

WHO WE ARE

Futures Tech BSN is engaged in the design and production of electronic materials, diagnostic tools, and monitoring equipment for the railway sector.

Continuous research and a strong commitment to improvement are the strengths of this young and forward-looking company – driving innovation, station after station.

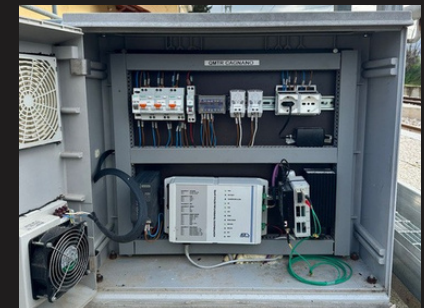
Our work is made possible thanks to our team: Giandomenico Buchagiar, CEO and Co-founder; Andrea De Gregorio, Commercial Director and Co-founder; and Spiro Buchagiar, Chief Operating Officer and Consultant, with over 30 years of experience in electronic materials for railway safety.

FIND US

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DP

Diagnostica del Deviatoio
(Railway Switch Diagnostics)

Operating Principles

For the interfacing of electronic diagnostic systems to the railway equipment of interest, it is necessary to interpose suitable signal conditioning units, for the sake of brevity indicated by the term “**diagnostic probes**” (**DP**). These electronic devices must consist of stages made expressly for non-intrusive interfacing with the railway equipment to be monitored.

The purpose of the diagnostic probes is to condition the electrical signals and make them available at their outputs for the subsequent analysis carried out through the data acquisition units (DAM) connected to them.

Types of Diagnostic Probes

1. Voltage and Current Measurement Probes

1.1 DC Voltage and Current Measurement
0–150 V (average, maximum, minimum, and ripple values).

1.2 AC Voltage and Current Measurement
0–400 V (RMS value, frequency, BMP, and duty cycle).

These probes are suitable for measuring track circuit codes as well as the various voltages and currents present in railway systems. Validation of the measured parameters and their correlation with other railway system parameters (REAM inputs, etc.) are performed at the remote monitoring station level.

2. Voltage and Current Measurement Probes with Operating Curve Generation

These probes are designed to analyze the operating behavior of railway point machines and level crossing barriers.

Curve diagnostics can be performed either locally (at probe level), with the generation of corresponding alarms, or remotely at the monitoring station level.

3. Interfaces for Local and Line Voltage Measurement with Phase Calculation and Disc Relay Torque Evaluation

These interfaces are designed for the analysis of the operating parameters of disc relays.

Validation of the measured parameters can be performed locally, with the generation of related alarms. In addition, parameter validation and correlation with other railway system parameters (REAM inputs, etc.) can be carried out at the remote monitoring station level.

Diagnostic Capability and Operational Reliability

Each probe must integrate self-diagnostic features able to detect internal malfunctions and transmit at least one specific alarm code in case of failure. When such a fault is detected, the device is automatically excluded from higher-level management systems, preventing the use of unreliable data.

This self-monitoring function enhances system reliability, ensuring that only healthy and validated sensors contribute to operational data processing.

Electrical Isolation and Protection Requirements

Probes and measuring devices must comply with electrical isolation requirements established by the relevant railway or industrial standards.

For example, the EN 50124-1 specification (as applied by the Italian Railway Network, RFI) defines insulation stress levels based on power supply characteristics and installation conditions. These parameters ensure equipment safety during use in railway signalling environments.

The minimum insulation resistance of any equipment must be at least 10 M Ω . When protective devices such as surge suppressors or ESP protectors are used between circuits and ground, the insulation resistance must remain no lower than 2 M Ω with the devices connected.

Dielectric strength and impulse withstand tests are carried out at specified voltage levels (50 Hz for dielectric tests and 1.2/50 μ s for impulse tests), depending on the rated insulation voltage and the type of equipment port. These requirements guarantee durability and operator safety under real-world electrical stress conditions.

Measurement Validation and Data Integrity

To ensure accuracy and consistency, every type of measurement must operate with a fixed minimum threshold value, expressed as a percentage of the full-scale range. This value — equal to twice the maximum permissible measurement error — enables the probe to start measurements autonomously (auto-trigger mode).

A measurement is considered valid only when its value remains stable over at least three consecutive samples. This validation approach, however, does not apply to continuous data acquisitions such as current or voltage curves.

For probes acquiring continuous data, the system must include a non-volatile memory buffer capable of storing at least the last ten acquisitions, ensuring reliable deferred transmission of data and continuous traceability.

Non-Intrusiveness and Signal Integrity

A fundamental design requirement for each probe is non-intrusiveness, meaning that its operation must not interfere with the normal functioning of the equipment under diagnosis.

