

The background of the top section is a photograph of a railway catenary system. A tall, white metal support pole is on the left, with several horizontal cross-arms. From these arms, multiple overhead wires (catenary and contact wires) run across the frame towards the right. The sky is a clear, pale blue. The Siemens logo is overlaid in the top left corner.

SIEMENS

Ingenuity for life

Sicat CMS

Catenary monitoring system
for overhead contact line systems

[siemens.com/rail-electrification](https://www.siemens.com/rail-electrification)

The contactless catenary monitoring system Sicat® CMS continuously monitors the tensile forces in the contact wire and catenary wire and also acquires and evaluates the sensor information. The filtered sensor information is transmitted to the control center via the system infrastructure. The status of the overhead contact line and the location of selected damage events can be detected quickly and precisely, thereby increasing the availability of the system.

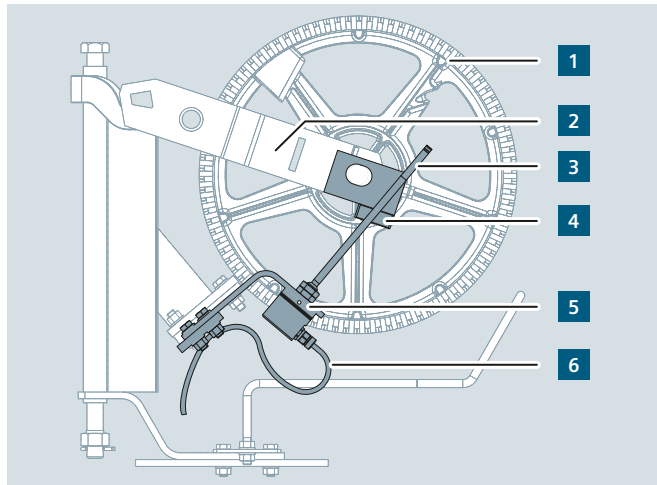
Features

- No influence on the tension wheel equipment and no wear due to contactless measurement
- Reliable fault detection with indication of location through continuous measurement of the inclination (and indirectly the tensile force) of the swing lever
- For all tension wheel equipment with weight sets, can also be retrofitted in existing installations
- Low space and maintenance requirements
- No flood of data, but event-driven alarms and fault messages through filtration of the measured values

Design

The Sicat CMS catenary monitoring system consists of the following modules:

- Sensors with cable connection and sensor fastenings on the tension wheel equipment
- Data acquisition station with sensor cable entry, connection of up to four sensors possible
- Fiber optic cable network between data acquisition and evaluation stations
- Evaluation station with Ethernet interface



- | | | | |
|---|---------------|---|-------------------|
| 1 | Tension wheel | 4 | Permanent magnet |
| 2 | Swing lever | 5 | Sensor fastenings |
| 3 | Sensor rod | 6 | Sensor cable |

Sensor arrangement on tension wheel assembly

Function

General

Any changes in the tensile force in overhead contact lines with tension wheel equipment lead to changes in the inclination of the swing lever and can be measured.

Normal operating loads, such as temperature-related changes in the length of the contact wire and catenary wire or in the contact wire uplift during train passage, result in minor changes in the position of the swing lever.

By contrast, a rupture of the contact wire or catenary wire or, for example, trees falling on the overhead contact line can cause a sudden and major change in the tensile force.

Measured value acquisition

Sicat CMS measures the position of the swing lever with a position encoder, which works on the basis of magnetic effects (magnetostriction). A permanent magnet as locator is installed to one side of the movable swing lever.

Together with the swing lever, this magnet moves along a sensor rod and generates analog measured values. An air gap between sensor rod and permanent magnet prevents any influence on the function of the tension wheel equipment. The measured values of the sensor are transmitted to the data acquisition station.

Evaluation and communication

The evaluation station receives the measured values of one or more data acquisition stations. A programmable logic controller is used in the evaluation station. It filters the measured values of the individual position encoders, processes them and then determines the current state of the overhead contact line system in real time. A comprehensive self-diagnosis is part of the evaluation station as well.

Equipped with an Ethernet interface, the evaluation station can communicate with a suitable system infrastructure, such as with a Scada system, via the standardized telecontrol protocol IEC 60870-5-104.

