

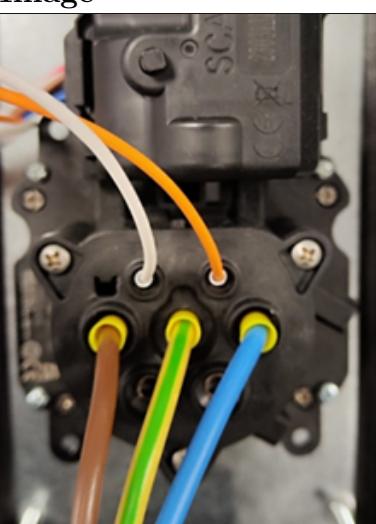
Image Acquisition Protocol for Anomaly Detection in Assembled EV Charging Station

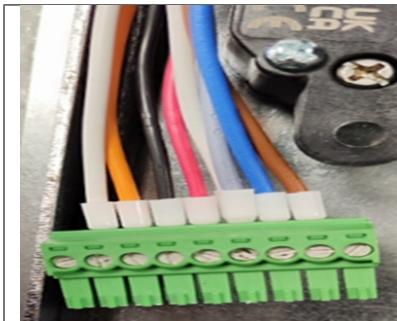
1 Objective

The objective of this protocol is to acquire high-quality images of an assembled EV charging station for anomaly detection. The dataset will be used to build an anomaly detection model to identify and classify defects and irregularities in the charging station components.

2 Possible Anomalies with Remarks and Doubts

As a driver for the acquisition protocol, we have considered several possible defects, reported in a list below. The final list of chosen defects will be reported in a separate file (`error_code_key_for_anomalies.pdf`) for better clarity.

Image	Description, Remarks, and Doubts
	<p>Socket side wiring: Check the correct connection through the color of the cables. Remarks: Can be seen clearly with the naked eye. Doubt: Will the color configuration be the same for all products and both ports in the same product?</p>



Signal side wiring: Correct connection is verified through color identification.

NOTE: At pin 4, the gray wire may sometimes be white. Since two wires are inserted into the pin and cannot be changed (supplier preassembled), the wire at pin 8 (white) may be replaced with pink or purple.

Remarks: Small in size, present on the bottom PCB and not clearly visible with the naked eye.

Doubt: Should this anomaly be considered by adjusting positioning or viewing from the side?



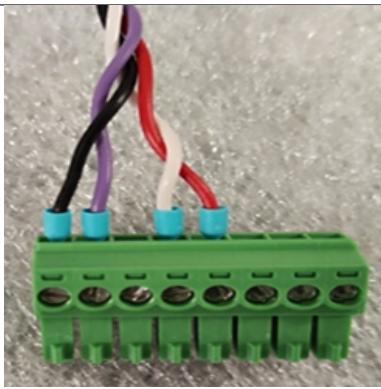
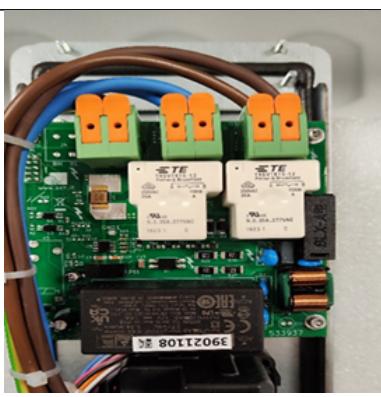
Check the correct insertion of the PINs in the connector (colors and position).

Remarks and Doubts: Same as previous.



