Connect

Maintenance and Installation Manual

Interactive Digital Art Installation for Metro Carriages

Document type	Technical maintenance manual
Audience	Installation and maintenance technicians
Version	1.0
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Project	EPS@ISEP 2026 – Team 5
Scope	Transport, installation, checks, repair, and decommissioning

Prepared for technical staff responsible for installing, maintaining, troubleshooting, and removing the Connect system.

Contents

1 Purpose and Target Audience

Connect is an interactive digital art installation for metro carriages (see Figure 1). Passenger contact with a handrail activates a light response: colour appears at the grip point, travels up the pole, and merges with other colours on the ceiling LED strips.

This manual is for technicians who install, inspect, maintain, troubleshoot, or remove the system. It is not written for passengers, because passengers only need to touch the pole during normal use and require no operating instructions.

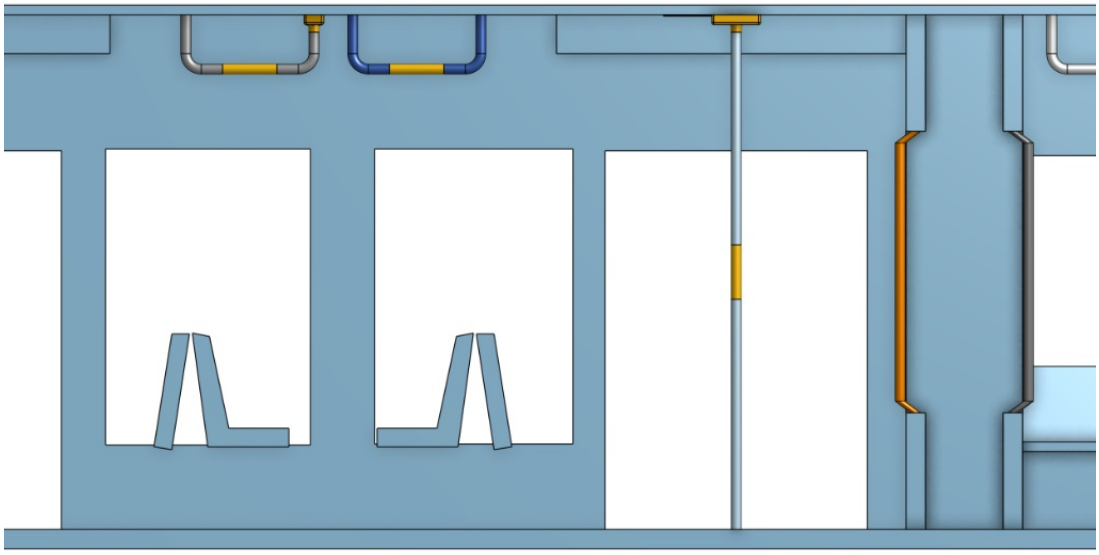

Figure 1: Overview of the installed Connect system, showing the carriage context for the handrail interaction zones.

2 System Summary

Table 1 summarises the subsystems that technicians must inspect, while Figure 2 shows the Velostat handrail-node schematic and how sensor, communication, power, and LED functions are connected.

Table 1: Summary of the main Connect subsystems and their maintenance relevance.

Subsystem	Description
Sensor nodes	ESP32-C3 Wemos C3 Mini boards read Velostat pressure-sensitive film mounted on handrail grip zones.
Communication	Nodes communicate with a master node through a linear CAN bus using MCP2551 transceivers.
Visual output	WS2813 addressable LED strips are mounted along poles and across the carriage ceiling.
Power	A 5 V DC supply powers nodes and LEDs. LED feeds must be fused and checked for voltage drop.
Enclosures	PLA node enclosures protect electronics and must not create sharp edges or passenger contact hazards.

