

# Energy Metering

## Train Energy Management System

TEMS – The Train Energy Management System is an integrated solution for energy, fuel measurement and eco-driving designed for energy saving and billing applications.

TEMS is a modular system. Each module shares the back-office component (DCS) in order to control the devices and manage all the measurements data.

The energy metering subsystem is compliant with the EN 50463 standard, TSI (Technical Specifications for Interoperability) and LOC&PAS (Locomotives and Passenger Rolling Stock of the Trans-European Rail System).

It guarantees a high level of accuracy and reliability and can be integrated with TCMS.

## System Overview

TEMS consists of on board and ground equipment.

The main on board subsystems are:

- A Railway Energy Meter/Railway Fuel Meter (REM/RFM) for train energy consumption and train fuel consumption metering. It includes a specific sensor for each type of train, interfaces to both on board TCMS and ground Data Collecting Service.
- A Train Eco Driver Advisory System (T-EDAS) that provides information to the train driver to reduce the energy/fuel consumption whilst keeping to the working timetable.
- A Traction Protection System (TPS) that monitors the high voltage line in real time in order to protect the traction equipment from over-voltages, over-currents and harmonics.

The ground systems (DCS) permit the storage and analysis of measured data, useful for different stakeholders: Train Operator, Infrastructure Manager, Energy Settlement System Manager.

## Data Collecting Service – TEMS Energy Portal

TEMS Energy Portal is a Data Collecting Service developed in collaboration with railway energy managers. The main feature is a central database which allows the different stakeholders to transform raw data into relevant information. Based on this data, decisions can be made to improve energy management, allocate costs and reduce energy consumption.

TEMS Energy Portal is a web application that collects data from any kind of measurement device, validates collected data using an extendable set of rules and automates operative procedures, such as threshold monitoring, energy model executions, report distributions, remote control and billing.

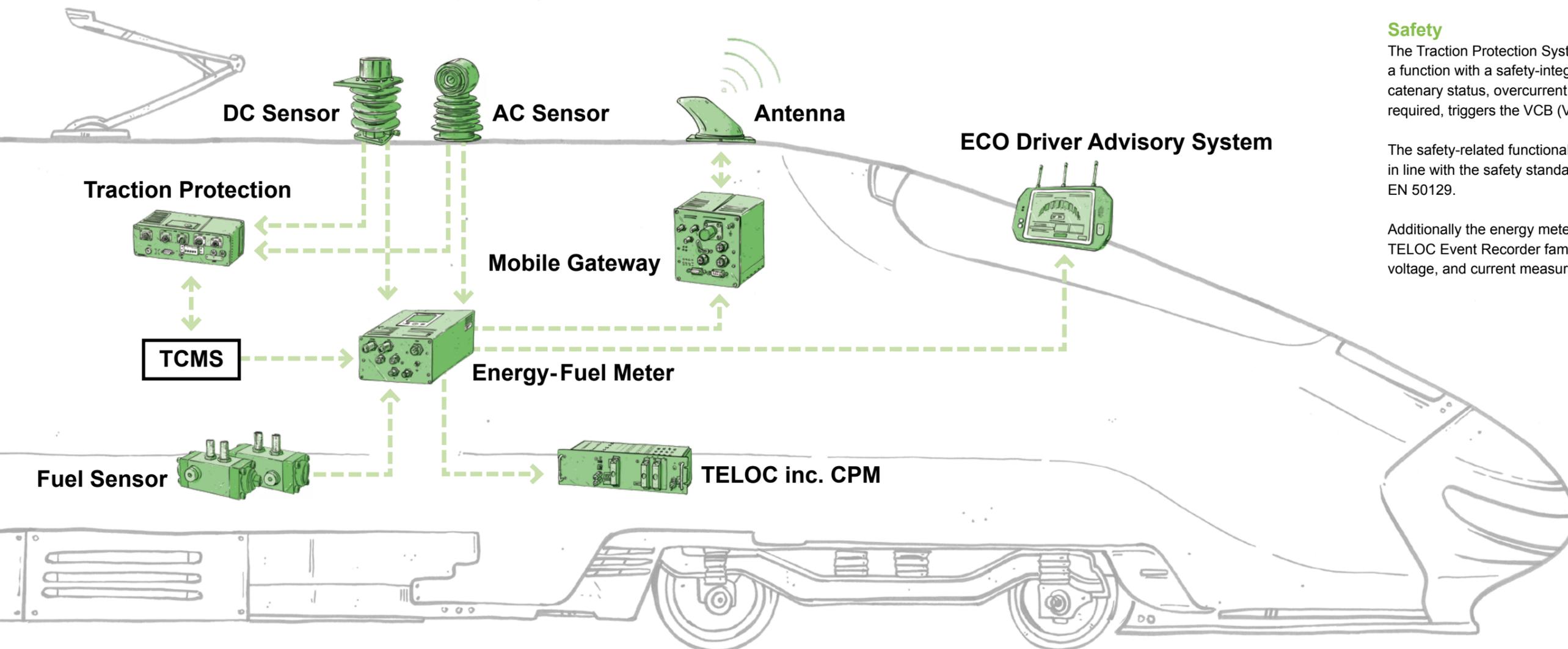


## Safety

The Traction Protection System of TEMS includes a function with a safety-integrity-level SIL2. It detects catenary status, overcurrent and harmonics, and if required, triggers the VCB (Vacuum Circuit Breaker).

