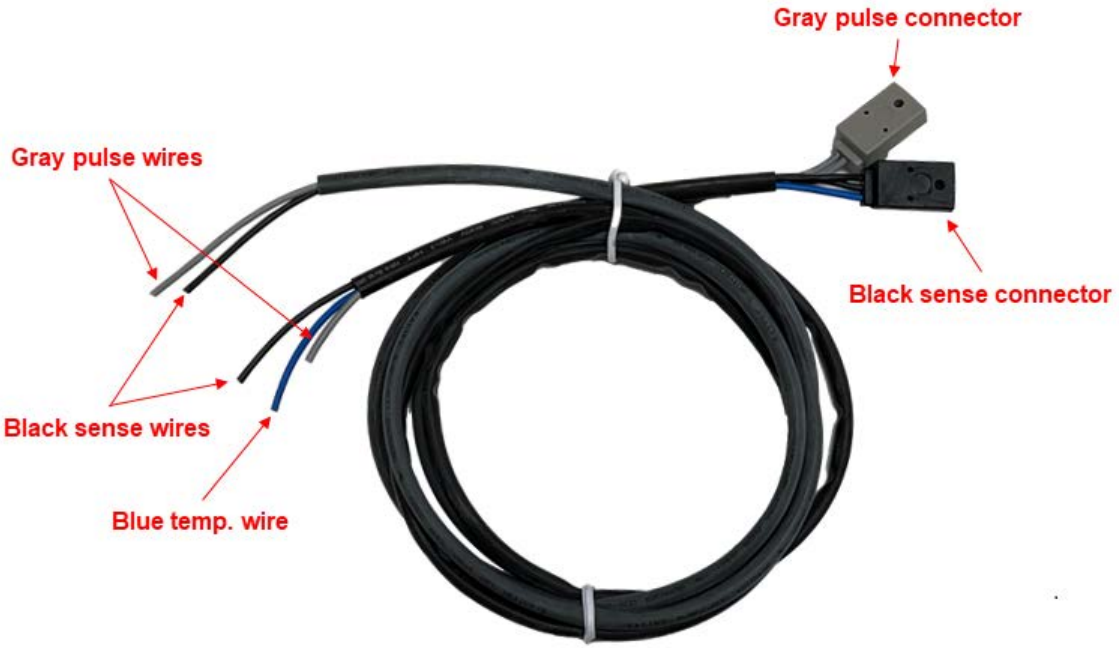
8.1.1 Positive Tab Harness

- **Red Sense Connector**: Connects to positive post.
    - Red Wire - Measures the cell voltage between it and the black sense wire connected to the negative post of the same cell. Measures the strap voltage between it and the black wire connected to the negative post of the next cell.

8.1.2 Negative Tab Harness

- **Black Sense Connector**: Connects to negative post.
    - Black Wires - Measures the cell voltage between it and the red sense wire connected to the negative post of the same cell. Measures the strap voltage between it and the red wire connected to the negative post of the previous cell.
    - Blue Wires - Measures the negative post temperature of the connected cell.
- **Gray Pulse Connector**: Connects to negative post.

- Gray Wires - Path for pulse current during pulse test, starting at the negative post of the connected cell, passed through the cell and the strap to the negative post of the next cell. Measures internal and strap resistance.



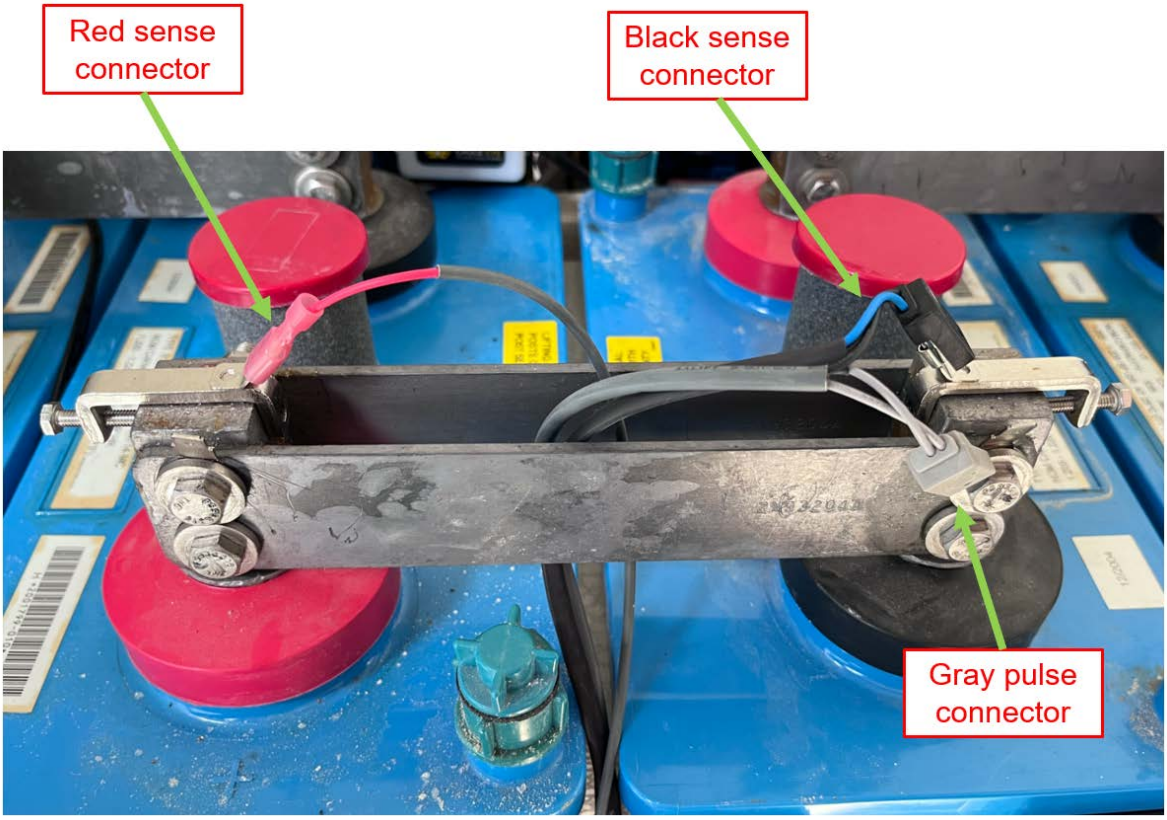
8.2 Connect Harnesses to Battery Connections

The exact steps here can vary depending on the type of connection hardware used.

Connecting to Mixed Clamp and Tab Washer

If the battery has an exposed square or round post, it's ideal to connect the sense leads to the clamps installed on the posts. The pulse lead would be installed on a tab washer.