Signal sampling must occur without altering the characteristics or safety performance of the system, both under normal and fault conditions. In particular, the probe must prevent:

- the application of unwanted voltages to safety equipment;
- the introduction of electromagnetic interference;
- the drawing of excessive current or alteration of impedance in coil supply circuits;
- short circuits on controlled power supplies;
- overcurrent in relay contacts under monitoring.

This ensures complete electrical neutrality of the probe, maintaining both operational integrity and system safety.

Technical Performance and Environmental Robustness

Probes must guarantee high precision and mechanical reliability, maintaining stable performance even in demanding railway environments.

Key requirements include:

- Accuracy: better than $\pm 2\%$ of full scale (Class 2) between $0\text{ }^{\circ}\text{C}$ and $+45\text{ }^{\circ}\text{C}$, and better than $\pm 3\%$ (Class 3) between $-25\text{ }^{\circ}\text{C}$ and $+70\text{ }^{\circ}\text{C}$.
- Input resilience: ability to withstand voltages or currents up to 300% of full scale for one minute.
- Adequate bandwidth, matched to the physical quantity being measured.
- Integrated Real-Time Clock (RTC) with accuracy better than $\pm 50\text{ ppm}$ over the entire temperature range.

- Digital output for improved precision and data consistency.
- Compliance with humidity, temperature, and mechanical stress specifications defined by the relevant railway operator.
- Tropicalized electronic boards, ensuring resistance to moisture and corrosion.
- For AC signal measurements, output values must be proportional to the true RMS of the measured signal.

These parameters guarantee both measurement fidelity and long-term resilience under operational stress.

Current Measurement and Digital Connectivity

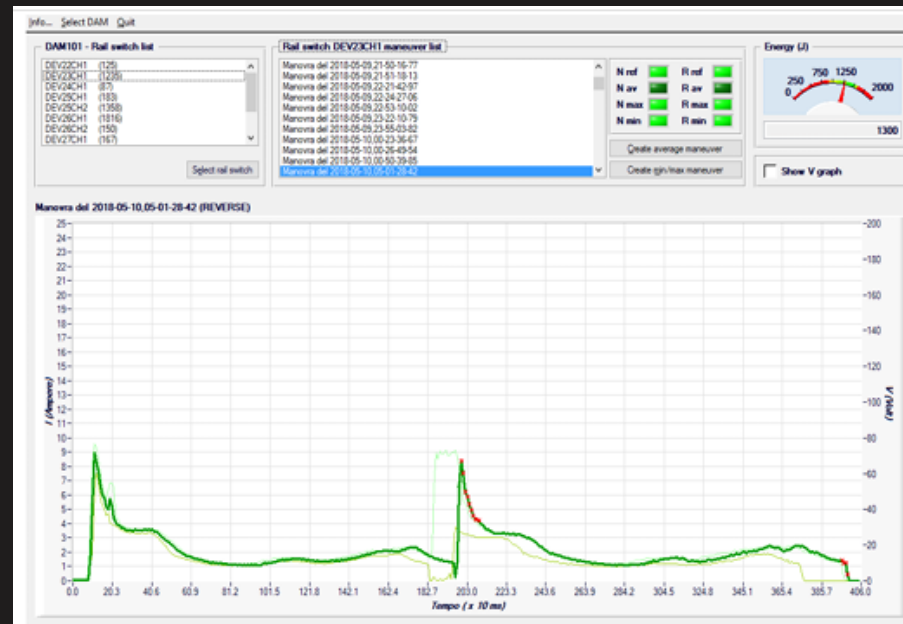
When current measurement is performed using shunt resistors, the shunt value must correspond to a voltage drop of 100 mV at the probe's full-scale current. This standardization ensures accuracy and interoperability across measurement devices.

Each probe features a two-wire CAN BUS digital output, shielded to reduce noise and designed for daisy-chain connection.

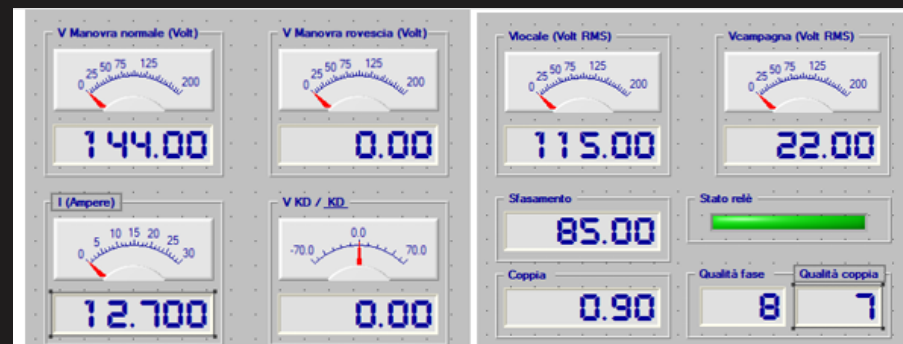
The connection system employs a male connector directly mounted on the probe PCB, with a corresponding flying connector to link multiple probes in sequence.