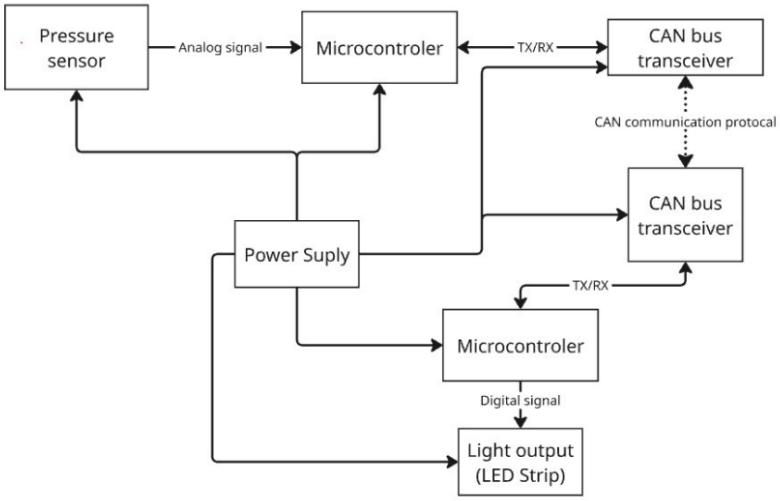

Figure 2: Black-box diagram of the Connect electrical and communication architecture, showing the pressure sensor, microcontroller, CAN bus interface, power supply, and LED output path.

2.1 Main Components per Carriage

Table 2 lists the principal components for one carriage installation.

Table 2: Main components required for one carriage installation.

Component	Typical part	Quantity	Function
Microcontroller	Wemos C3 Mini	6	5 sensor nodes + 1 master
CAN transceiver	MCP2551	6	CAN physical layer
Touch sensor	Velostat film	5	Handrail touch detection
LED strip	WS2813, 60 LED/m	6 m	Pole and ceiling light output
Power supply	5 V / 10 A DC	1	Main low-voltage power
CAN cable	22 AWG twisted pair	10 m	Node communication
Termination	120 Ω resistor	2	One at each CAN bus end

3 Safety Requirements

Warning: Only qualified personnel may work on the 230 V AC input side of the power supply. Lock out/tag out carriage power before opening enclosures, disconnecting harnesses, or replacing components.

- Keep all passenger-accessible parts below 5 V DC and fully enclosed.
- Never energise the LED strips before verifying the supply is between 4.75 V and 5.25 V.
- Do not allow sharp edges, loose covers, exposed wires, or protruding enclosures near passenger contact areas.
- Secure ceiling LED strips with adhesive and mechanical clips every 300 mm.
- Remove the system from service if there is overheating, smell, smoke, water ingress, unstable mounting, or repeated CAN errors.
- Before returning the carriage to service, close all enclosures and exit maintenance mode.

4 Installation Checklist

Complete the checklist in Table 3 before the first power-on; use Figure 3 to verify enclosure mounting dimensions and service access.

Table 3: Pre-power-on installation checklist for technicians.

Check	Done	Initials
Carriage out of service and lock out/tag out applied	☐	
All parts received and inspected for damage	☐	
Mounting drawing for carriage model available	☐	
Velostat strips installed on grip zones and covered safely	☐	
Node enclosures fixed securely with no sharp/protruding edges	☐	
CAN bus wired as a linear trunk, not a star	☐	
120 Ω termination installed at both CAN bus ends	☐	
LED strips bonded and mechanically clipped every 300 mm	☐	
5 V supply measured before LED connection	☐	
Firmware version checked on all nodes	☐	

