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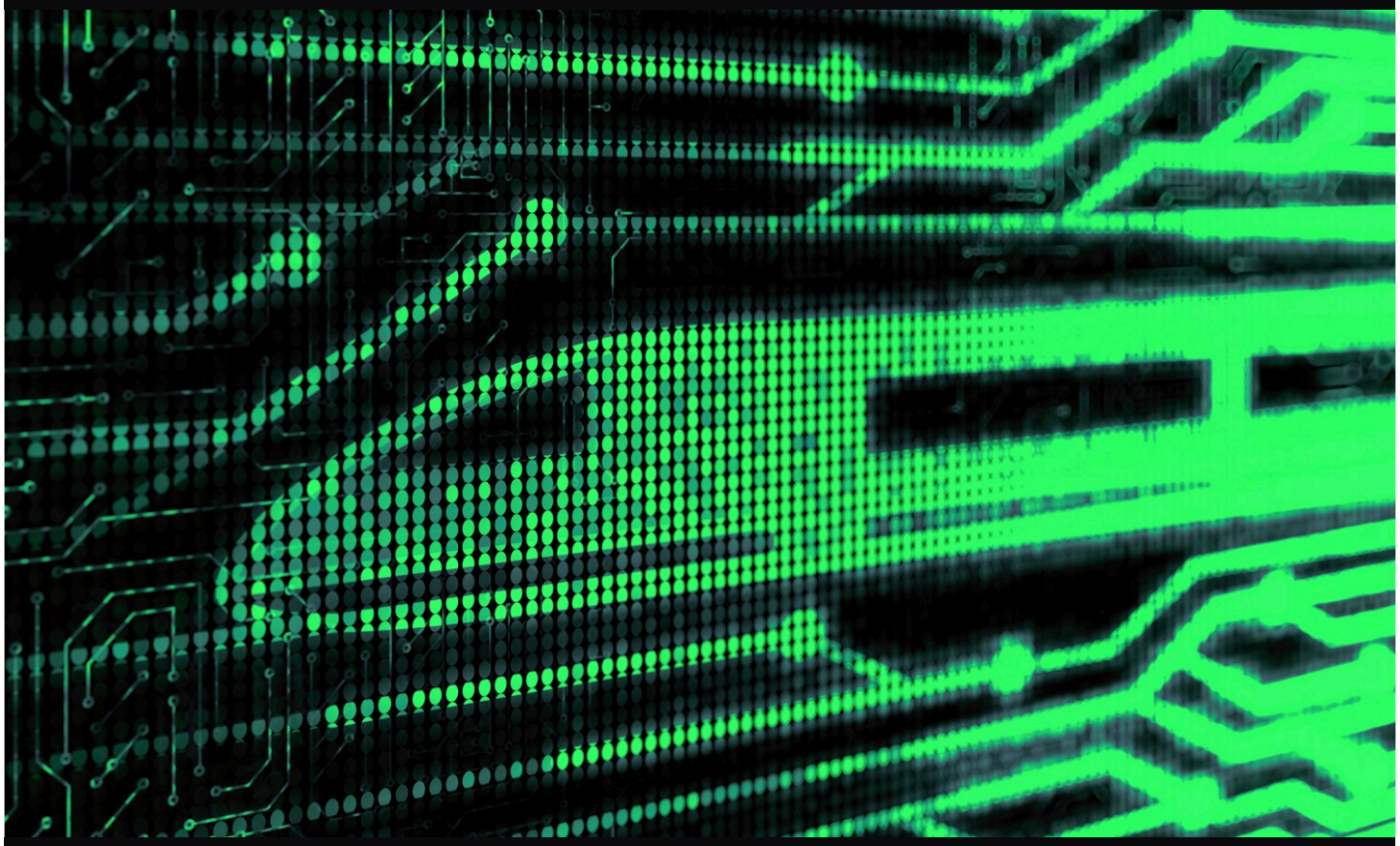


DC energy metering system

i-LE 3000
Smart Energy Meter

Falko
zone-based analysis system
for traction energy consumption

ELESTER-PKP

i-LE 3000

Smart DC energy meter

The 45WE electric train unit from the IMPULS product range, manufactured by Newag S.A., with the factory-fitted LE 3000plus energy meter.
The first in Poland, comprehensive metering of rolling stock designed for billing purposes has been implemented by Koleje Mazowieckie, a railway company in the Mazowieckie Province, using the meter manufactured by ELESTER-PKP.