Field of application

The function and features of Sicat CMS are suitable for manifold uses by operators and maintainers of overhead contact lines:

Condition-based maintenance through early detection of faults in the overhead contact line and thus avoidance of incidents and delays, for example, by means of:

- Alarms when tensile force values exceed or fall below the limit values;
- Monitoring of the efficiency of the tension wheel equipment and friction losses in the tensioning sections,
- More detailed evaluation of contact force test runs due to knowledge of the lateral tensile forces acting in the overhead contact line during test runs.

Increased safety of the installation and operation due to

- Determination of the functional readiness of overhead contact lines through acquisition of the lateral tensile

forces in the catenary. If the train driver is warned well in advance, rail operation can be maintained even in storm conditions;

- Avoidance or limitation of consequential damage, e.g. due to a train entering a faulty section.
- Reliable detection of short-circuits with high-resistance fault impedance in case of rupture of a conductor in the overhead contact line.

Limitation of fault duration in case of damage events and thus increased system availability due to

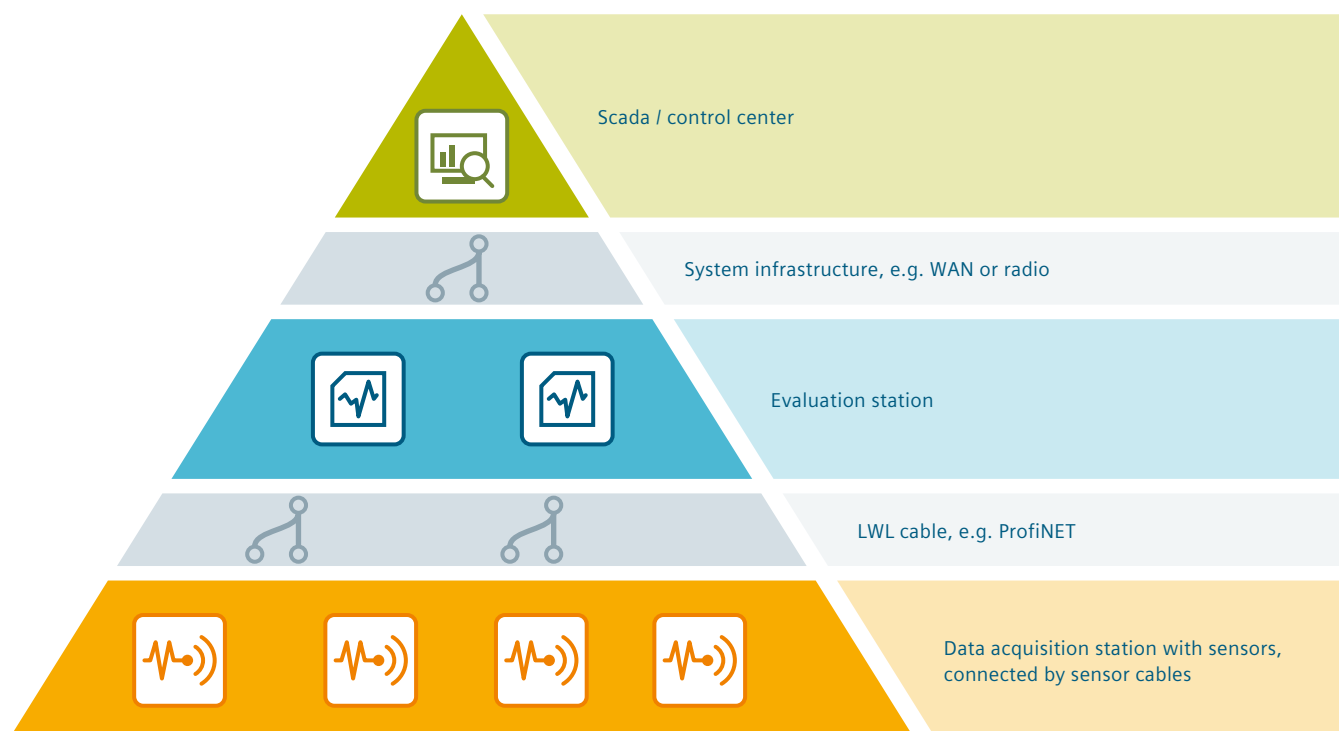
- Quick detection, evaluation and localization of faults in the overhead contact line system (e.g. rupture of contact wire) enables pinpoint fault rectification.
- Detection of temporary effects on the overhead contact line system, which might require an inspection or repair measure.