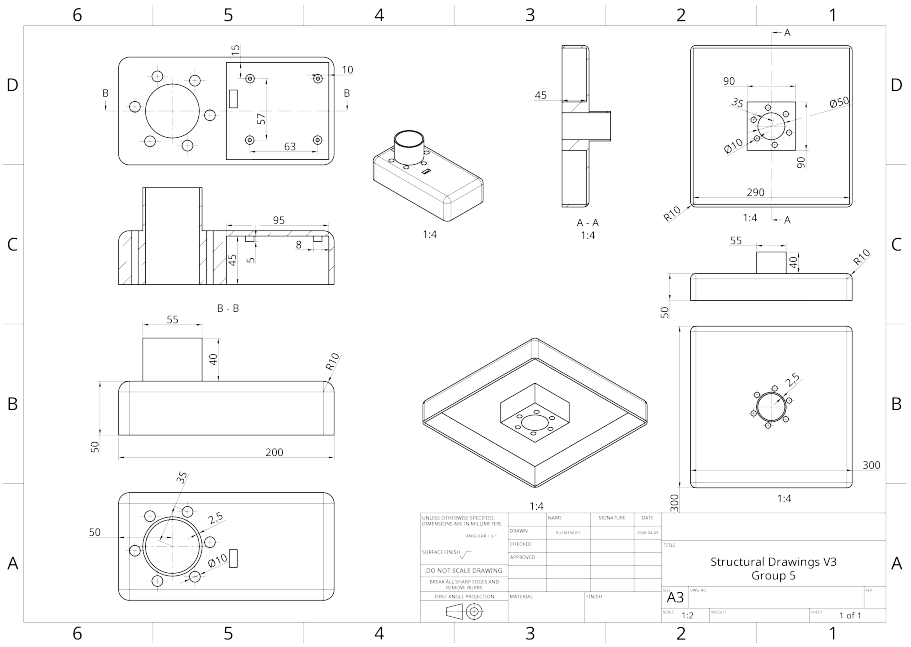

Figure 3: Mechanical drawing of the handrail node enclosure and mounting parts used during installation checks.

5 Installation Procedure

1. Prepare handrail sensors. Cut each Velostat strip to the required grip-zone size, attach the sensor leads, wrap it around the handrail, and cover it with heat-shrink or the approved protective sleeve. Do not leave conductive film exposed.

2. Mount node enclosures. Clean the mounting area with isopropyl alcohol, attach the enclosure using approved tape or screws, and route the sensor, CAN, and power wires through the cable gland.

Use the central-node schematic in Figure 4 as the reference layout for communication and power routing.

3. Wire the CAN bus. Connect Node 1 → Node 2 → Node 3 → Node 4 → Node 5 → Master. Use twisted pair, keep stubs below 100 mm, and place 120 Ω resistors at the two ends only.

4. Install LED strips. Clean pole and ceiling surfaces, cut WS2813 strips only at marked pads, bond strips with VHB tape, add clips every 300 mm, and connect data in the correct direction.

5. Connect power. Use a fused 5 V LED feed and a separate 5 V feed for nodes where possible. Use heavier wire for LED power runs than for signal wiring. Measure voltage at the far end of strips under test load.

6. Commission. Power on, confirm the master boot indication, open the maintenance dashboard, verify all nodes are online, test each handrail, and record node IDs and firmware versions.