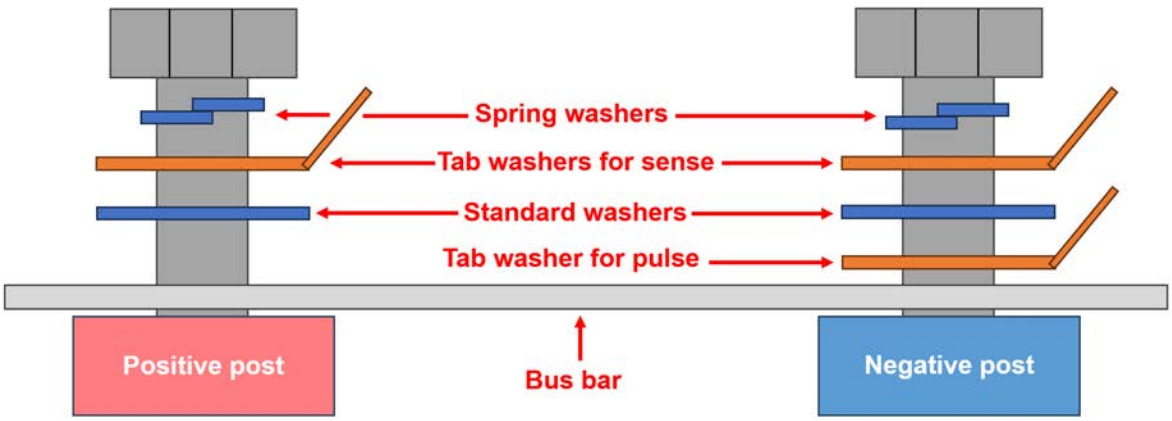
1. Connect the red sense connector to the single tab-clamp installed on the positive post.
2. Connect the black sense connector to the single tab-clamp installed on the negative post.
3. Connect the gray pulse connector to the tab washer installed on the negative post. The tab washer can be in various location such as on the excess bolt thread or between the bus bar and the washer and nut of the bolt.



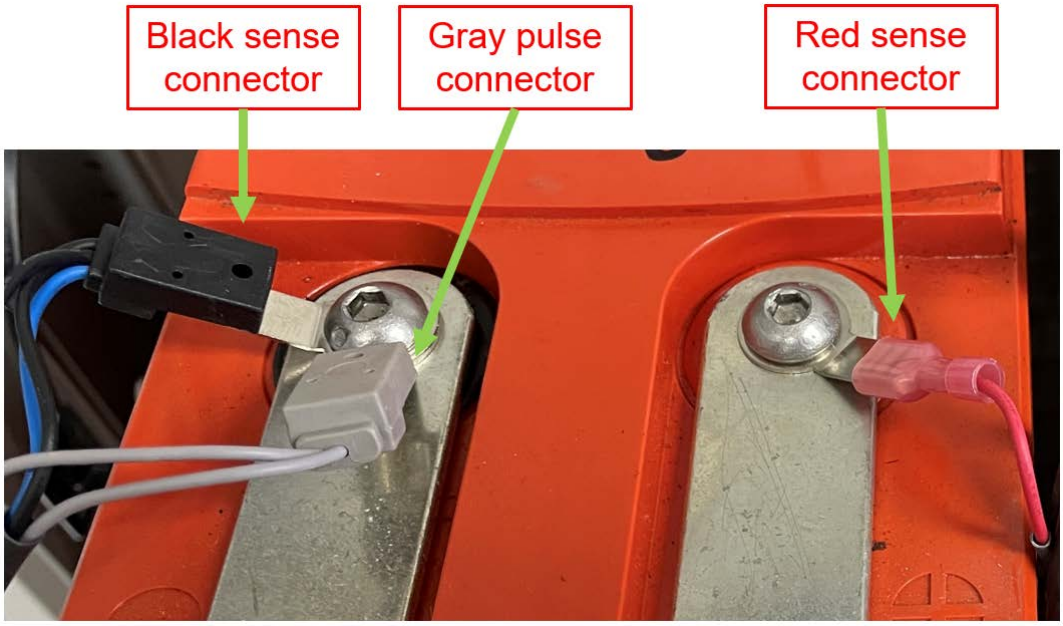
Connecting to Tab Washer Only

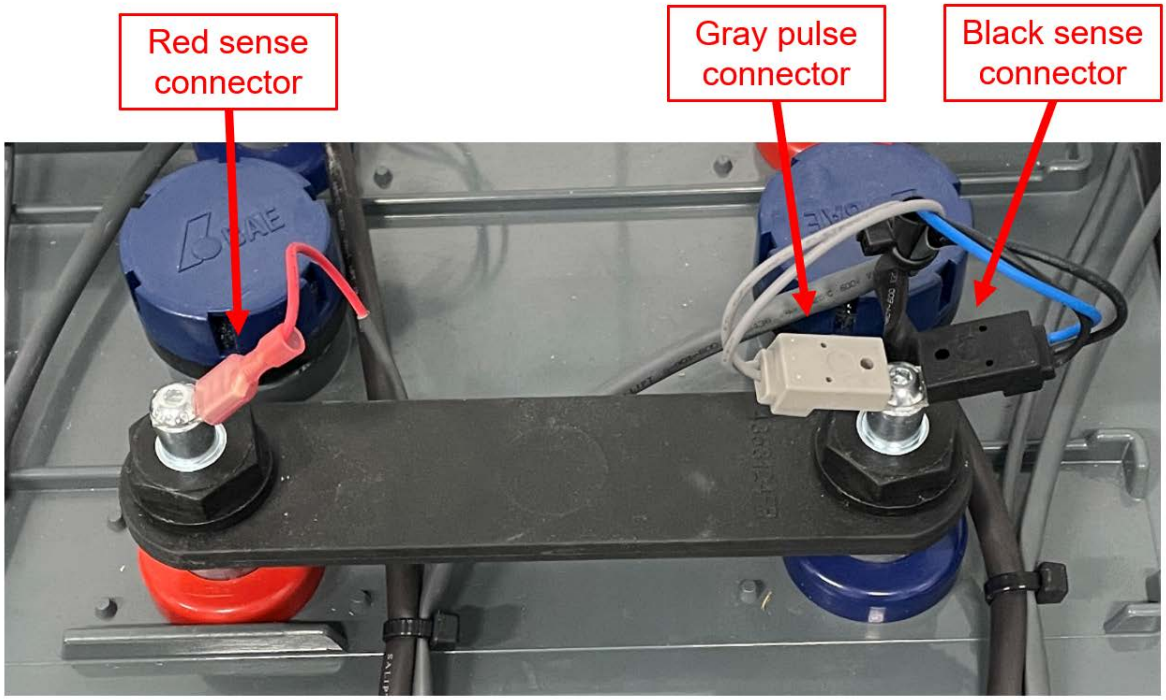
If there is no exposed post to fit hardware on then the connectors must be fitted to tab washers only.

1. Connect the red sense connector to the tab washer on the positive post.
2. Connect the black sense connector to the top tab washer on the negative post.
    - **NOTE: As mentioned in section, if a spring washer is used, the sense tab washer must be installed between the spring washer and standard washer.**
3. Connect the gray pulse connector to the bottom tab washer on the negative post.



4. In some cases, the tab washers may be installed on standoff bolt hardware. In this case, follow the same connection sequence.





8.3 Connect Special Terminal Harness

The special terminal harness allows measurement of the terminal connection resistance between the charger cable and last negative battery post. It carries the pulse from the +1 sensor.

1. Connect the tab connector as follow depending on the clamp type:
    - **C-Clamp**: Connect to the tab on the clamp.
    - **Tab washer:** Connect to the bottom tab washer closest to the post.