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	<p>Check the correct insertion of the PINs in the connector (colors and position).</p> <p>Remarks and Doubts: Same as previous.</p>
	<p>Example of power card connection: The objective is to visually inspect both the input and output lines.</p> <p>Remarks: Can be seen clearly with the naked eye.</p>
	<p>Check the correct positioning of wiring and connectors on the board side.</p> <p>Remarks: Present upside down, with the view obstructed by the panel. Cannot be seen clearly even from the side.</p> <p>Doubt: How can this region be captured given the tight space constraints?</p>

	<p>Example of missing connection on driver board 2.</p> <p>Remarks and Doubts: Same as previous.</p>
	<p>Presence of labels.</p> <p>Remarks: Easily noticeable with the naked eye.</p>
	<p>Presence of a rubber ring on corner screws.</p> <p>Remarks: Easily noticeable with the naked eye. Sometimes obstructed by wires, especially in the top left corner.</p>
	<p>Number and color of cables passing through the current sensor.</p> <p>Remarks: Visibility is heavily obstructed by other wires on top.</p>



Presence of conformal coating on boards.

Remarks: Slightly obstructed by wires, but most parts are visible with the naked eye.

3 Equipment and Setup

3.1 Camera System

- **Cameras:** Two high-resolution **Intel RealSense Depth Camera D435i**, equipped with stereo and depth sensors.
- **Resolution & Format:** Images captured at **1920 × 1080** resolution in **PNG** format to retain fine details.

3.2 Lighting Setup

- Controlled artificial lighting to minimize shadows and reflections.
- Adjustable lighting positions to capture optimal details from different perspectives.

3.3 Environmental Setup

- **Enclosure:** Custom **closed-box setup** with a **reflective silver coating** for consistent illumination.
- **Base Surface:** **Black-colored base** to minimize reflections directly hitting the camera.
- **Object Placement:** The charging station object will be placed securely on a **black board with pores** using pins for stabilization.

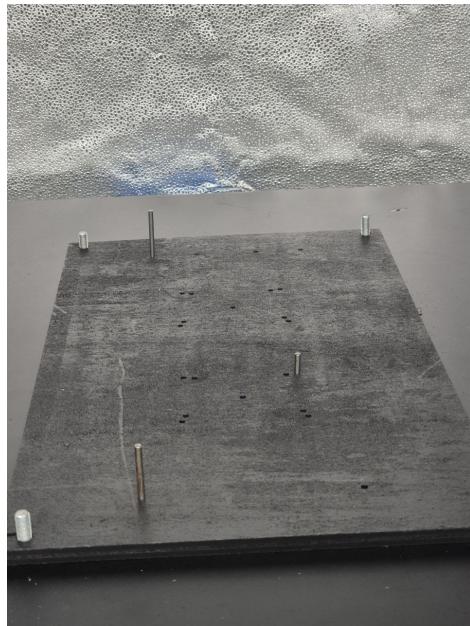


Figure 1: Black base with pores and pins setup

- Two long pins on the left corners.
- One medium pin at the right middle corner (near the second port of the circuit).

3.4 Camera Mounting & Positioning

- Custom-built adjustable camera stand with both horizontal and vertical adjustments.

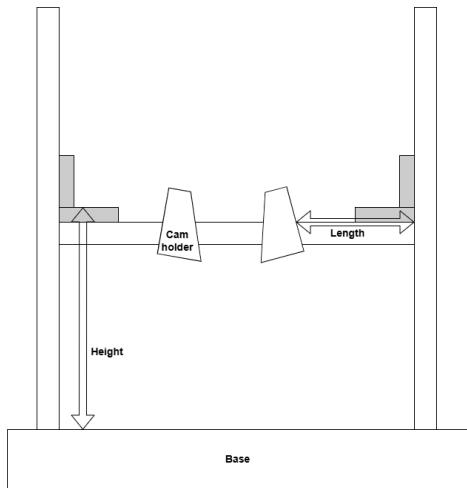


Figure 2: Camera stand measurement references

- * Angled perspectives with camera holder adjusted through different screw configurations for capturing **depth variations**(Figure 2).

4 Acquisition Conditions

4.1 Processing Configuration

- **Post-processing and auto-exposure:** Disabled to ensure unaltered raw image capture.
- **Configuration File:** Standardized settings using `config_default.json`.

4.2 Setup Variations

Several setups were tested to explore the best angles, lighting, and perspectives for capturing anomalies. The following setups have the same camera configuration taken from the simple metal panel dataset (`config_default.json`), and any changes are mentioned with new values and remarks.