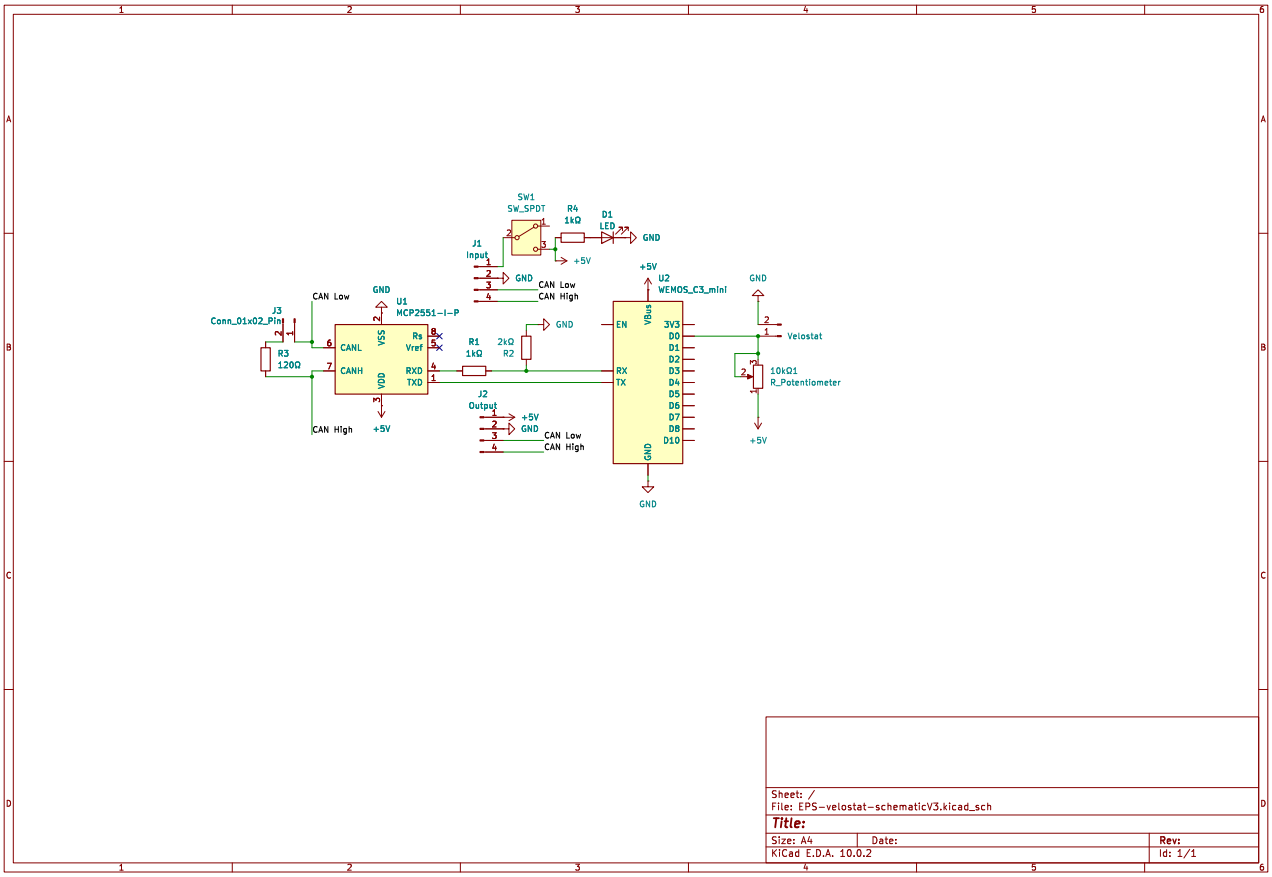

Figure 4: Central-node schematic used as the commissioning reference for CAN, power, and output wiring.

6 Routine Maintenance

Follow the schedule in Table 4 during depot checks.

Table 4: Routine maintenance schedule and expected acceptance criteria.

Interval	Task	Expected result
Daily	Visual check of LED strips, enclosures, and handrail surfaces	No loose parts, dark zones, or damage
Weekly	Touch-test each handrail	Correct colour response within 200 ms
Weekly	Inspect cable clips and visible conduit	No chafing, loose clips, or exposed wiring
Monthly	Run dashboard diagnostic	All nodes online; no persistent CAN errors
Monthly	Check Velostat sensor readings	Stable unloaded/pressed values
6 months	Check enclosure screws and LED clips	Secure, no vibration damage
Annually	Review firmware and wiring harness condition	Update only from approved release

7 Troubleshooting

Use Table 5 for first-line diagnosis and the Velostat-node schematic in Figure 5 when tracing the signal path.

Table 5: Common faults, likely causes, and first corrective actions.

Fault	Likely cause	Action
No LEDs respond	No 5 V, master not booted, CAN fault	Check PSU, master boot, and 60 Ω CAN resistance with power off.
One handrail inactive	Sensor fault, node offline, loose connector	Check dashboard node status, Velostat resistance, and node wiring.
LED strip partly dark	Damaged strip section or bad solder joint	Replace affected WS2813 segment at cut pads.
Intermittent nodes	CAN stub too long, loose cable, missing termination	Inspect bus topology, connectors, and end resistors.
System overheats or smells	Electrical fault or overloaded power feed	Disconnect power immediately and keep out of service.
Dashboard unavailable	Master not in maintenance mode or Wi-Fi issue	Connect USB serial and enable maintenance mode again.