9.0 Terminate Harness Wires

Once all the cable clamps and tab harnesses are all connected to the battery, it's time to terminate the wires to the IDC connectors on the sensors.

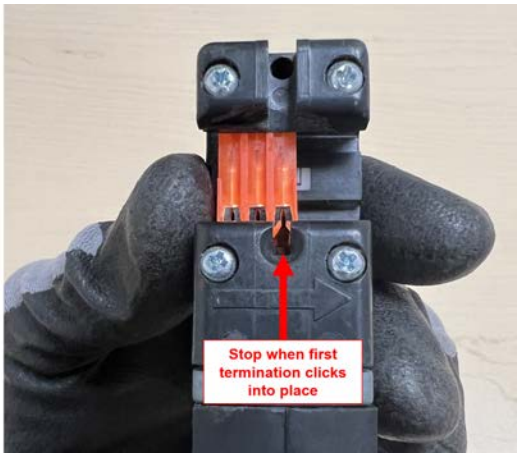
Parts & Tools Needed

Part/Tool	Use	Where to Find
IDC Connectors	Plug harness wires into the VIGILANT Sensors	Connected to each sensor out of the box
IDC Crimp Tool	Crimp the harness wires to the IDC connector	Not provided
Wire Stripper	Cut or strip wires as needed	Not provided

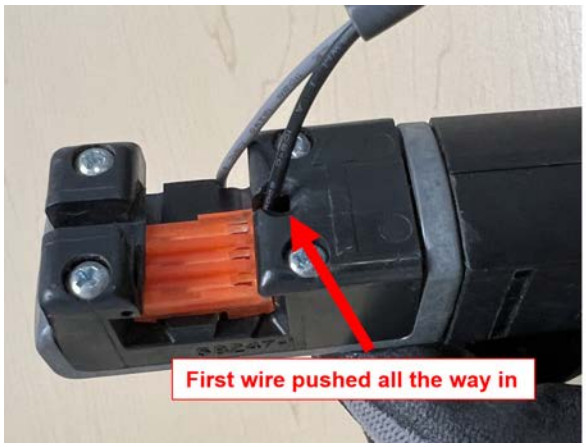
9.1 How to Use IDC Crimp Tool

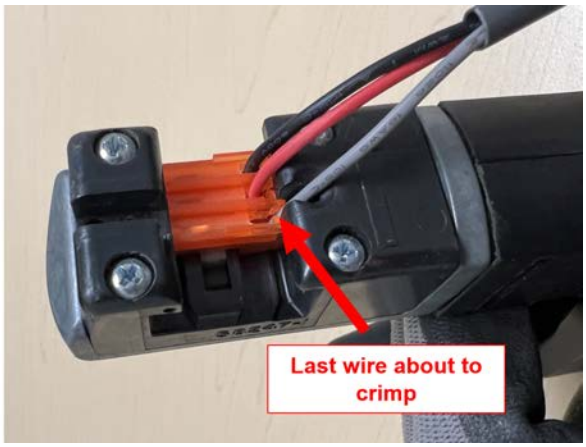
The steps in this section will heavily rely on use of the IDC crimp die and handle. Together these will be referred to as the IDC crimp tool. The process of using the crimp tool is mostly the same for every sensor.

1. Slide the IDC connector into the die as shown below. The IDC should click into place at the first termination point.

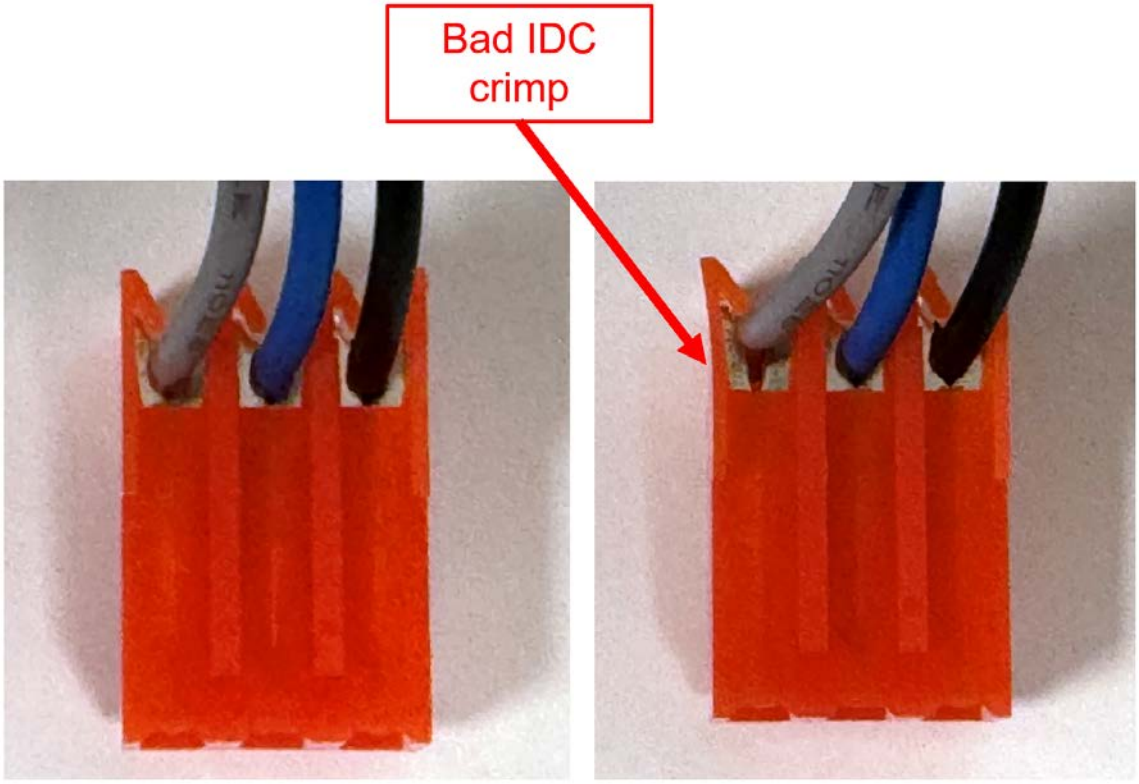


2. Insert the wire into the hole, be sure to push and hold the wire all the way in.
3. Squeeze the crimp handle to crimp the connection. The IDC should automatically move to the next termination point.





4. Repeat this process for each wire, the IDC should eject on the last crimp. The specific sequence to crimp each wire will be outlined in the following steps.
5. After crimping all wires, double check that they are seated all the way into the IDC. Note the bad crimp below where the black wire is not seated fully into the IDC. Any bad crimps should be found during section 10 where connections are tested.



9.2 Wire Management

During these steps, the wiring harnesses will need to be cut and fitted around the battery. Each harness is 3.3 ft (1m) long. There aren't any specific steps to adjusting the harnesses but the points below are considered best practice:

- The wiring should be cut as short as possible while not pulling on the components - a bit of slack is recommended.
- If possible, route the wiring between cells.

- Use cable ties, sticky back pads, and other cable management supplies to ensure the wiring is as neat as possible.
- Keep the wiring consistent cell to cell, if routing the cables a certain way on the first cell it should be repeated that way throughout the install.
- Do not zip tie wiring to the battery bus bars or posts, this can introduce noise and corrosion to the system.

