

# RailSentinel-24

Hardware v1.0 · **Design targets**

Control-power monitor and transient recorder for DC fast-charger cabinets

RailSentinel-24 (RS-24) mounts on the DIN rail inside a DC fast-charger cabinet and monitors the 24 V auxiliary supply that every relay driver, contactor coil and controller board depends on. It detects and records the inductive transients that reset controllers before they can write a log, timestamps them against a battery-backed clock, stores them locally, and reports them over Ethernet, WiFi or cellular — independently of the charger's own controller.

The measurement front-end sits on its own galvanically isolated domain, referenced to the rail; the ESP32 controller, storage and radios sit on the isolated secondary side. A phone tapped on the enclosure reads the last events over NFC without app, network or login.

**12–62 V**

DC rail range, one hardware variant for 12 / 24 / 48 V systems

**< 2  $\mu$ s**

hardware transient detection latency

 **$\pm 0.15$  V**

absolute rail-voltage accuracy after calibration

**5 kV<sub>RMS</sub>**

reinforced isolation, measurement to controller side

## POWER INPUT

|                           |                        |                                                           |
|---------------------------|------------------------|-----------------------------------------------------------|
| Supply source             | from monitored rail    | J_IN; no separate supply                                  |
| Nominal input             | 24 V DC                | 12 V and 48 V systems supported                           |
| Operating input           | 9 – 62 V DC            | 80 V rated buck converter                                 |
| Input protection          | TVS + reverse polarity | SMBJ60A-class clamp; P-FET reverse protection, indefinite |
| Board power               | < 0.5 W typ.           | WiFi active; ~1 W peak on transmit                        |
| Hold-up through rail dips | planned                | Supercapacitor hold-up scheduled for hardware v1.1        |

## RAIL MEASUREMENT

|                    |               |                                                   |
|--------------------|---------------|---------------------------------------------------|
| Voltage range      | 0 – 62 V      | 20-bit digital power monitor, direct bus sensing  |
| Voltage accuracy   | $\pm 0.15$ V  | absolute, after 3-point calibration               |
| Voltage resolution | < 1 mV        | 20-bit conversion                                 |
| Current range      | $\pm 3.2$ A   | full cabinet aux load, 50 m $\Omega$ Kelvin shunt |
| Trend sample rate  | up to 860 SPS | rail voltage and current                          |
| Ripple trending    | firmware      | rolling baseline, PSU-degradation indicator       |

## TRANSIENT CAPTURE

|                |                      |                                                             |
|----------------|----------------------|-------------------------------------------------------------|
| Detection      | hardware comparator  | < 2 $\mu$ s to interrupt, independent of firmware           |
| Threshold      | 20 – 60 V adaptive   | set from firmware, configurable per site                    |
| Peak amplitude | 16-bit, $\pm 0.5$ mV | analog peak-hold, digitised on the measurement side         |
| Event envelope | 50 ms window         | 0.3 – 1.2 ms/sample; sub- $\mu$ s waveform planned for v2.0 |
| Timestamp      | $\pm 2$ ppm RTC      | battery-backed (CR2032), valid offline                      |
| Local storage  | 16 MB flash          | $\geq 1,000$ -event ring buffer, survives power loss        |

## ISOLATION AND SAFETY

|                 |                                |                                                                              |
|-----------------|--------------------------------|------------------------------------------------------------------------------|
| Barrier         | 5 kV <sub>RMS</sub> reinforced | digital isolator between measurement (rail-referenced) and controller domain |
| Isolated supply | push-pull transformer          | 5 kV <sub>RMS</sub> rated                                                    |
| Service port    | isolated UART                  | touch-accessible port double-insulated from mains-derived circuits           |
| Function        | monitoring only                | RS-24 does not control, inhibit or switch any charger function               |

## CONNECTIVITY

|               |                  |                                                                |
|---------------|------------------|----------------------------------------------------------------|
| WiFi          | 802.11 b/g/n     | main board; external antenna (U.FL)                            |
| Ethernet      | 10/100, RJ45     | COM-ETH board                                                  |
| Cellular      | NB-IoT / LTE-M   | COM-LTE board (RS-24-F)                                        |
| Protocol      | MQTT, TLS        | telemetry, events, configuration                               |
| NFC           | ISO 14443 Type 2 | passive tag, works unpowered; external antenna on IP67 variant |
| Field service | UART, OTA        | signed firmware updates                                        |

## ENVIRONMENTAL AND MECHANICAL

|                       |                     |                                            |
|-----------------------|---------------------|--------------------------------------------|
| Operating temperature | –10 ... +70 °C      | cabinet interior                           |
| Storage temperature   | –20 ... +85 °C      |                                            |
| Humidity              | 5 – 95 % RH         | non-condensing                             |
| Main board            | 65 × 55 mm          | 4-layer; M3 grid 58.5 × 48.5 mm            |
| Expansion             | FFC, 14-pin 0.5 mm  | Sense-EXP and COM boards, removable        |
| Vibration / shock     | IEC 60068-2-6 / -27 | DIN-rail equipment profile (design target) |