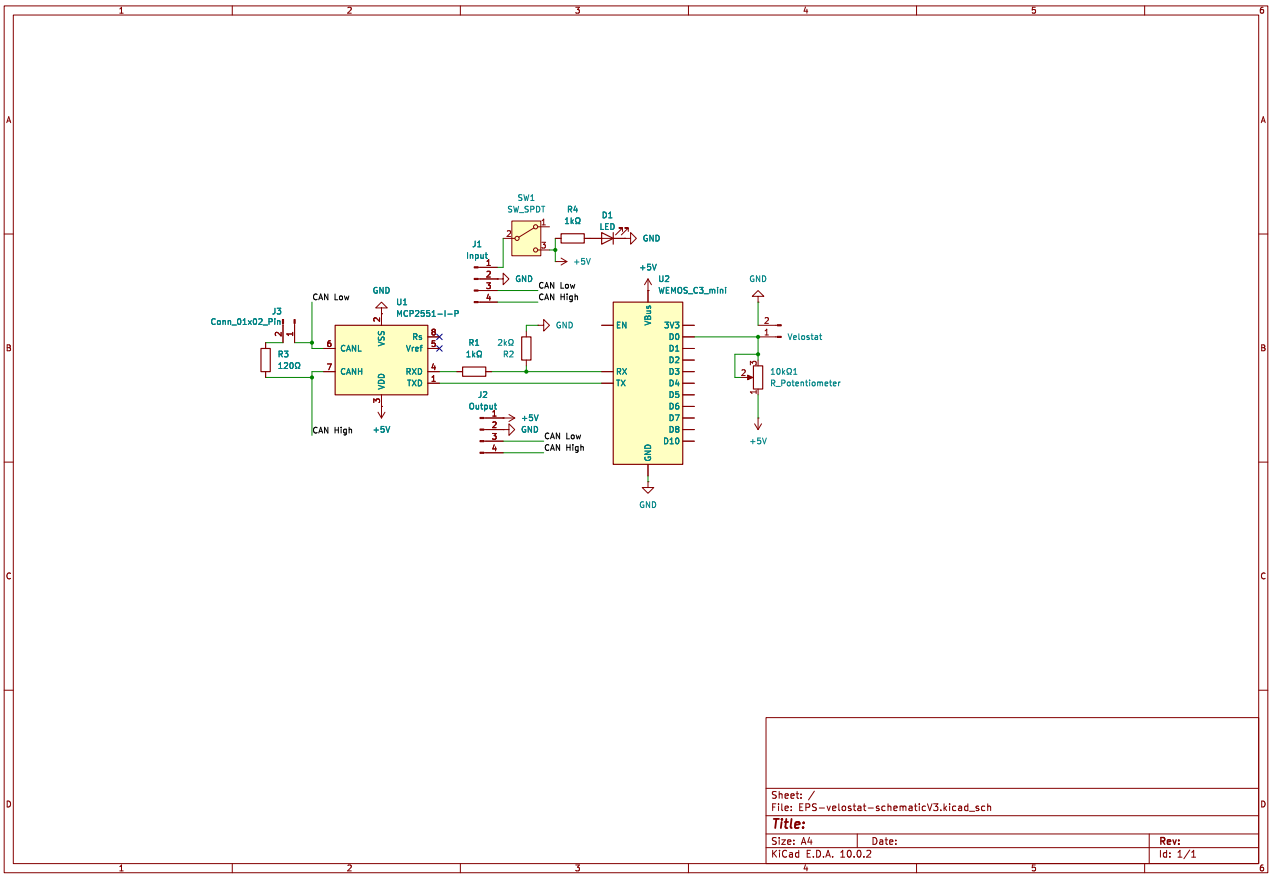

Figure 5: Detailed Velostat-node schematic used to trace diagnostic faults from the sensor input through the ESP32-C3 and CAN interface.