Below are some examples of wiring on various battery types:

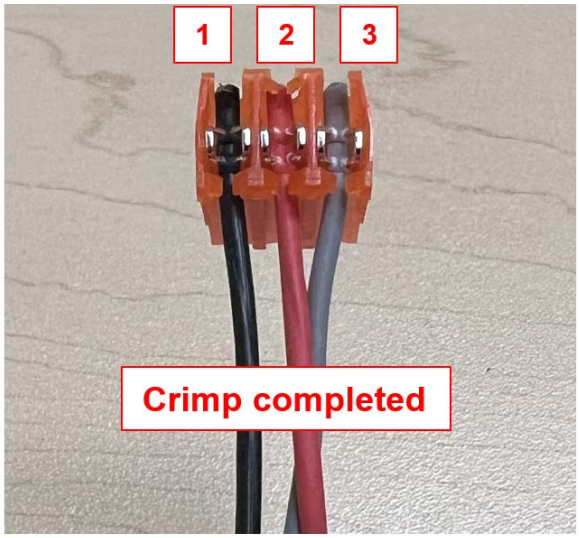

Flooded (VLA)


Sealed (VRLA)

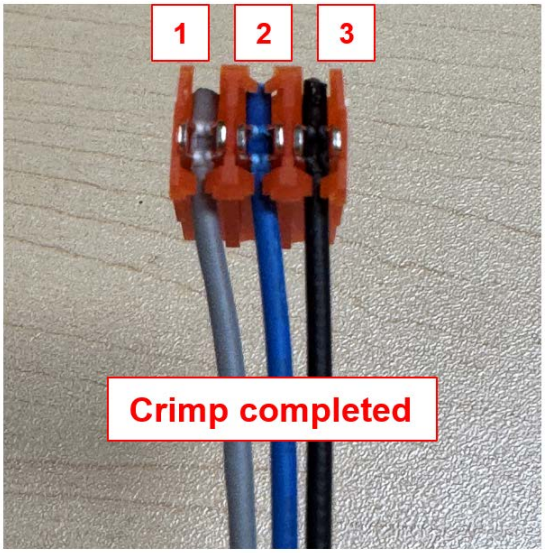
9.3 Positive Cable Clamp & First Sensor

The first and last sensor connection differs from all the middle sensors on the system. Starting with the first sensor, follow the steps below:

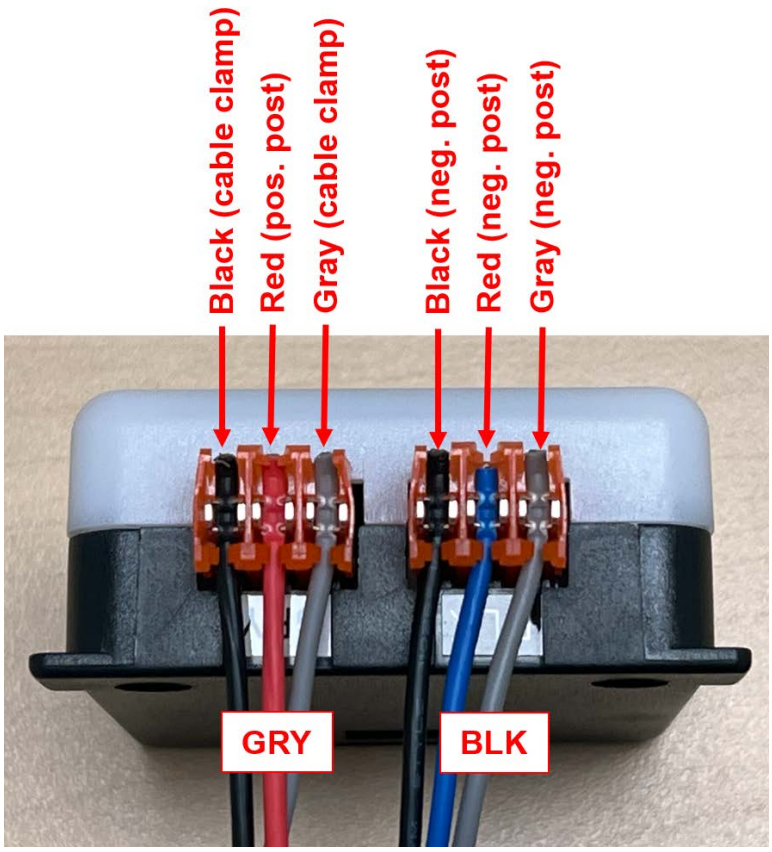
1. Starting with the **GRY IDC** from the first sensor, crimp the following wires in the order listed below:
    - Position 1: Crimp the **black sense wire** from the **positive cable clamp** installed on the charger cable.
    - Position 2: Crimp the **red sense wire** from the **red sense connector** installed on the positive post.
    - Position 3: Crimp the **gray pulse wire** from the **positive cable clamp** installed on the charger cable.



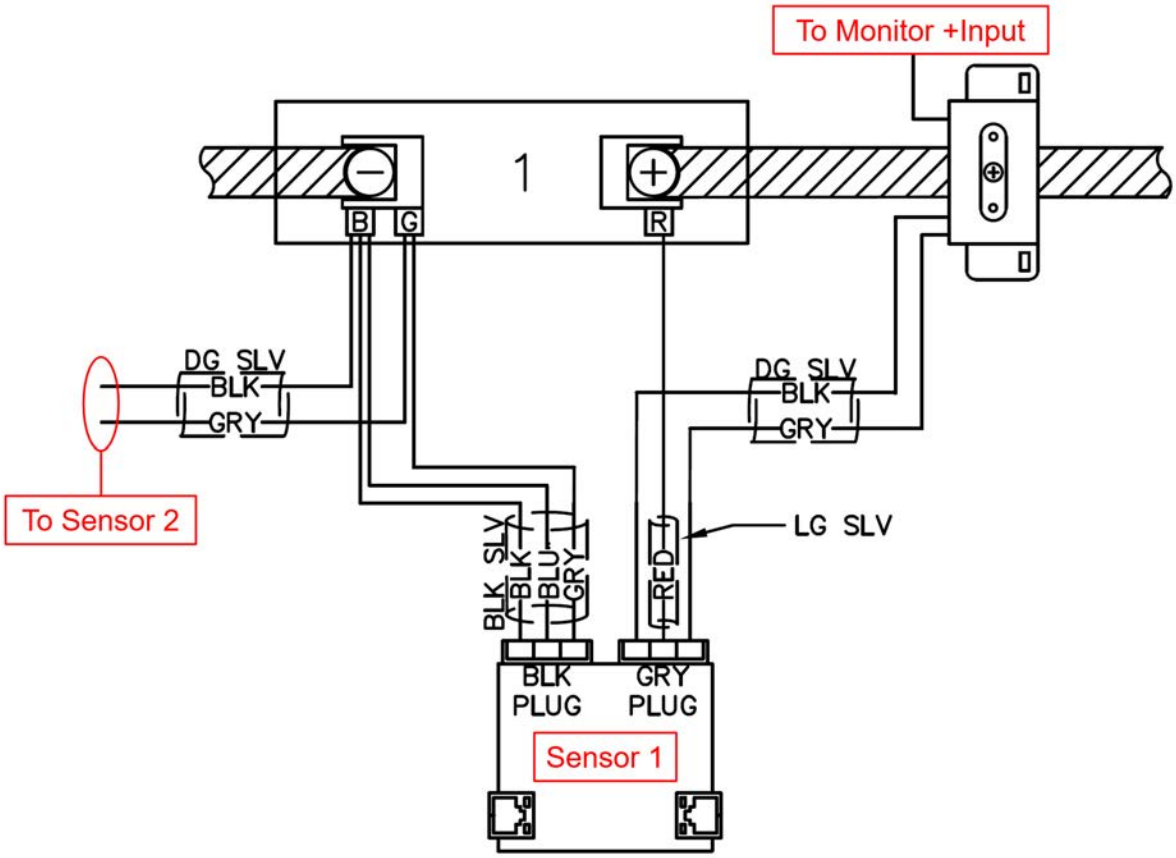
2. Moving on to the **BLK IDC** from the first sensor, crimp the following wires in the order listed below:
    - Position 1: Crimp either of the **black sense wires** from the **black sense connector** installed on the negative post.
    - Position 2: Crimp the **blue sense wire** from **black sense connector** installed on the negative post.
    - Position 3: Crimp either of the **gray pulse wires** from the **gray pulse connector** installed on the negative post.



