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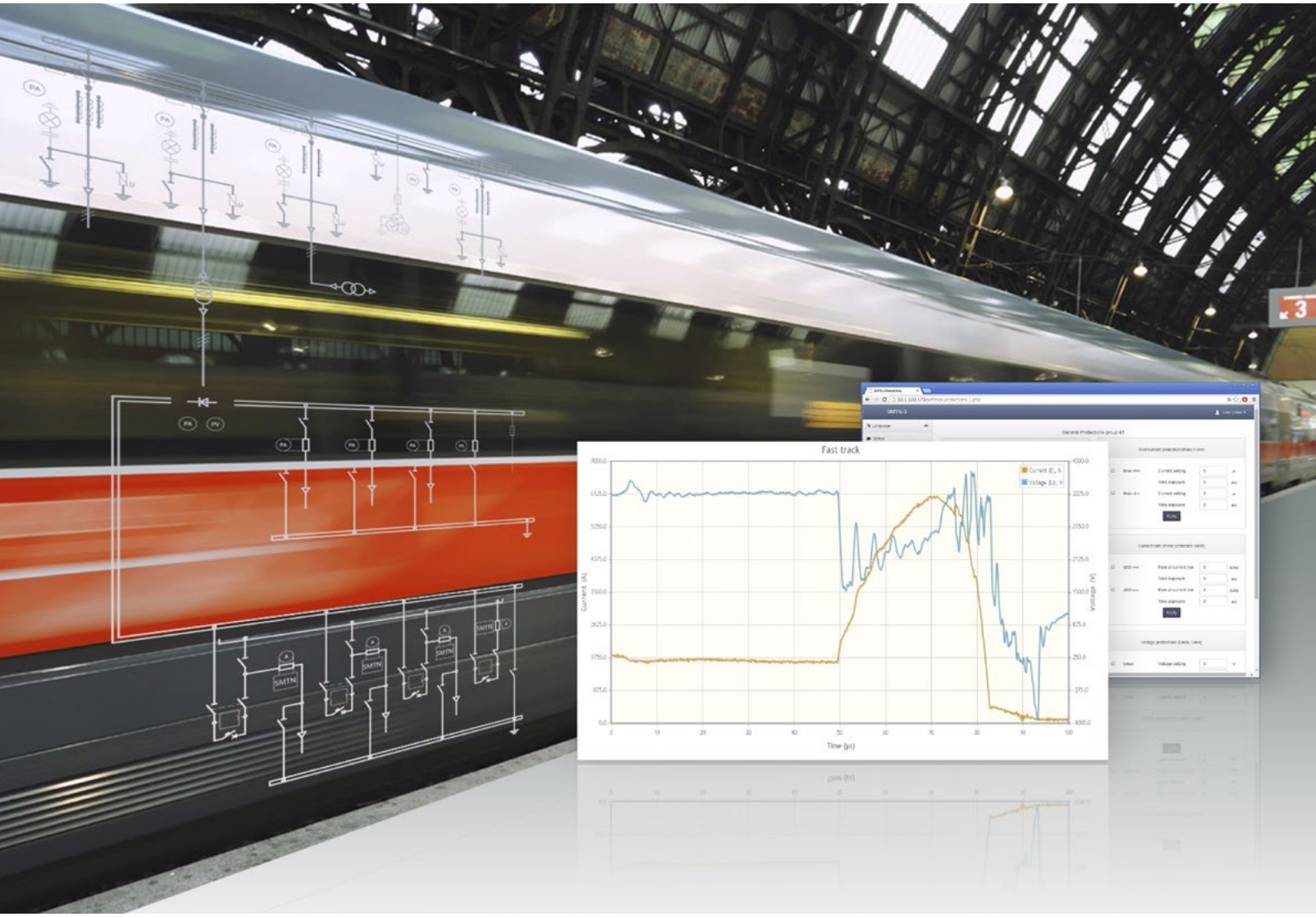


TRACTION NETWORK MONITORING AND PROTECTION SYSTEM SMTN-3

CITY ELECTRIC TRANSPORT ■
RAILWAYS ■ SUBWAY ■ INDUSTRIAL APPLICATION

BUILDING FUTURE **TOGETHER**!

Traction network monitoring and protection system

Traction network monitoring and protection system, series SMTN-3 is designed for:

- traction network protection against short circuit current and harmful overloads;
- traction network parameters monitoring;
- data acquisition for the subsequent analysis of emergency processes.

Application Area

SMTN-3 is designed for installation in rolling stock, industrial machinery and DC traction substations.

SMTN-3 alredy providing protection in city electric transport, metro, railways, industrial machinery, as well as in mining industry traction substations switchgears.

System capabilities

Traction networks protection is provided by monitoring of traction network voltage and current dynamics change. When measured parameter exceeds pre-set value system generates a command to safely open high speed circuit breaker.