System integration and interfaces

Due to its integration into the overall installation, Sicat CMS has various interfaces which have to be clarified with the system operator in advance:

- Sensor mounting on the tension wheel equipment
- Cable routing from the sensor to the data acquisition station
- Installation locations of the data acquisition and evaluation stations

- Fiber optic cable routes between data acquisition and evaluation stations
- Transfer of data and communication from the evaluation station to the system infrastructure, to Scada and the control center, data mapping
- Local external power supply of Sicat CMS in the contact line system



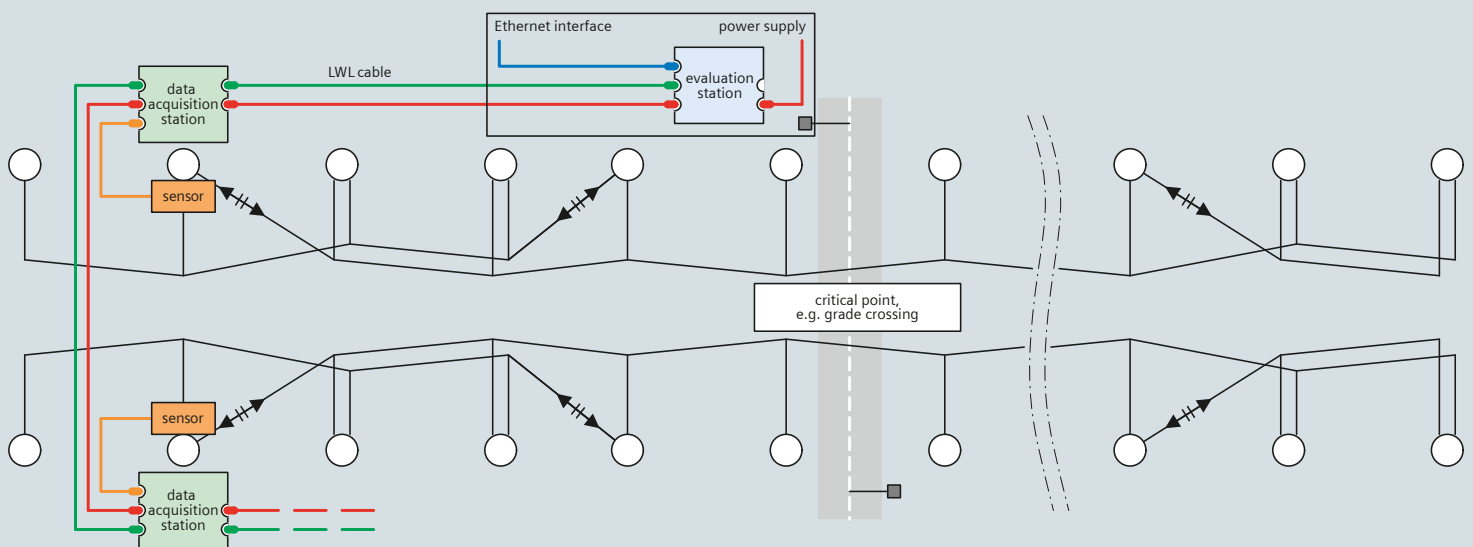
System design (schematic representation)

Standard configurations

1 Monitoring of critical points, data exchange by cable

Sicat CMS monitors single tension lengths of the overhead contact line within the limited area of a critical point.
The data is exchanged via fiber optic cables.