The i-LE 3000 meter is a modern traction power and energy measuring device. Readings provided by the device allow transport operators to apply an individual billing policy. The devices comply with all standards and guidelines, and as such they can be used in traction vehicles. With the applied technical solutions, the meters supplied by ELESTER-PKP have been selected and installed in new traction vehicles manufactured in Poland by Bombardier, Newag, Pesa and Stadler for years.

Meter design and installation on the vehicle

The i-LE 3000 DC energy meter consists of four main elements installed in various parts of the vehicle. These are a low-voltage KOM communication part, a high-voltage HVM metering part, a measuring shunt and an external GSM/GPS antenna.

The measurement is based on the voltage drop across the measuring shunt, which is located within the vehicle main circuit and connected to the high-voltage HVM measurement part. The HVM measuring transmitter in a standard version is equipped with an internal fuse base. In the model with reduced overall dimensions, the base is located in another place on the vehicle. The data collected from counters is transmitted to the communication module via two-way fibre optic link. Data transmission and satellite localisation are ensured by a suitable GSM/GPS antenna, which is installed directly on the vehicle roof.

The FLIRT3 electric train unit manufactured by Stadler, with the factory-fitted LE 3000plus energy meter.

Basic functionality

The i-LE 3000 meter measures total traction energy flow and total power consumed by the vehicle. It is also provided with a counter for the energy returned to the traction grid (recuperative energy). Measurement data is arranged together with the information on current vehicle use, consumption time and geographic location. Once the data is collected, it is wirelessly transmitted to the billing system. Monitoring of the counter location is ensured by a GPS system. Precise localisation is necessary to assign the consumed energy to the corresponding Distribution System Operator, since it may be changed as the vehicle travels along its route. When the transport operator is changed, the operator's representative, using a proximity card assigned to the meter, initiates a new energy counting session in the billing system. The HVM measuring transmitter is powered only by the voltage being measured. The meter provides the required measuring accuracy of class 1. Readings are recorded at appropriate time intervals, which can be adapted to the transport operator's needs. In a conventional meter these cycles last for 1, 5 or 15 minutes. Apart from the data necessary to execute billing functions, all information relating to operation of the meter and power grid parameters is collected as well. In order to ensure appropriate safety of the collected data, the device is provided with memory resistant to electromagnetic interference (EMC). A conventional version of the meter is equipped with an expanded self-diagnostic function. In this way the condition of measuring routes and connectivity between individual elements can be checked and proper operation of the communication module can be verified. The self-diagnostic function is automatic and runs when the device is switched on or when requested remotely or locally using the control panel.

The PesaDART electric train unit manufactured by PESA Bydgoszcz SA, with the factory-fitted LE 3000plus energy meter.

Safe communication with the billing system

Communication between the counter and the billing system is based on wireless data transmission, using a mobile phone network. In order to guarantee uninterrupted data transmission even at the moment when the power supplied to the traction vehicle fails, the communication part of the i-LE 3000 counter is equipped with a battery. Efficiency of the cell together with battery power status is appropriately monitored. As an additional supply source is applied, the communication part can finish up the transmission and files are protected from being corrupted. What is important is the fact that the counter provides measuring data and events by transmitting XML files to the billing system. An advantage of this file format is data protection in the file structure. It is also possible to analyse the contents without any specialised software.

i-LE 3000 - low-voltage KOM communication part

Counter setup via website

The i-LE 3000 meter is equipped with remote access to setup functions. Once logged in to the counter website, operational and functional parameters can be edited. The user has also access to up-to-date and archived measuring and location data as well as recorded events. The application also enables creating summary sheets, filtering and exporting files supported by spreadsheet software.

The program automatically detects the meter type and its design to adapt the website interface to setup options available for a given version. This allows operation personnel to use one unified tool for comprehensive operation of all counters. The solution facilitates management of utility software versions used to set up i-LE 3000 meters by maintenance personnel.

Connection of the counter with on-board systems

The i-LE 3000 DC energy meter is equipped with communication to integrate the meter with the on-board equipment system. For that purpose, the CANopen high-level communication protocol is implemented. This functionality allows the on-board systems to use freely current measuring, location and information data from the counter without interference in basic measurement operation of the counter. It is also possible when the on-board network is based on Ethernet.