3. At this point, both IDC connectors for the first sensor should be fully crimped as shown below.
    - ***CAUTION:*** *Do not plug any crimped IDC connectors into the sensors. The picture below is for example only. The IDCs should not be plugged into the sensors until the commissioning. If they are it could damage the sensor.*



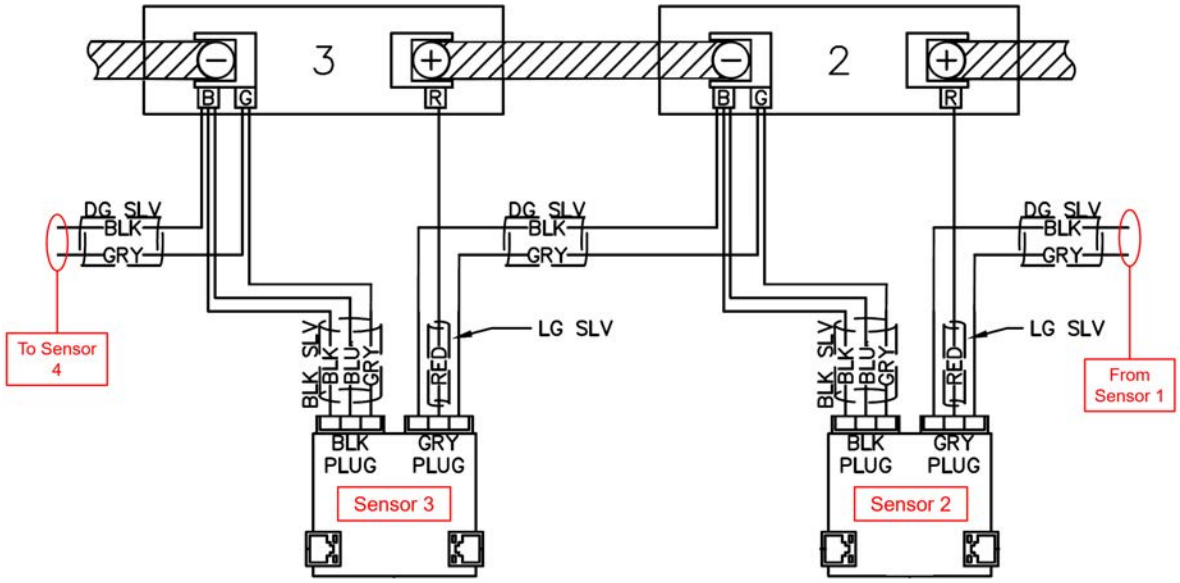
4. Finally, the completed wiring for the positive cable clamp and first sensor should look like shown below. All wires are terminated except a single black sense and gray pulse from the negative post. These will be terminated in the next main step.



9.4 Middle Sensors

The middle sensors are all the sensors between the first and last. In most scenarios, terminating the harnesses to these sensors is a repeatable process. With the first sensor wired to the cable clamp and first cell, there should still be a black sense and gray pulse wire from the negative clamp of the first (previous) cell.

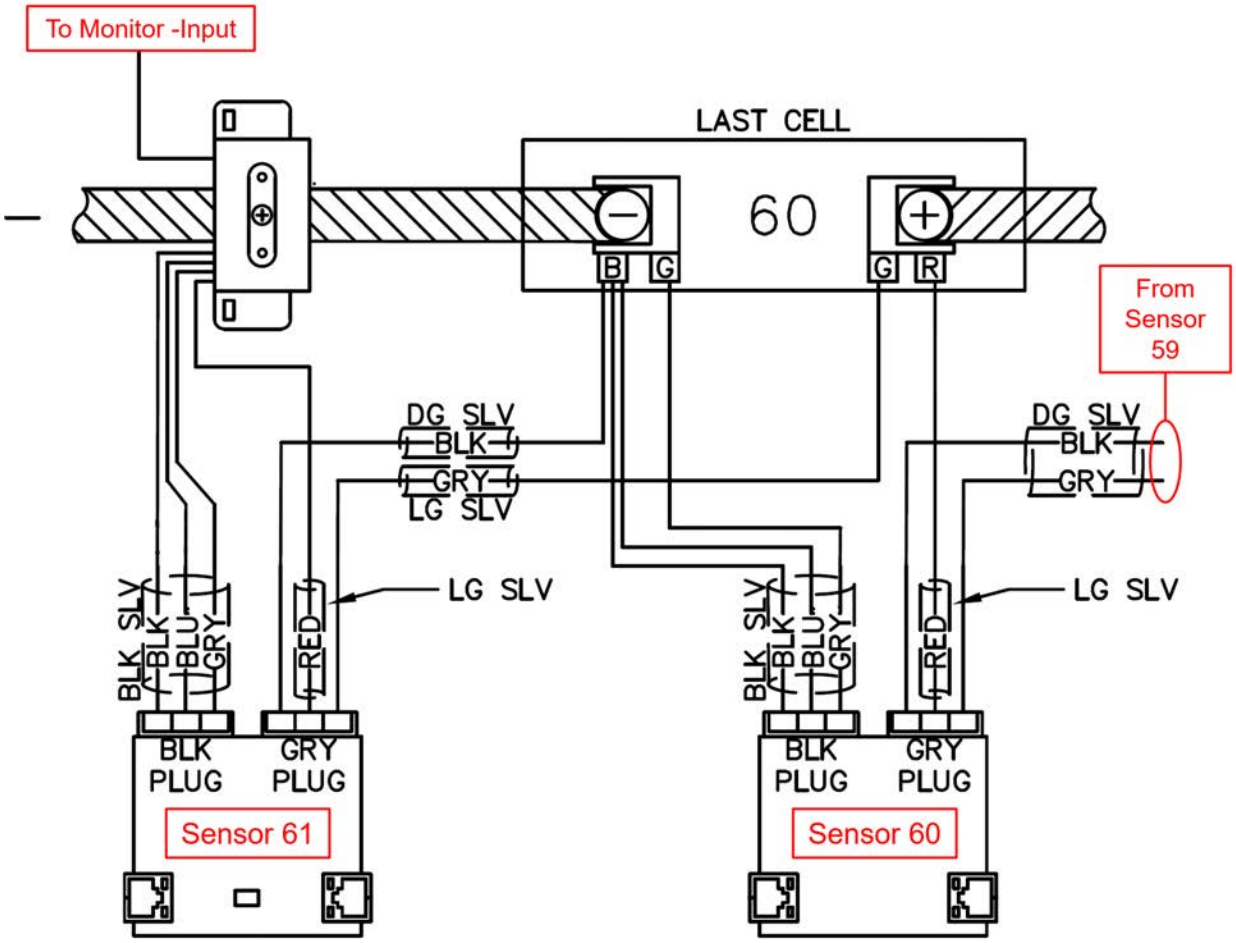
1. Starting with the **GRY IDC** from the second sensor, crimp the following wires in the order listed below:
    - Position 1: Crimp the **black sense wire** from **black sense connector** installed on the negative post of the previous cell.
    - Position 2: Crimp the **red sense wire** from the **red sense connector** installed on the positive post.
    - Position 3: Crimp the **gray pulse wire** from the **gray pulse connector** installed on the negative post of the previous cell.
2. Moving on to the **BLK IDC** from the second sensor, crimp the following wires in the order listed below:
    - Position 1: Crimp either of the **black sense wires** from the **black sense connector** installed on the negative post.
    - Position 2: Crimp the **blue sense wire** from **black sense connector** installed on the negative post.
    - Position 3: Crimp either of the gray pulse wires from the **gray pulse connector** installed on the negative post.
3. As mentioned in 8.2, **do not plug the sensor IDC connectors into the sensors yet**. This is done during the commissioning process.
4. Repeat this process for every sensor up to the last sensor. The sequence of wiring from sensor to sensor should look like below.