## SENSING EXPANSION (SENSE-EXP, OPTIONAL)

|             |                       |                                                      |
|-------------|-----------------------|------------------------------------------------------|
| Temperature | 4 × NTC, $\pm 0.5$ °C | probe inputs, 1 kV fault-protected                   |
| Acoustic    | MEMS microphone       | 5-band signature per event; contactor and fan health |
| Vibration   | 3-axis MEMS           | fan / mechanical state                               |

|             |                                    |                                    |          |            |                      |
|-------------|------------------------------------|------------------------------------|----------|------------|----------------------|
| Correlation | vibration,<br>acoustic,<br>thermal | with Sense-EXP board, per<br>event | Main bus | clip-on CT | AC input correlation |
|-------------|------------------------------------|------------------------------------|----------|------------|----------------------|

VARIANTS

|                                                                                                                                         |                                                                                                                                               |                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| <div>RS-24-S</div> <div><b>Standard</b><br/>DIN-rail enclosure, IP40. Ethernet or WiFi. For managed sites. NFC on the front face.</div> | <div>RS-24-F</div> <div><b>Field</b><br/>IP67 enclosure, cellular. External NFC antenna through the lid. For remote and motorway sites.</div> | <div>RS-24-M</div> <div><b>OEM module</b><br/>Bare main board on standoffs for factory integration. REST API, signed OTA. Per-unit licence.</div> |
|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|

**Status.** Hardware v1.0 is in bench bring-up. All values are design targets from the hardware design documentation and are subject to change until validation is complete. The product is not yet CE marked and not commercially available; pilot units are supplied under a pilot agreement. Specifications will be replaced by measured values in Rev. 1.0 of this datasheet.

ORDERING AND CONFIGURATION

| CONFIGURATION    | BOARDS                       | ENCLOSURE      | CONNECTIVITY   | TYPICAL USE                                           |
|------------------|------------------------------|----------------|----------------|-------------------------------------------------------|
| RS-24-S Basic    | Main                         | DIN rail, IP40 | WiFi           | Service companies, single sites                       |
| RS-24-S Standard | Main + COM-ETH               | DIN rail, IP40 | Ethernet       | Managed CPO sites                                     |
| RS-24-S Full     | Main + Sense-EXP + COM-ETH   | DIN rail, IP40 | Ethernet       | Root-cause analysis, thermal and acoustic correlation |
| RS-24-F          | Main + COM-LTE (+ Sense-EXP) | IP67           | NB-IoT / LTE-M | Remote sites without network                          |
| RS-24-M          | Main (bare)                  | none           | any            | OEM factory integration                               |

Enclosures: Italtronic Modulbox XTS (DIN) and Bopla Bocube (IP67). COM-LTE and RS-485 boards follow the main board and COM-ETH in the release sequence.

INSTALLATION SUMMARY

|                          |                |                                                                                                     |
|--------------------------|----------------|-----------------------------------------------------------------------------------------------------|
| Mounting                 | 35 mm DIN rail | 6 M width; or M3 standoffs (RS-24-M)                                                                |
| Wiring                   | 2 wires        | J_IN from the 24 V rail; optional pass-through J_OUT for current measurement of the downstream load |
| Commissioning            | NFC / UART     | network credentials and thresholds set on first boot                                                |
| Probe cables (Sense-EXP) | ≤ 500 mm       | 300 V rated, 85 °C, flame retardant; route away from DC busbars                                     |
| Service port             | J2             | isolated; for commissioning and field flashing only                                                 |

DATA AND SOFTWARE

|             |                                         |                                                                           |
|-------------|-----------------------------------------|---------------------------------------------------------------------------|
| Telemetry   | every 5 s (configurable)                | rail voltage, current, temperatures, vibration, acoustic level, uptime    |
| Events      | on trigger                              | peak amplitude, duration, envelope, timestamp, correlated sensor snapshot |
| Dashboard   | web                                     | per-device trends, event log, fleet view; commissioning report (planned)  |
| Integration | MQTT, REST API                          | OEM data interface for RS-24-M                                            |
| Security    | TLS, per-device credentials, signed OTA | designed to Cyber Resilience Act requirements                             |

COMPLIANCE ROADMAP

|                          |              |                                                                                              |
|--------------------------|--------------|----------------------------------------------------------------------------------------------|
| CE (LVD, EMC, RED, RoHS) | planned      | pre-compliance testing scheduled; certification targeted 2027                                |
| Isolation                | IEC 62368-1  | reinforced barrier and isolated service port designed to \$5.4 double-insulation requirement |
| Cyber Resilience Act     | designed for | secure development, update capability, vulnerability handling                                |

REVISION HISTORY

|         |         |                                                                                                       |
|---------|---------|-------------------------------------------------------------------------------------------------------|
| Rev. P1 | 2026-09 | First preliminary release based on hardware v1.0 design documentation. All values are design targets. |
|---------|---------|-------------------------------------------------------------------------------------------------------|

**Contact.** Pilot and partnership enquiries: hello@morgen-tech.com · OEM integration: sales@morgen-tech.com · Documentation: info@morgen-tech.com. Detailed hardware design, sensing analysis and calibration documents are available to pilot partners under NDA.