The first and last probes in the chain must include termination resistors for proper bus balancing.

This digital architecture enables fast, reliable data transfer and easy system integration, aligning with modern railway diagnostic platforms.



Example of the output of a probe for the railway switch control



Example of remote control of the electrical parameters of a railway switch and a disc relay

Curve Analysis with Machine Learning

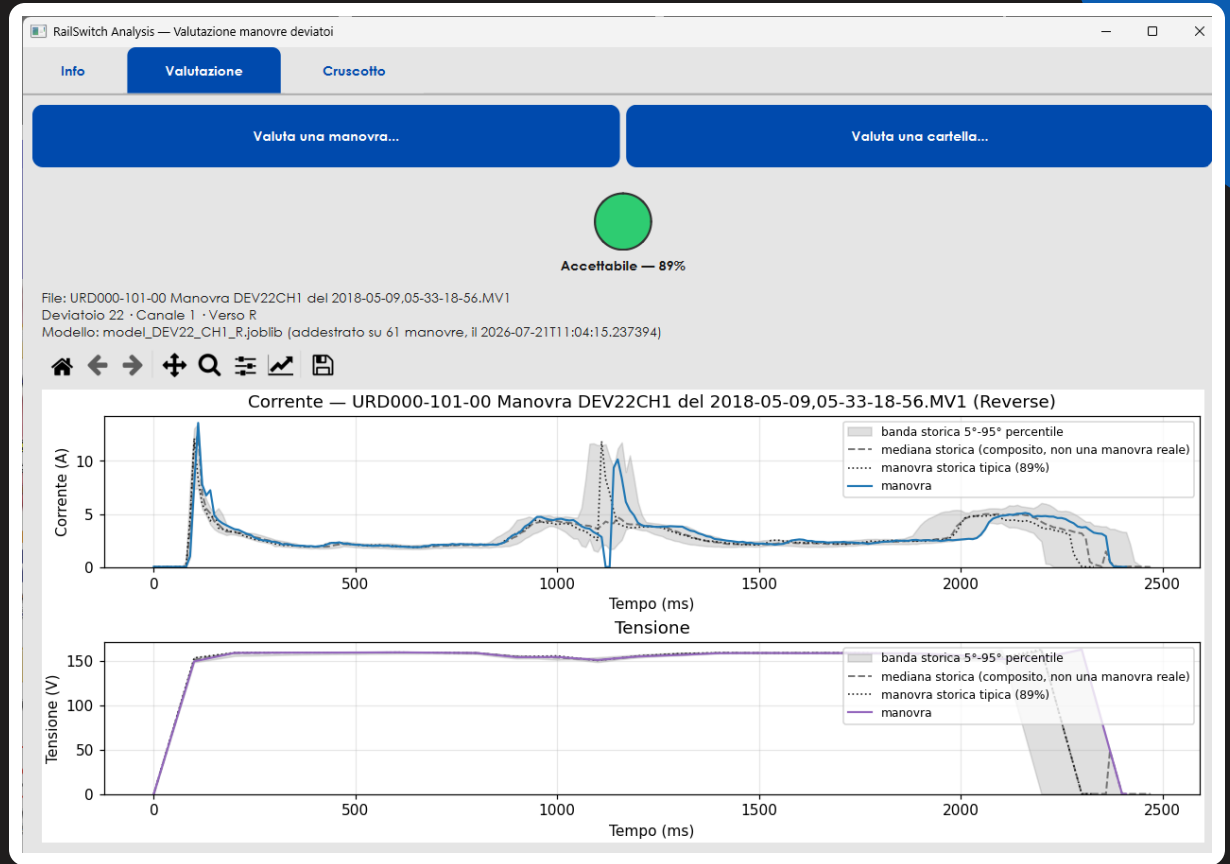
The switch operating curves collected by the probe can be analyzed using **Machine Learning** algorithms.

The software can assign an **acceptability grade** to the curve — or curves — of an individual railway switch, to check whether they are acceptable and, if not, **how far they deviate from the nominal curve**.

This makes it possible to detect any switch anomaly or degradation in advance and carry out **predictive maintenance**, avoiding traffic disruptions and saving both money and human resources.

- 1 **Curves**
collected by the probe at every operation
- 2 **Machine Learning**
comparison with the nominal curve
- 3 **Acceptability grade**
early detection of anomalies and degradation

STUDY IMAGE



Study image. Evaluation of a railway switch operation: the software compares the current and voltage curves with the historical band (5th–95th percentile) and the historical median, and returns an acceptability grade (in this example, “Acceptable — 89%”).