9.5 Negative Cable Clamp & Last Sensor

The last sensor has the most unique connection to the battery and is incorporated with the negative cable clamp. Note below that one of the gray pulse wires will not be used and should be cut.

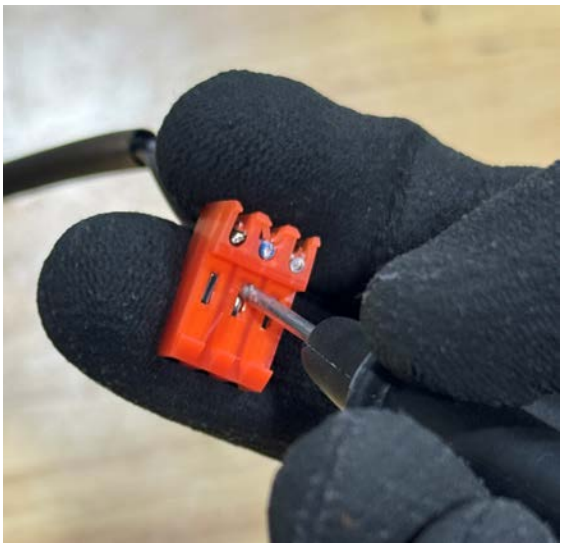
1. Starting with the **GRY IDC** from the last sensor, crimp the following wires in the order listed below:
    - Position 1: Crimp the **black sense wire** from **black sense connector** installed on the negative post of the previous cell.
    - Position 2: Crimp the **red sense wire** from the **negative cable clamp** installed on the charger cable.
    - Position 3: Crimp the **gray pulse wire** from the **gray pulse connector** installed on the positive post of the previous cell.
        - ***NOTE:*** *This gray wire is the* ***special tab harness*** *that is installed on the last positive post. Normally this connection would use the gray wire from the gray pulse connector installed on the negative post of the previous cell. For the last sensor, that extra gray wire is not used and should be cut off.*
2. Moving on to the **BLK IDC** from the last sensor, crimp the following wires in the order listed below:
    - Position 1: Crimp the **black sense wire** from the **negative cable clamp** installed on the charger cable.
    - Position 2: Crimp the **blue sense wire** from the **negative cable clamp** installed on the charger cable.
    - Position 3: Crimp the **gray pulse wire** from the **negative cable clamp** installed on the charger cable.
3. When completed, the wiring should look like shown below.



10.0 Test Connections

At this point all connections between the Vigilant and the battery system should be made. Now the connections need to be verified using a calibrated multimeter. There are a few points to understand before proceeding:

1. Various resistance values are referenced below. Always check the resistance of the multimeter leads before confirming these measurements.
2. For any measurement at the IDC connector, the test lead should make contact with the exposed pins on the front of the connector as shown below. Further steps will not make this clarification.



2. All stated measurements assume the meter reads 0 ohms when the leads are shorted together. If not, subtract the value of the leads from the measurements. For example, if the measured resistance should be less than 0.15 ohms, but the meter leads read 0.1 ohms when shorted, a measured value of 0.2 would be acceptable.

10.1 Test Cable Clamp Connections

The cable clamps were installed in Section 7.0. This section will use a meter to check that the connections are within the specified range. **NOTE: Before testing any cable clamp connections, ensure the monitor is powered off and the input power connections are unplugged.**

1. On both clamps, check the resistance between the two grub screws on the clamp - it should be **less than 0.15 Ω**.

2. On the positive cable clamp:
    - Both grub screws to the gray wire - **less than 0.15 Ω**
    - Both grub screws to the black wire - **less than 0.15 Ω**
3. On the negative cable clamp:
    - Both grub screws to the gray wire - **less than 0.15 Ω**
    - Both grub screws to the blue wire - **approximately 8-12 kΩ**
    - Both grub screws to the black wire - **less than 0.15 Ω**

10.2 Test Sensor IDC Connections

The steps here are similar to the above, except all measurements will be between the sensor IDC and the battery post the wire is connected to. For each sensor, test the following:

1. On the left IDC with the black-sleeved cable (all these wires are connected to the same cell/unit the sensor is on):
    - Negative post to the gray wire - **less than 0.15 Ω**
    - Negative post to the blue wire - **approximately 8=12 kΩ**
    - Negative post to the gray wire - **less than 0.15 Ω**

2. On the right IDC with the gray-sleeved cable (the gray and black wire are connected to the negative post of the previous cell/unit):
    - Negative post to the gray wire - **less than 0.15 Ω**
    - Positive post to the red wire - **less than 0.15 Ω**
    - Negative post to the black wire - **less than 0.15 Ω**

11.0 Make Longer Cable Runs

The installation requires a number of longer cables to be made. How many depending on the battery rack layout. At a minimum, longer RJ12 cables will be required between the first and last sensor to the monitor.