8 Component Replacement

Velostat sensor film: Power off the node, remove the protective sleeve, disconnect or desolder the old film, install a new film strip, cover it safely, and confirm touch response.

WS2813 LED segment: Power off LED feed, remove clips near the fault, warm adhesive gently if needed, cut at marked pads, solder in a matching replacement segment, re-bond, clip, and test.

Refer to Figure 6 before opening or replacing a node enclosure.

Wemos C3 Mini node: Power off the full 5 V system, photograph wiring, disconnect sensor, CAN, power, and LED connections, replace the module, flash approved firmware, reconnect, and commission the node.

MCP2551 CAN transceiver: Replace only if one node remains offline after wiring, firmware, and power checks. After replacement, verify CAN communication from the dashboard.

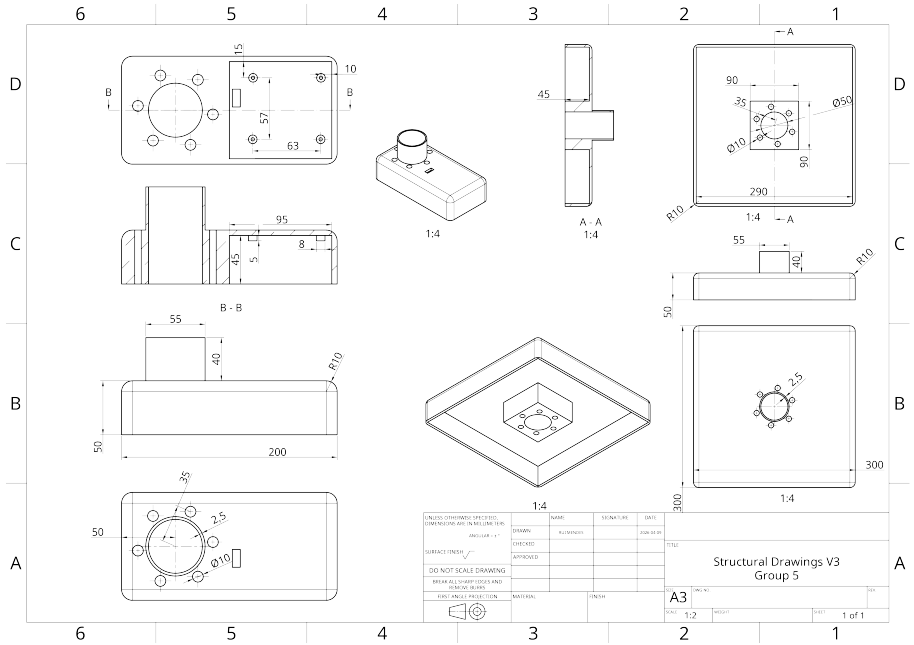

Figure 6: Serviceable sensor-node enclosure drawing used to identify mounting geometry, cable openings, and access points during replacement work.

9 Decommissioning and Records

To remove Connect from a carriage, take the carriage out of service, apply lock out/tag out, disconnect mains input by a qualified electrician, wait 60 seconds for the 5 V rail to discharge, then remove LED strips, clips, enclosures, wiring, and PSU. Clean adhesive residue and sort electronics for reuse, repair, or WEEE recycling.

Every service event must record: date, carriage ID, technician, service type, firmware version, node status, fault symptoms, parts replaced, action taken, and final system status. Table 6 provides a compact record format.

Table 6: Short maintenance record for service events and final system status.

Date / carriage	Technician	Action performed	Final status

10 Support Contacts

Use Table 7 for technical escalation and local depot follow-up.

Table 7: Support contacts for technical escalation and depot follow-up.

Role	Name	Contact
Project technical lead	EPS@ISEP Team 5	epsatisep@gmail.com
ISEP client contact	ISEP	mail@isep.ipp.pt / +351 22 834 0500
Depot maintenance manager	To be completed	To be completed