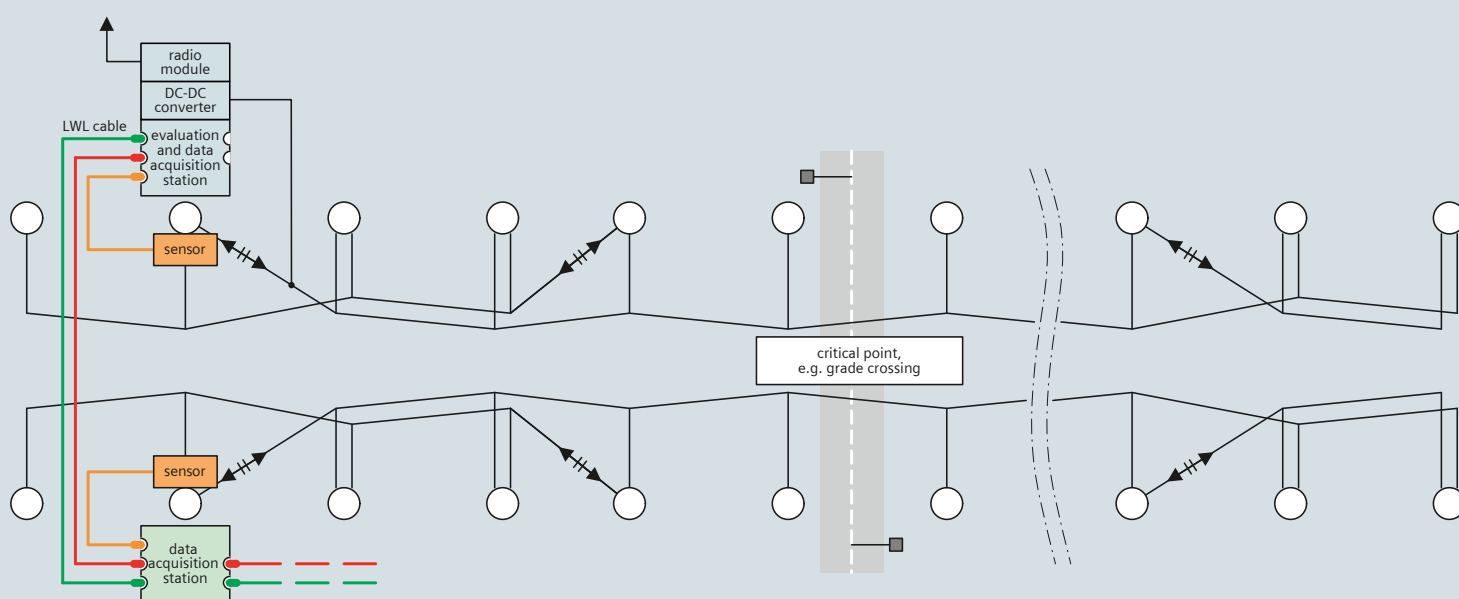
Application	Critical points such as <ul style="list-style-type: none"> • Grade crossings • Bridges • Platforms • Tunnel mouths • Areas accessible to the public, e.g. pedestrian zones
Data acquisition station	<ul style="list-style-type: none"> • Connection of up to four sensors (cable length max. 15 m) • If necessary, additional data acquisition stations
Evaluation station	<ul style="list-style-type: none"> • Integrated into the system infrastructure on the line (substation, signaling system, etc.)
Data exchange	between data acquisition and evaluation stations <ul style="list-style-type: none"> • Fiber optic cable (max. 3 km length) between data acquisition and Scada / control center <ul style="list-style-type: none"> • Ethernet interface
Power supply	<ul style="list-style-type: none"> • Local external connection



2 Monitoring of critical points data change by radio

Sicat CMS monitors single tension lengths of the overhead contact line within the limited area of a critical point.
The data is exchanged wirelessly via radio modules.

Application	Critical points such as <ul style="list-style-type: none"> • Grade crossings • Bridges • Platforms • Tunnel mouths • Temporary maintenance of-way work sites
Data acquisition station	<ul style="list-style-type: none"> • Connection of up to four sensors (cable length max. 15 m) • If necessary, additional data acquisition stations
Evaluation station	<ul style="list-style-type: none"> • Flexible installation location due to radio module
Data exchange	between data acquisition and evaluation stations <ul style="list-style-type: none"> • Fiber optic cable (max. 3 km length) between data acquisition and Scada / control center <ul style="list-style-type: none"> • Wireless with radio module
Power supply	<ul style="list-style-type: none"> • Batteries with DC-DC converter • Local external connection