Example of Power Guard

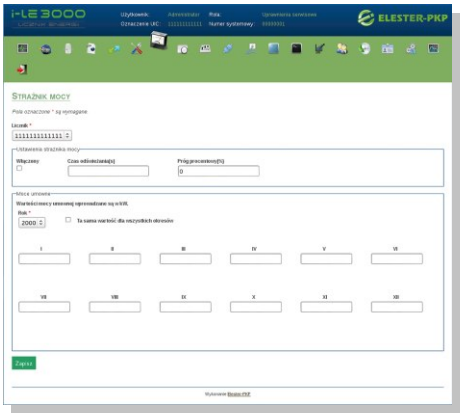
During operation of traction vehicles, it is likely that instantaneous power is exceeded. Such events are often associated with additional fees and penalties charged by Distribution System Operators. In order to limit the occurrence of such adverse situations, the i-LE 3000 counter is equipped with a software and hardware function, i.e. the Power Guard.

This functionality of the counter can inform the driver on the possibility of exceeding pre-defined limit values in advance. Depending on the traffic situation, the driver may take the message into consideration by adapting the driving technique to current limitations or temporarily suspend operation of some on-board systems (e.g. air conditioning, heating). The i-LE 3000 meter generates three types of signals such as information on approaching to the limit value, warning on a nearly exceeded value and alarm on exceeded predefined values. Messages generated by the Power Guard function can be displayed on devices on the vehicle using the CANopen protocol or presented to the driver in another way.

The FLIRT3 train unit manufactured by Stadler, equipped with the LE 3000plus energy meter. *The communication part is located in the vicinity of the vehicle's articulated joint, and the HVM high-voltage transmitter together with the shunt is installed on the roof.*

Smart grid

One of challenges and opportunities of the modern electrical power engineering is the possibility of creating smart electrical power grids based on new IT technologies. Benefits from this new approach can increase effectiveness, provide better safety and reduce costs. An element which is necessary in construction of smart grids is efficient communication between all participants on the energy market and smart measurement systems (Smart Metering). The i-LE 3000 meter is equipped with two-way communication which, together with the Falko analysis system for traction energy consumption, creates a smart metering system, providing a wider range of applications and construction of a smart railway electrical power grid. As soon as at the design stage, one of the objectives faced by the designers was the need to create a system which would not only serve for measurement but also establish a digital connection between the electricity supplier and consumer. Cooperation of both parties will make it possible to implement new improvement solutions and increase effectiveness jointly. Exceeding the instantaneous power is a phenomenon which occurs not only in traction vehicles but also in the infrastructure of the Distribution System Operator. When the power consumption is exceeded at the traction substation, instantaneous, complete or partial shutdowns can be the consequence. Such events have an adverse impact on the entire electrical power system, including both energy consumers and suppliers. The situation affects smooth traffic operation. A solution which can be applied to protect power supply systems is the option of a wider application of the smart metering system (i-LE 3000 and Falko).



Preview of the setup website
– Power Guard option

Additional applications of counters

The guidelines in force permit implementation of DC energy billing based on readouts from the devices which are not installed only on traction vehicles. For some railway operators, taking the measurement at siding or the locomotive shed is a convenient solution. In this situation, the i-LE 3000 meter is mounted directly at the traction pole, traction substation or track sectioning cabin. The on-pole version of the energy meter requires just an additional enclosure to protect the device from weather conditions. The formal procedure of technical acceptance and calibration is analogical to activities associated with devices mounted on traction vehicles.

The LE 3000plus meter has been awarded with the EXPOPOWER Gold Medal at the International Power Industry Fair in Poznań.

Application of two HMV measuring transmitters

The i-LE 3000 meter is equipped with connectors for up to two high-voltage measuring systems, and such an additional HVM measuring part can be connected as well. The other measuring module can be assigned, for instance, to reading out the energy consumed only for auxiliary needs of the vehicle. With such a solution, the transport operator is provided with a tool for monitoring the power consumed by on-board systems (e.g. heating, air-conditioning and lighting).

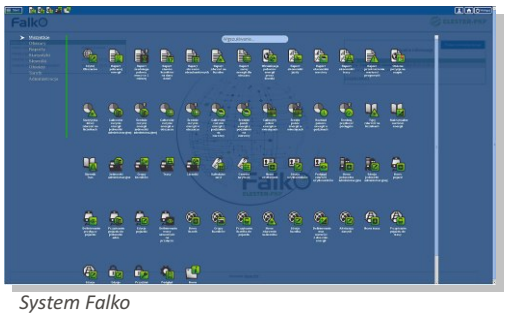
The LE 3000plus energy meter has been rewarded with the Medal given by the President of the Association of Polish Electrical Engineers.