SMTN-3 provides the following operation capabilities:

- measurement of traction network voltage and current values and shapes in different modes, including short-circuit situation;
- protection of traction network against short-circuit currents, including remote short circuits low currents and overloads;
- waveforms records and plots of voltage and current values and shape under short circuits (one of emergency process protections detection in traction network);
- waveforms storage and display, as well as data for further analysis transfer to upper level system (or PC);
- software-based internal configuration setting (protections input, protective characteristics selection, number of protection stages, etc.);
- local and remote input, storage and display of protection settings;
- storage of two setting sets and switching of setting sets by external signal;
- information on the number and time of protections operation storage and output;
- current distribution analysis.

Design

▲ DC Switchgear 3.3 kV

SMTN-3 consists of separate functional modules, fixed on DIN-rail and connected by optic fiber:

- measuring module with voltage divider is located in high voltage area (busbar compartment);
- processing module is located in low voltage area (control compartment).

Measuring and processing modules are connected with fiber optic cable that provides transmission of information between modules, as well as galvanic isolation between high voltage measuring circuits and secondary circuits.

▲ Processing and measuring modules

System components functions

Measuring module is directly connected to voltage and current measurement primary sensors. Current sensor is a resistive element of power circuit (shunt). Voltage sensor is a resistive voltage divider located inside measuring module. It is provided for the measured voltage reduction to the level suitable for further processing in the electronic modules.

Main functions of measuring module:

- processing of raw data from sensors (shunts, voltage dividers);
- galvanic isolation of low voltage circuits from traction network high potential;
- pre-filtering of input signal based on analogue and digital filters;
- transfer of input electrical values analogue processed data in processing module using optical cable.

Processing module processes all the data received from measuring module and other additional modules, as well as digital inputs. Processing module consists of several computer systems with integrated data bus.

Main functions of processing module:

- primary processing and storage of current data from measuring module;
- current and voltage values normalisation;
- validity diagnostics and control of data received from measuring module;
- protection functions (analysis of data from measuring module according to protection algorithms);
- generation of switching devices emergency tripping signals in accordance with protection functions;
- registration and storage of traction network emergency processes data;
- system events logging;
- system settings storage;
- system self-test;
- communication with traction substation automated control system upper-level system;
- gateway for change and configuration of system parameters using “Human Machine” interface (HMI).

Protection functions

SMTN-3 provides smooth and reliable operation of the system, as well as filtering against false tripping. It performs the following protection functions:

- instantaneous overcurrent;
- overcurrent protection;
- current rate of rise protection;
- current increment directional protection;
- overvoltage protection;
- under voltage protection;
- thermal protection;
- breaker failure.

Optionally, the system is equipped with the following systems (modules) that extend functional range of the system as a whole:

- line tester (short circuits tester);
- cable insulation control system.

Line tester (short circuits tester) allows to determine line impedance before high-speed circuit breaker closing. In case if line impedance is lower then the setting parameter, the system interrupts closing cycle of high-speed circuit breaker.

Cable insulation control system continuously monitors cable insulation resistance and gives a warning signal in case of insulation deterioration. A signal to open high-speed circuit breaker is given in case of cable insulation fault.

▲ Line tester (short circuits tester)

▲Cable insulation control system

▲ HMI interface on panel PC screen

Events and parameters logging

SMTN-3 generates and stores the following records:

- events log;
- failures log;
- emergency waveforms records.

All records are stored on nonvolatile solid data storage device that guarantees high reliability and data storage in case of power supply interruption.

SMTN-3 system provides generation and storage of emergency oscilloscope records. Emergency waveform record generation is performed automatically when one of protective functions operates.

Two records of emergency waveforms are generated and saved when one of the protection functions operates:

- “Fast plot”;
- “Slow plot”.

Emergency waveform records include but not limited to:

- current and voltage waveforms generated directly from the measured values (sampling period 50 mks for «Fast plot» and 100 ms for «Slow plot»); state diagram of digital inputs and outputs for the entire duration of voltage and current recording;
- precise timing;
- type of protection which was triggered;
- visualisation of values and settings.

The length of «Fast plot» and «Slow plot» graphs is fixed and contains 2048 current and voltage values.

Time of each record is:

- “Fast plot” - 100 ms;
- “Slow plot” - 100 s.

«Fast» and «Slow» plots contain abundant information for analysis of development, consequences and nature of accident occurred, as well as raw current/voltage values for pre- and post- event history.

Number of current and voltage samples in «Prehistory» for each waveform is an individually set parameter and can be changed in settings.

SMTN-3 storage memory formed in a form of loop with a maximum of 200 saved records.

Emergency records can be viewed using WEB-interface, read by upper level system via Ethernet or saved on external USB-disk for later analysis using a PC.