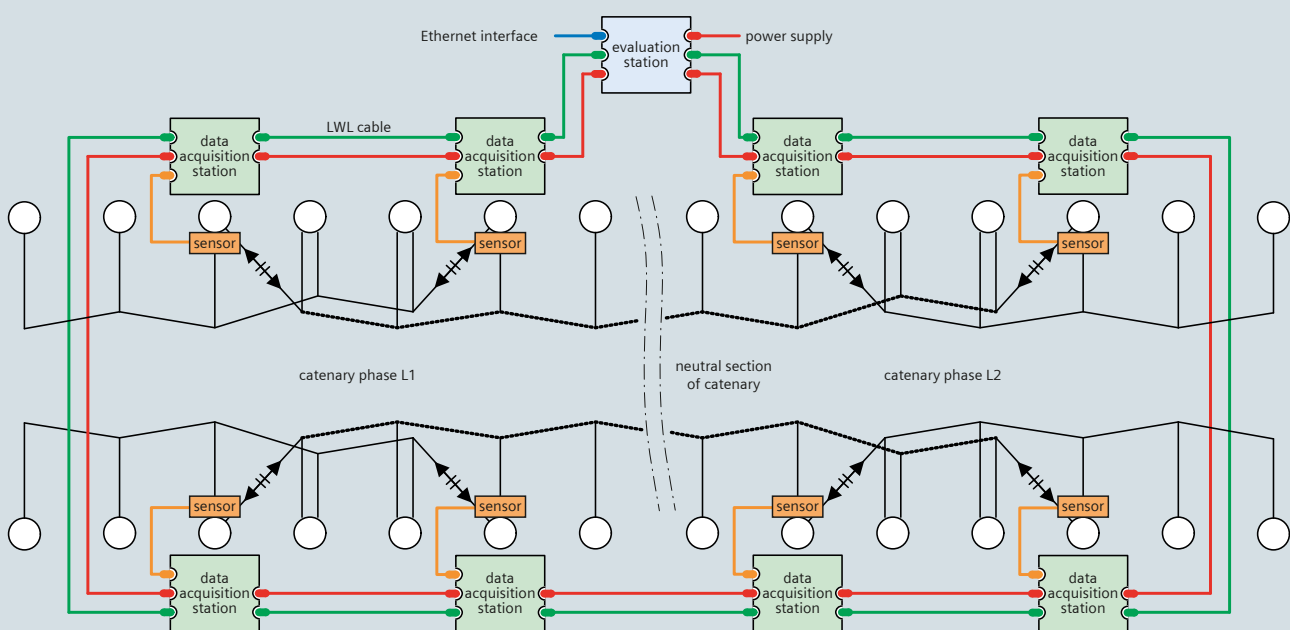


Standard configurations

3 Monitoring of phase isolation gap

Sicat CMS monitors the phase isolation gap of the overhead contact line as a particularly critical point. The data is exchanged via fiber optic cables.

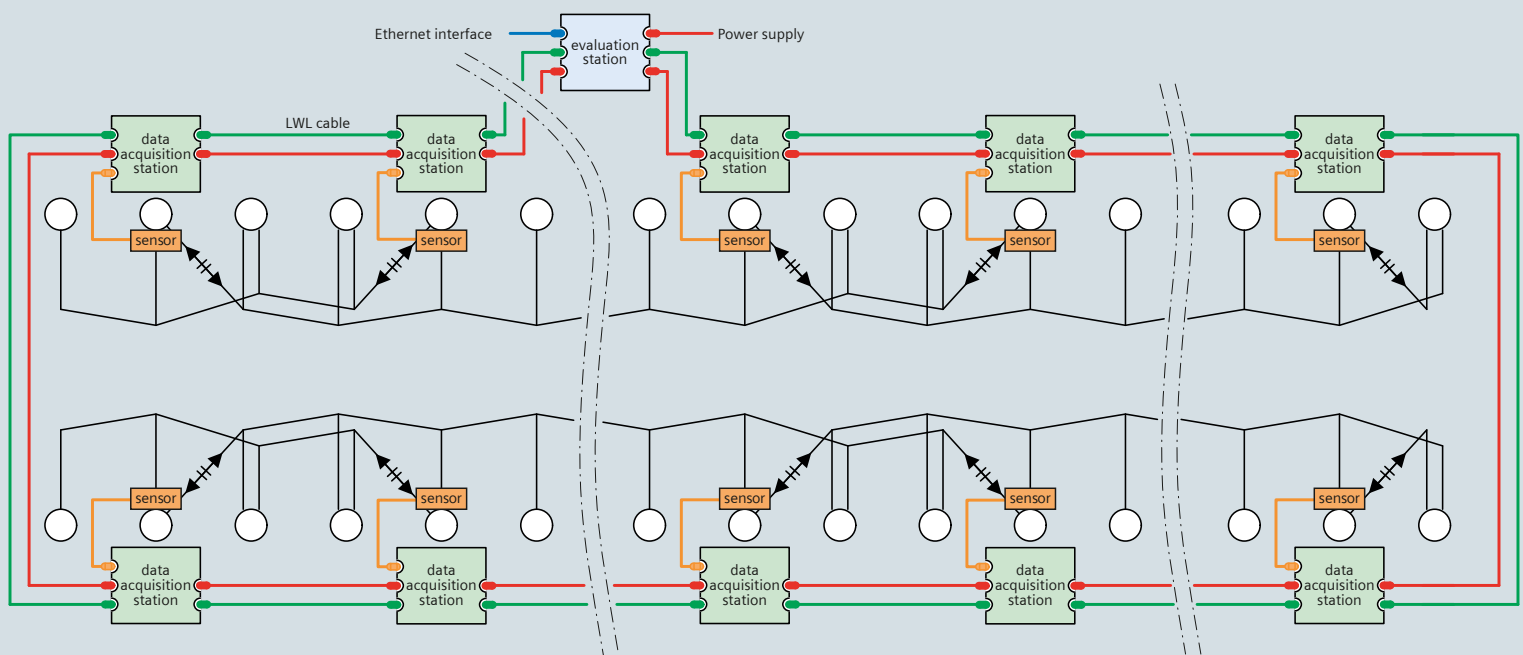
Application	Phase isolation of adjacent feeder sections by a neutral section
Data acquisition station	<ul style="list-style-type: none"> • Connection of up to two sensors (cable length max. 15 m) • If necessary, additional data acquisition stations
Evaluation station	<ul style="list-style-type: none"> • Integrated into the system infrastructure on the line • Alternatively, higher flexibility due to radio module
Data exchange	<p>between data acquisition and evaluation stations</p> <ul style="list-style-type: none"> • Fiber optic cable (max. 3 km length) • Redundancy due to the ring feeder <p>between data acquisition and Scada / control center</p> <ul style="list-style-type: none"> • Ethernet interface • Alternatively, wireless with radio module
Power supply	<ul style="list-style-type: none"> • Local external connection