The safety-related functionality has been implemented in line with the safety standards EN 50126, EN 50128 and EN 50129.

Additionally the energy meter can interface with the TELOC Event Recorder family and stores energy, voltage, and current measurement data in real time.





### AC/DC Sensors

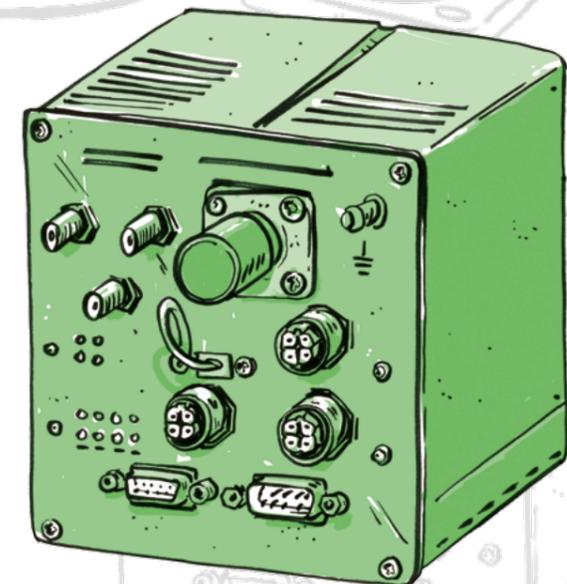
A wide range of rugged AC/DC voltage and current transducers are available depending upon the train class and catenary systems. The accuracy class of all sensors is 0.5R in accordance with EN 50463. The Current and Voltage Measurement Functions (CMF, VMF) can be integrated in one single device for space and weight saving. Transducers with double output are also available to be used for traction interface as well as for energy measurements.

### Mobile Gateway

The communication gateway can be integrated into the REM energy meter or it can be standalone. It permits the bi-directional communication between on-board train devices and ground stations/servers. Available communication interfaces:

- Ethernet/MVB ports for onboard systems (TCMS)
- GSM-R/GPRS/EDGE
- UMTS/HSDPA/LTE
- Wi-Fi for hot-spot depot links
- GPS

Services: FTP, SSH, SNMP agent, SMS alert.  
EN 50155 and IEC 61375-2-6 compliant.  
Power supply: 24/36 /72/110 VDC.

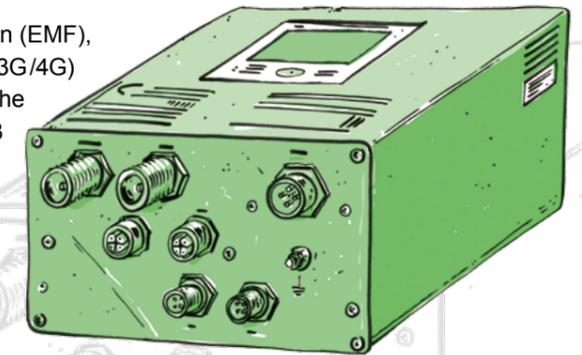


### Energy and Fuel Meter

REM102 is a device that combines an Energy Metering Function (EMF), a Data Handling System (DHS), a Communication Unit (GSM-R/3G/4G) and a Global Positioning System (GPS) in a single unit. It was the first one certified by a Railway Notified Body according to EN50463 and is widely used in Europe by several Train-operators and approved for billing by Eress. It is capable of measuring the energy consumed and regenerated by trains with an accuracy of Class 0.5R or better. The energy data is time-integrated based on a reference period which is selectable and stored on the device internal memory for at least 60 days. The internal GPS receiver allows location, date and time data to be correlated with stored energy data. Energy Data can be shared with TCMS including real time voltage, current and power readings. The meter is remotely controlled to perform:

- Energy analysis
- Software upload
- Diagnostics

Additionally, REM102 can be interfaced with a wide range of sensors already installed on the train.

