At the system design of railway electrification systems we combine the calculations of our simulation tool Sitras® Sidytrac with our extensive system know-how.

With the help of the software the workflows will be standardized and automated, so sources of errors are reduced and the efficiency are increased.

Features:

- Detailed design of new AC or DC traction systems with electrical dimensioning of substations and contact line systems:
  - economical design of the entire system
  - calculation of power reserves for further extensions
- System comparisons and feasibility studies
- System optimization concerning energy consumption and erection costs

Data processing

<table>
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<th>Results</th>
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<td>Graphical control of input data</td>
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System design with Sitras Sidytrac

Simulation of AC and DC traction power supply

Technical Information / Version 1.1.1

www.siemens.com/mobility
Areas of application

With the help of Sitras Sidytrac the system design and calculation of the complete traction power supply system is carried out.

Overall system design
- Simulated train operation and network calculation for AC and DC railways
- Optimization of feeding concepts
- Definition of substation locations
- Energy demand calculations for railway lines
- Calculation and assessment of contingency operation
- Current load of contact lines, busbars, switchgears and transformers
- Calculation of line impedances and potentials along the line

Safety of persons and protection of installations
- Calculation of rail potentials/touch voltages
- Assessment of stray currents for DC railways

Protection design
- Short circuit calculations DC/AC railways
- Maximum operational currents of feeding sections
- Design parameters for relay coordination

Network reaction/voltage quality
- 3-phase unbalance because of single-phase railway loads
- 3-phase voltage fluctuation study
- Resonance behavior of railway lines

Interference, magnetic fields, electromagnetic compatibility
- Studies and calculations of electric and magnetic fields of railway lines and/or traction substations
- Calculation of psophometric interference in telecommunication cables, i.e., frequency analysis of the electromagnetic interference
- Mutual interference between DC and AC railways
- Induced voltages in parallel conductors, e.g., cable screens and signal lines

Program structure

The simulation software Sitras Sidytrac consists of three blocks:
- Input block
- Calculation block
- Output block
Input block

The program input block serves to condition the railway network as well as traction unit, schedule, and electrical network data. Complex railway networks with main and branch lines can be modelled.

The following data are entered:

**Railway network, topography**
- Railway stations
- Mileage
- Gradients
- Curve radii
- Speed profiles
- Location and type of tunnels

**Vehicle**
- Mass
- Maximum speed
- Traction resistance
- Efficiency
- Power factor
- Traction and braking efforts
- Auxiliaries, power consumption

**Schedule**
- Synchronized schedules
- Individual schedules

**Electrical network**
- Network topology
- Feeding points and short-circuit power
- Transformers
- Rectifiers, inverters
- Switchgears
- Feeders (overhead power lines, cables)
- Contact line system
- Resistors, reactors, capacitors
- Stationary consumers
- Energy storage units

Calculation block

This second program block is the calculation kernel of Sitras Sidytrac.

The calculation operates according to the time-step method. At every time step two processes are performed.

First, the operating cycle program calculates the location of the vehicles in the network and their active and reactive power input and output. These electric loads are inserted into the static network and the dynamic electrical network then calculated from this.

Second, the electrical loadflow calculates the currents, voltages and the available power in all nodes and branches of the network for the next step of train movement.

At the end of the processes all mechanical and electrical quantities are available for evaluation and graphical representation.

Output block

The third program block evaluates the electrical data for detailed design of the main power supply components. It also provides the graphic display of the calculation results.

The results can be represented clearly in predefined lists and graphics to comply with specific requirements.

**Graphical control of input data**
- Railway network, topography
- Vehicles
- Graphical schedule, calculated
- Electrical network

**Vehicle results**
- Currents
- Voltages
- Total power
- Traction power
- Recuperated power
- Losses in braking resistance
- Mechanic power
- Auxiliaries
- Losses
- Power factor
- Efficiencies
- Position
- Velocity
- Acceleration
- Traction effort
- Braking effort
- Payload

Example: Vehicle results (Current, voltage and velocity versus time)
**Electrical network results**
- Currents in network branches
- Supply voltages
- Extreme values of voltage
- Rail potential
- Total power
- Active power
- Currents versus way
- Short-circuit currents
- Stray currents

**Induced voltages**
- Transmission losses
- Conversion losses
- Energy balance
- Impedance for protection relay settings
- Magnetic fields
- Thermal loads
- Trigger delay angle by controlled rectifier

**Representation**
The results and the related input data are stored in a database and automatically processed and customized into a predefined html-format. This feature enables the customer to perform easy-to-use analyzing functions.

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**Magnetic fields of a double-track 1x 25 kV systems with return conductor**

**html output of the results**