4 Area-wide monitoring

Sicat CMS monitors the complete overhead contact line system of an electrified railway line.
The data is exchanged via fiber optic cables.

Application	Complete monitoring of open line and tunnel sections with high traffic density or high availability
Data acquisition station	<ul style="list-style-type: none"> • Connection of up to two sensors (cable length max. 15 m) • If necessary, additional data acquisition stations
Evaluation station	<ul style="list-style-type: none"> • Connection of max. 40 data acquisition stations • Integrated into the system infrastructure on the line (e.g. substation)
Data exchange	<p>between data acquisition and evaluation stations</p> <ul style="list-style-type: none"> • Fiber optic cable (max. 3 km length) • Redundancy due to the ring feeder <p>between data acquisition and Scada / control center</p> <ul style="list-style-type: none"> • Ethernet interface
Power supply	<ul style="list-style-type: none"> • Local external connection



Technical data

Technical data		
Power supply *		90...350 V DC / 85...264 V AC
Power consumption	nominal current per power pack	approx. 1.2 A (at 230 V AC)
Perm. ambient temperature	if necessary with heating	-40...+55 °C
Casing	<ul style="list-style-type: none"> • Dimensions of tunnel variant (W x H x D) • Dimensions of outdoor variant (W x H x D) • Installation locations • Degree of protection • Climatization • Earth bolt 	380 x 380 x 210 mm 530 x 690 x 270 mm wall or pole mounting IP66 on request M16x30
Measured value acquisition	<ul style="list-style-type: none"> • Sensor • Analog signal input • Position encoder • Accuracy of complete system • Sensor sequence • Sensor cable: max. length / diameter 	magnetostrictive position encoder 4...20 mA permanent magnet 0.1 mm 0.5 ms 15 m / Ø 7 mm
Evaluation	<ul style="list-style-type: none"> • Number of sensors per data acquisition station • Number of data acquisition stations per evaluation station • Evaluation sequence 	1...4 1...40 0.1 s
Communication	<ul style="list-style-type: none"> • Within the system • To Scada 	fiber optic cable, e.g. ProfiNET Ethernet, telecontrol protocol acc. to IEC 60870-5-104 (with fiber optic cable)

* Other voltages on request

References

Long-term tests

- HSL Zuid, Netherlands, since April 2006
- Tunnel Fuentecilla, Spain, since April 2007
- ÖBB, Austria, investigation of efficiency on the line Vienna – St. Pölten



Installation of the first series-produced system on the Madrid – Segovia – Valladolid high-speed line was started at the end of 2007 and completed for the start of operation in autumn 2008. Seven evaluation stations with a total of 120 data acquisition stations and 240 sensors acquire data on the state of the catenary systems on the 140-km-long line.

Further projects and operators which use Sicat CMS:

- HAVAG, Halle, Germany
- VB Graz, Austria
- eHighway Gävle, Sweden



Security information

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

For more information about industrial security, please visit:
<http://www.siemens.com/industrialsecurity>.

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