Installation of the i-LE 3000 meter on the vehicle requires little interference in the vehicle main circuit. Prior to installation, it is necessary to compile relevant design documentation to be approved by the Distribution System Operator. Upgrade projects are usually preceded by vehicle inventory (site inspection) to determine a convenient place for installation of individual elements. For this stage of work, ELESTER-PKP offers full support and assistance as well.

ELESTER-PKP has been recommended by the Polish Association of Electrical Engineers in the scope of equipment design, specialised software development as well as provision of services and works relating to electrical power.

Zone-based analysis system for traction energy consumpti

The Falko system is an application designed for optimisation of electric energy consumption by aiding analyses on the part of railway operators. Operation of the software is based on measuring data obtained from the DC meters installed on traction vehicles. The software collects the data in the central database, then the data is processed, thus providing the personnel with information necessary to monitor and supervise energy consumption. From a long-term perspective, the data obtained from the meters provides perfect research material for planning and optimisation of electricity consumption.



System Falko

Reports and statistics

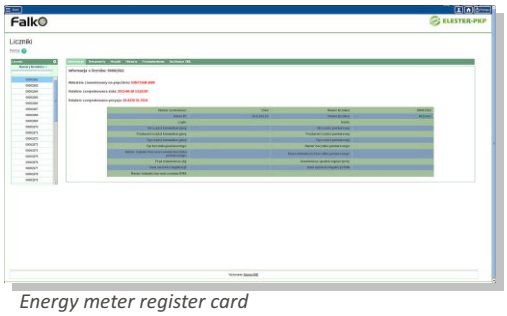
Based on the measuring data recorded by the meter, the transport operator can appropriately manage and execute the traction energy policy as well as implement optimisation and saving activities. The Falko software can collect large volumes of data and perform many analyses, comparisons, sequential arrangement and generate statistics. The data can be suitably filtered and processed quantitatively and qualitatively, with respect to zones, taking into account additional parameters to be set. The presented materials can be displayed in tables or in the form of general and detailed graphs. It is worth emphasising that when the application was at the development stage, one of the priorities was to provide many users with the capability of very fast generation of complex reports and statistics. Therefore, publication of documents takes place in real time even if the volume of the data is big.

Energy consumption report

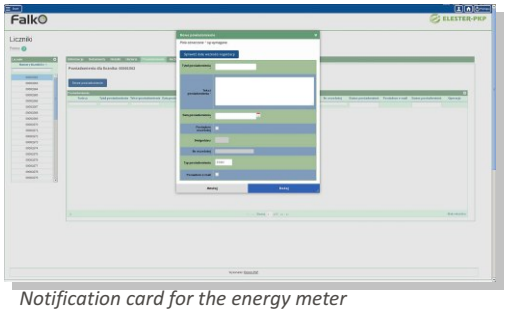
An important element of the application, which enables finding a correspondence between the measuring data and costs-related actual situation, is the electricity tariff calculator. The function makes it possible to calculate fees according to the indicated tariff, pricelist, time and selected vehicles. The tariff pricelist can be edited, and as such the user can perform various cost comparisons. Additionally, from the perspective of savings, the application can generate reports on driving and route economics.

Zones

The software is provided with a precise scalable map on which the user can define any geographic area. The indicated area may be assigned to an appropriate layer with a definable time interval when it is active. This functionality allows generation of reports and statistics for given routes, provinces, countries or locomotive sheds. Data can be analysed in terms of single vehicles and characterised groups. For drawing an area on the map, a simple graphic editor is used.



Energy meter register card



Notification card for the energy meter

Passporting

Passporting functions built in the system allow operation personnel to keep an effective meter registry. Each device is equipped a registry card in the system. It contains precise information on the applied elements (e.g. shunts, transmitters) as well as their characteristics and calibration intervals. The software also enables classification and generation of vehicle cards containing detailed technical data of the rolling stock and assignment of meters to such cards. With time-based notes, Falko allows planning works and reminds of upcoming events as defined. Changes and service modifications made in the meters can be recorded, with full history of such works and measuring data (e.g. routes, speed values, events on the meter) available for operation personnel.