4.2.1 Setup 1

- **Height of the stand:** 55.7 cm
- **Length from sides:** 25 cm

- **Lighting:** No manual lights
- **Remarks:** Similar to the anomaly detection setup used for panels. Right-side camera may clip part of the object.

4.2.2 Setup 2

- **Height of the stand:** 55.7 cm
- **Length from sides:** 19.5 cm
- **Lighting:** No manual lights
- **Remarks:** The entire object is fully visible without any clipping.

4.2.3 Setup 3

- **Height of the stand:** 55.7 cm
- **Length from sides:** 19.5 cm
- **Lighting:** Manual bottom and top lights, set between 2–3
- **Remarks:** Clear details visible from both cameras, including meshes and wire connections.

4.2.4 Setup 4

- **Height of the stand:** 55.7 cm
- **Length from sides:** 19.5 cm
- **Lighting:** Manual bottom and top lights, set between 2–3
- **Saturation:** Set to 70 in `config_default.json`
- **Remarks:** Wire colors appear more vivid, aiding in detecting logical anomalies like incorrect connections.

4.2.5 Setup 5

- **Height of the stand:** 64 cm, measured from the black base to the end of the l element, as shown in Fig. 2.
- **Length from sides:** 52.7 cm (right side only, measured from the right stand to the camera itself, not the camera holder)
- **Lighting:** Only manual bottom light set to 3
- **Saturation:** Set to 70 in `config_default.json`
- **Camera Holder:** Fixed with a bottom screw on the outer edge, facing the object vertically, from above. The camera holder part touching the camera is in direct contact with the metal bar.
- **Plastic white base** We used a plastic white base of 14/15 millimeters in height, in order to protect the object.
- **Remarks:** This top-down view provides a clear look at PCB boards and other components.

5 Conclusion

While some configurations might be useful for future acquisitions of specific defects, the final configuration chosen for the assembled panel dataset is number 5. We have reported examples of the object acquired with the different setups in Fig.