Parts & Tools Needed

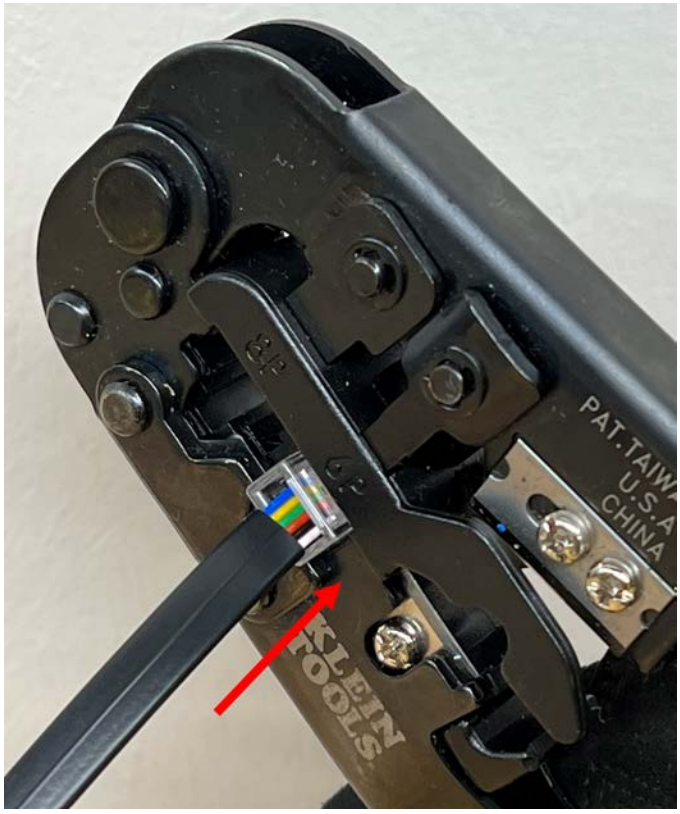
Part/Tool	Use	Where to Find
RJ12 Cable	Sensor power and communications	Not provided
RJ12 Connectors	Sensor power and communications	Not provided
RJ12 Crimper	Crimp RJ12 cables to connectors	Not provided

11.1 How to Use RJ12 Crimp Tool

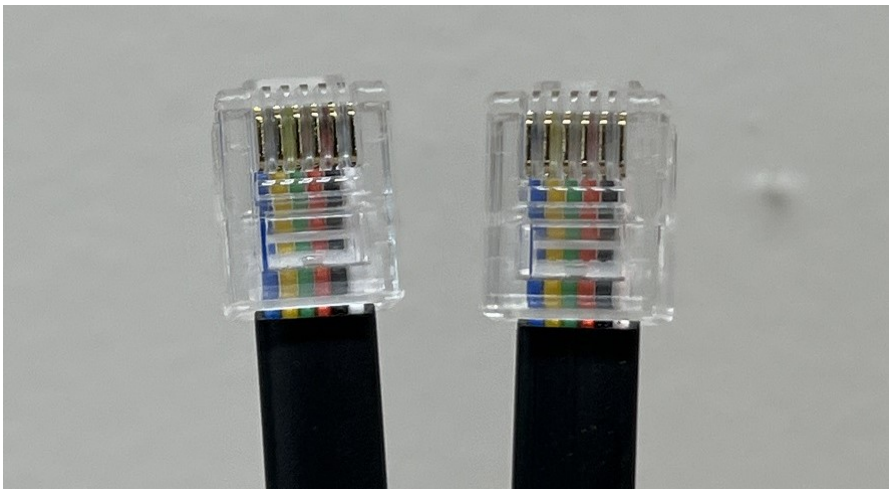
The steps in this section will rely on crimping custom length RJ12 cables.

1. With the crimp tool in hand, strip back cable to expose the 6 colored wires.

2. Insert the RJ12 connector into the "6P" slot on crimp tool, then insert the cable into the connector.



3. Take note of the orientation of the colored wires. The next crimp must be done in the exact same orientation. **Failure to crimp the cable correctly can result in damaged sensors and/or the monitor.**
4. After crimping, hold both connectors side by side, the wires should be in the same orientation on each connector (e.g., both blue wires on the left like below).



11.2 Monitor to Sensors

This step will cover making the longer RJ12 cables between the monitor and sensors.

1. Route the first cable from the monitor to the first sensor and cut to length. Cables should be secured along their route using cable ties.
2. Route the second cable from the monitor to the last sensor and cut to length.
3. With the cables cut to length, crimp the RJ12 connectors to both ends.

4. Connect the first cable to the leftmost RJ12 port on the monitor, then route the cable to the sensor and connect it.
5. Connect the second cable to the next RJ12 port on the monitor, then route the cable to the last sensor, but leave it disconnected.
6. When completed, both cables should be connected to the monitor and routed to the sensors, secured with cable ties. Only the first sensor should be connected, with the last sensor disconnected.

11.3 Sensor to Sensor

Many battery racks are split into tiers and/or steps. In this case, the provided 1 ft RJ12 cable with each sensor may not be long enough. Custom cables will need to be made.

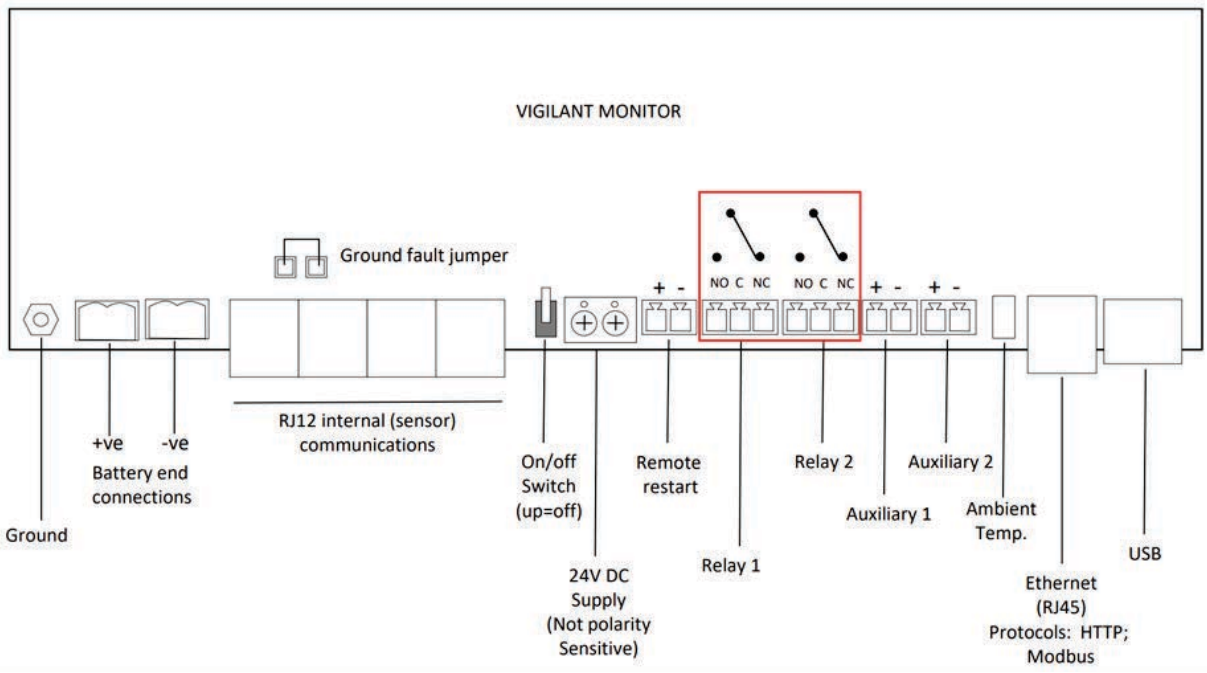
1. Route the cable from the first sensor to the next sensor to determine the length.
2. Follow the steps above to crimp the cables the same way.
3. Plug the made cable into the first sensor, then route the cable to the next sensor securing it with cable ties.
4. Leave the cable unplugged at the next sensor.