Localisation

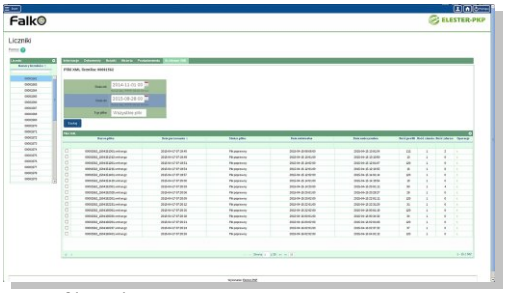
The Falko application provides a current preview of locations of all vehicles. The location of the rolling stock being observed is visualised on a scalable map and refreshed as the stock is travelling, together with current measurements and speed of trains. The application can display completed archive travels together with their full description. Additionally, it is possible to mark the location in which a given event took place, for example power failure or deterioration of power supply parameters.

Falko requires no installation on workstations and is available via standard web browser. The platform allows working on multi-user stations with diversified levels of authorisation. A convenient solution provided by the software is the possibility to create notes relating the different statuses; the notes can be viewed by operation personnel. Reports and statistics are generated in the PDF format. Its appearance and position can be adapted to the transport operator's standards. For further processing, the data can be exported to spreadsheet files. Moreover, the software offers convenient setup of data sources and appropriate administration of the system to have it adapted to the users' needs and convenience.

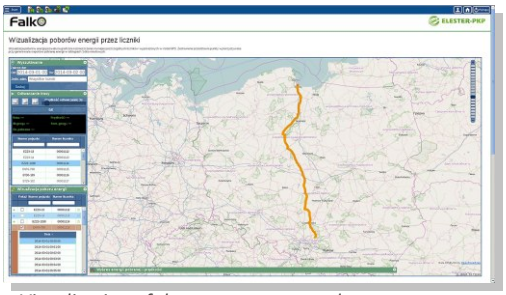
Visualisation of the energy consumed by the meter

Test version:

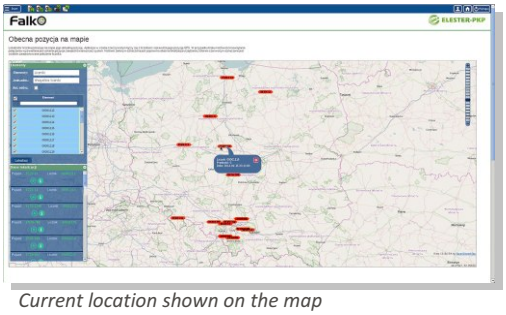
www.elester-pkp.com.pl/falko



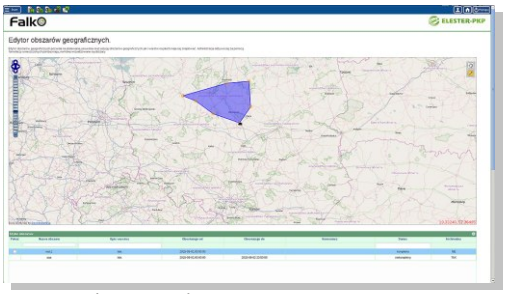
XML file archive



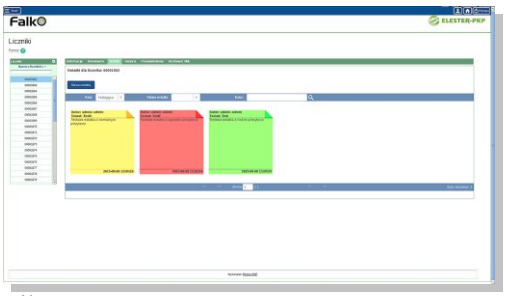
Visualisation of the energy consumed by the meter



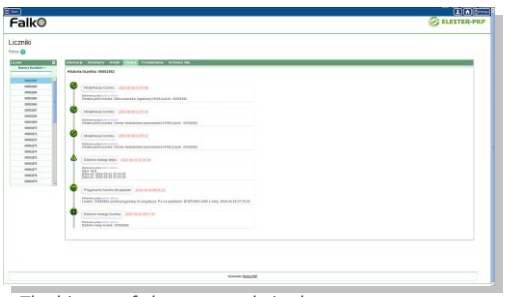
Current location shown on the map



Geographic zone editor



Note generator



The history of changes made in the energy meter

The information contained in this document presents a general description of technical capabilities which may deviate from specific cases. The required parameters must be specified while placing an order.

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