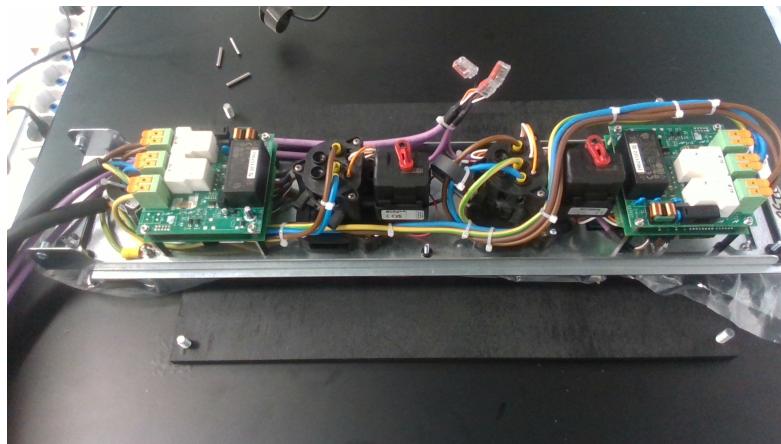


Figure 3: Image acquired with setup 1

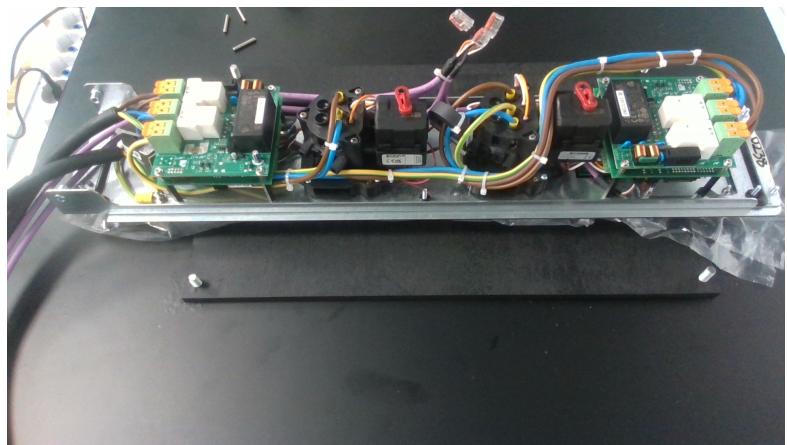


Figure 4: Image acquired with setup 2

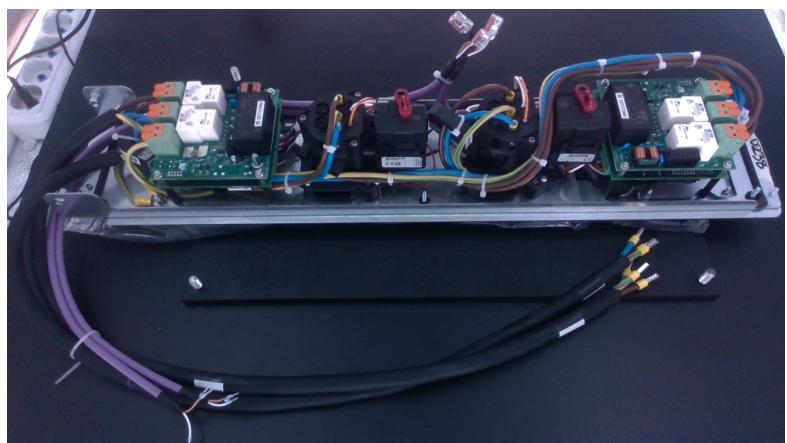


Figure 5: Image acquired with setup 3

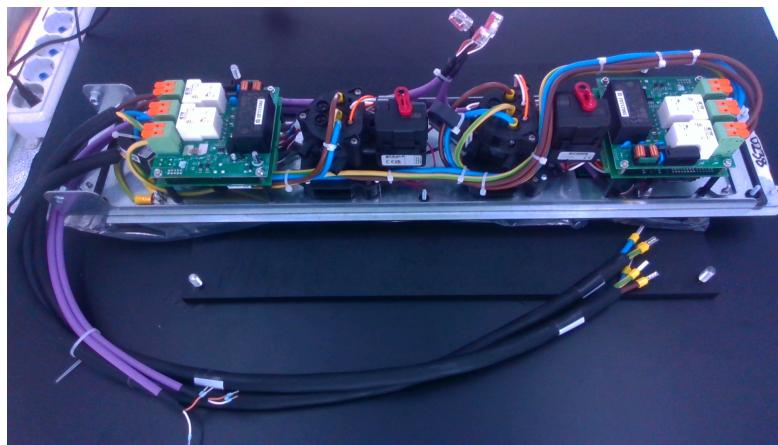


Figure 6: Image acquired with setup 4

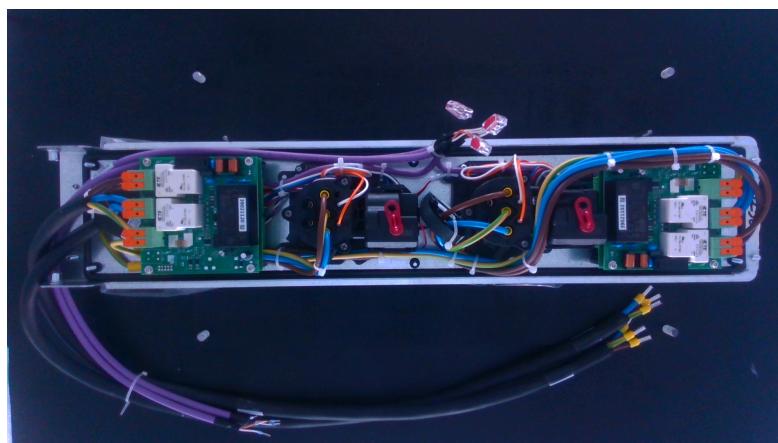


Figure 7: Image acquired with setup 5