When all the longer cable runs are made, the system should be left with only the RJ12 cable from the monitor to the first sensor connected. All other RJ12 cables should only be connected on one end.

12.0 Connect Alarm Relays

The VIGILANT has (2) dry contact alarms on the monitor as shown below.

- **Relay 1**: Critical Battery Alarm
- **Relay 2**: Watchdog Alarm



For both relays, the maximum power rating is 300 watts, not to be exceeded. If the breaking voltage is 300V then the breaking capacity could be as high as 1A.

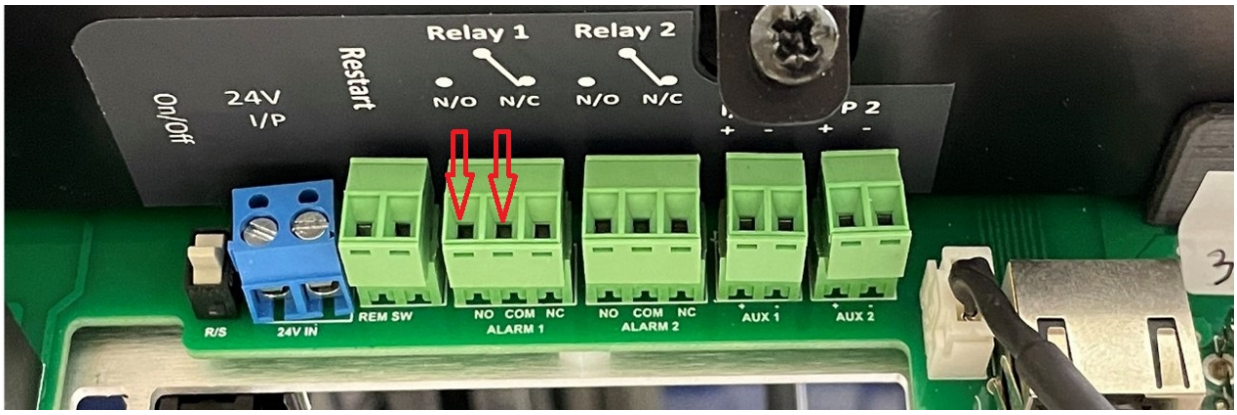
12.1 Relay 1 - Critical Battery Alarm

Relay 1 is assigned to alarm should any critical battery alarm occur. Below are the parameters which can trigger this alarm:

- Critical battery voltage (high or low)
- Critical cell voltage (high or low)
- Critical post temperature (high or low)
- Critical cell resistance
- Critical connection resistance (high or low)
- Battery continuity (open circuit)
- Loss of sensor communications
- Switch off voltage
- Electrolyte level low (measured by ELM)
- Battery case temperature (measured by ELM)
- Ground fault

When the relay in alarm, the Battery Alarm LED on the monitor will turn red. The relay and LED should clear immediately after an alarm has cleared in the web-interface.

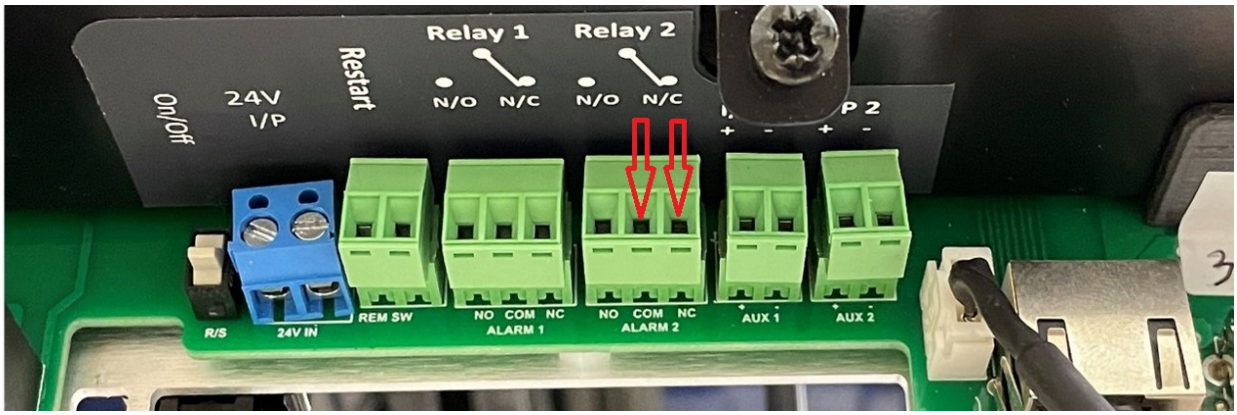
Relay 1 is **Normally Open**, so wire the alarm cabling to NO and C.



12.2 Relay 2 - Watchdog Alarm

Relay 2 is energized by the watchdog timer when the system is powered on. This relay will go into alarm if there is no communication over the sensor bus. This could occur if the system is powered off, reset, or there is some type of internal failure with the CPU.

Relay 2 is **Normally Closed**, so wire the alarm cabling to NC and C.



***NOTE**: It is not currently possible to parallel the wiring between Relay 1 and 2.*

13.0 Post Installation Checklist

When all the steps up to this point are completed, the system should be in a state that is ready for start-up and commissioning. Prior to proceeding with start-up, final checks should be made to ensure the system is installed correctly. A copy of this checklist will be provided in the Installation Form.

VIGILANT Monitor

- [x] Mounted securely with DIN rail clip locked
- [x] Ambient temperature sensor plugged in and secured near the monitor
- [x] Both power connectors disconnected
- [x] Voltage at power connectors verified
- [x] Power switch in the OFF position (pointed up)
- [x] Only the RJ12 cable from the monitor to the first sensor is plugged in (additional RJ should be disconnected)
- [x] Alarm relays wired correctly

VIGILANT Sensors

- [x] All sensors securely mounted and in the cradles
- [x] Only the first sensor RJ12 cable is connected to the monitor
- [x] The RJ12 cables for all other sensors are connected to only one side of the sensor
- [x] Both the BLK and GRY IDCs are disconnected from each sensor

ELM Sensors (if used)

- [x] Cradles are securely mounted to each cell and do not pull off if tugged
- [x] The point of the lower arrow on the cradle is aligned with the top of the minimum line
- [x] There are no obstructions between the sensor and the battery jar such as battery labels, debris, etc.
- [x] The ELM ribbon cable is connected to the VIGILANT sensor

System Wiring

- [x] Input voltage wiring between the cable clamps and monitor is managed and secured

- [x] All harness wires are terminated to the sensor IDCs correctly
- [x] All harness wires are routed and managed neatly for a clean look
- [x] Any wiring between battery racks/steps/tiers is managed and secured