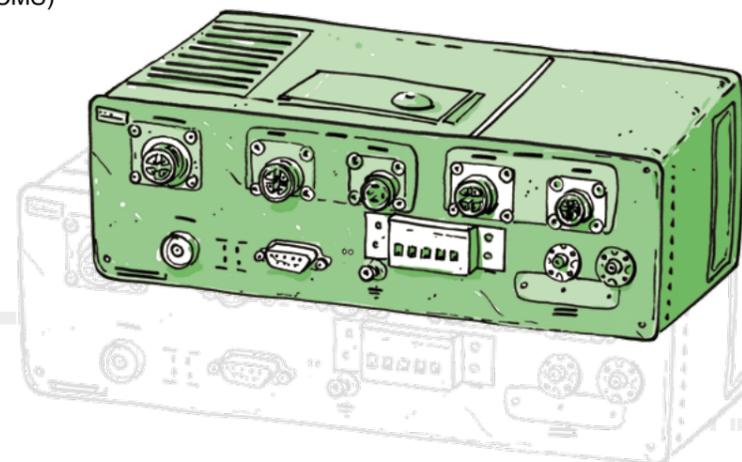


### Traction Protection System

The Traction Protection System is a device (RTP100) that interfaces with high voltage sensors to monitor the catenary status and controls other equipment through independent outputs e.g. triggers the VCB (Vacuum Circuit Breaker). The system provides the following functions:

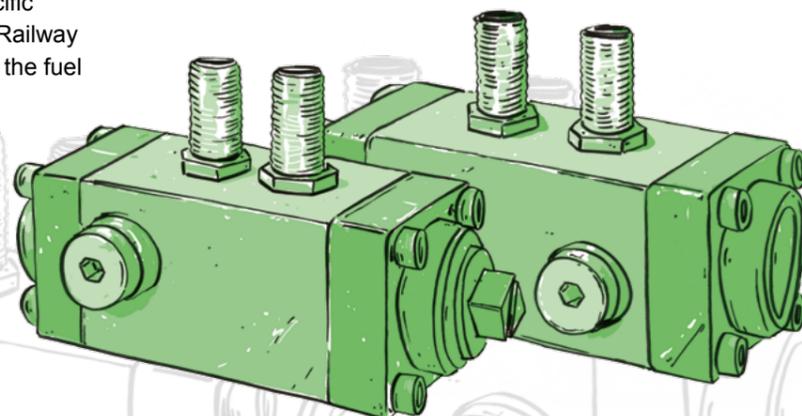
- Overvoltage protection (IEEE 59) (EN 50129 SIL2)
- Undervoltage Protection (IEEE 27) (EN 50129 SIL2)
- Time-independent Overcurrent Protection (IEEE 50/51) (EN 50129 SIL2)
- DC catenary voltage detection.

Each function is configurable in terms of function enabling/disabling, timing, thresholds. It is possible to connect the device to the TCMS in order to share the status of the catenary, including information about the trip events.



### Fuel Sensors

The Fuel Sensor can be connected to a specific version of an energy meter called RFM100 (Railway Fuel Meter) in order to monitor and measure the fuel consumption of railway diesel engines. Two spindle-tube-insert sensors are used per engine, one for the inner line and one for the return line. The relevant engine flow rate consumption is the difference between the inner flow rate and the return flow rate. The differential flow rate is calculated in real time by the RFM100 and each sensor is temperature compensated.



### Driver Advisory System

T-EDAS (Train Eco Driver Advisory System) allows the train driver to improve the two most important driving features and constraints: keeping to the working timetable and energy saving. The system complements the driver's existing knowledge and experience with:

- accurate up-to-date knowledge of the journey in terms of speed restrictions, gradient profile and stops
- the punctuality of the service
- advice on how to optimise driving style in order to fulfil the different objectives all at once

This is achieved by repeatedly running different algorithms using complex optimisation strategies based on physical parameters and current location and speed. In addition to the on-train features, important off-line analysis can be carried out on the ground server.



## AC/DC systems installed on Class 377 EMU (Electrostar) from Bombardier UK

The Class 377 of trains have been equipped with DC or AC/DC architecture composed of multiple energy metering points per train unit. The scope of supply includes roof mounted AC sensors, indoor DC sensors, energy meters and combined GPS/GSM antenna.



Tom Walker

## AC systems installed on Class 88 Dual Locomotives from Stadler Valencia

This project includes the traction protection function on a standard Saira Electronics AC metering system. The protection function (integrated in the energy meter) triggers the VCB control in case of overvoltages, overcurrents and short circuits. Additionally the leakage current is monitored.

The scope of supply is:

- Standard AC energy meter with integrated 3G communication unit
- AC Transducers with dual output (EMF+Traction)
- Ethernet TCMS interface
- WiFi commissioning

At DCS level the following functions have been used:

- Full remote access
- Real time monitoring

Advantages:

- Reduced system cost
- Reduced installation time
- Increased system diagnostics



## AC systems installed on Class 800 IEP trains from Hitachi Rail Europe

For the Hitachi IEP (Intercity Express Program) project Saira Electronics delivers energy metering systems composed of an energy meter, AC voltage and current transducers. The transducers have the capability to simultaneously manage the energy metering signal and the traction management function.

The energy meter is equipped with an ethernet based TCMS interface that allows the exchange of information, such as voltage, current, power readings and energy data. Data will also be sent to the Data Collecting Service.



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