SMTN-3 system also logs maximum values of current and voltage. When newly measured current or voltage values exceed the previously logged ones, new values are recorded instead of old ones. Comparison is made independently for current and voltage channels.

Recorded maximum values can be reset, commencing new “maximum values” logging cycle begins.

Parameters setting

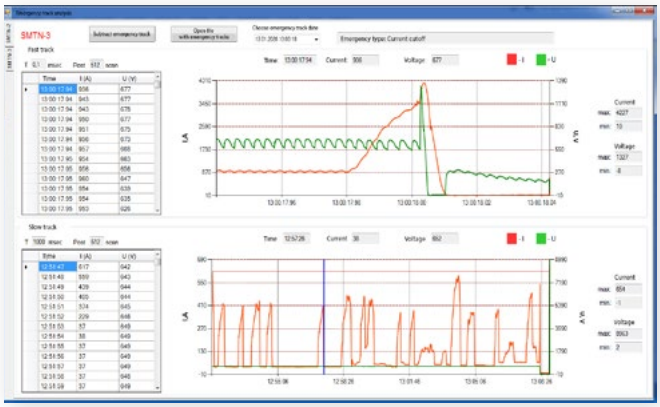
SMTN-3 system provides the following methods of parameters setting, for both the system itself and protection functions:

- local «Human Machine» interface based on LCD touch screen;
- remote «Human Machine» interface based on WEB-technologies;
- remote access to device using ModBusTCP/IP protocol, for upper level systems and power management systems, etc.

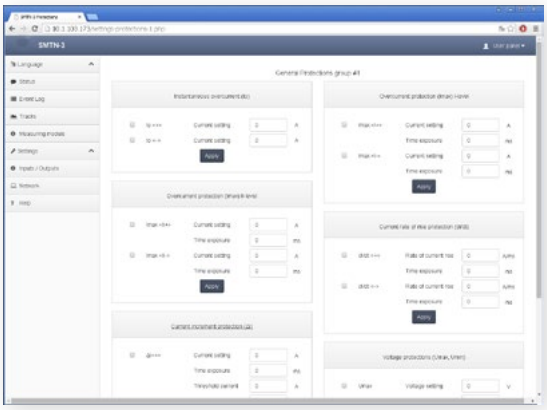
Remote «Human Machine» interface based on WEB-technology is an integrated WEB-server in each SMTN-3 processing module. It does not require any additional software installation on computer.

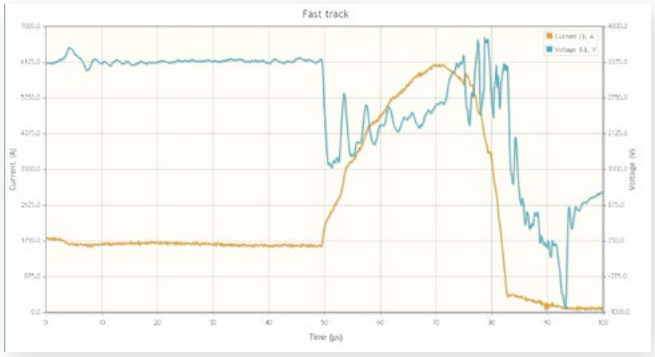
This interface is used to configure, display and analysis of data acquired by SMTN-3 system.
Communication with SMTN-3 WEB-server can be fulfilled via Ethernet cable or by wireless connection via PC, tablet or smartphone. Only WEB-browser installed on the device is required to work with SMTN-3 WEB-server.

«Human Machine» interface has integral multi-language support.

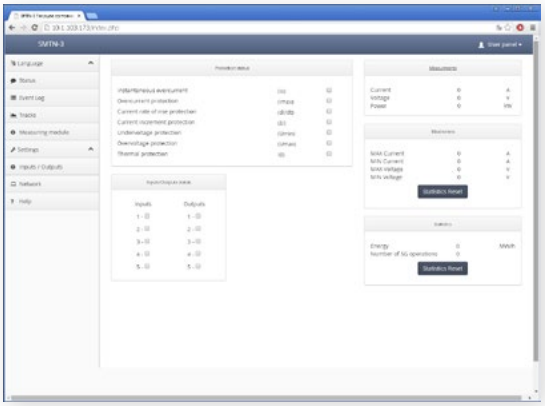


▲ Remote viewing of emergency records





▲ Fast track curve in WEB interface



▲ Parameters setting screens

Main technical details of traction network monitoring and protection system SMTN-3

Name of parameter		Value
Main parameters		
Number of current measuring channels	pc.	1
Number of voltage measuring channels	pc.	1
Type of current sensor		Shunt
Power circuit voltage measuring range	V	-2000...+2000* -8000...+8000*
Input voltage range for power circuit current measuring channel (DC generated voltage on shunt)	V	-0.5...+0.5
Current measuring range where: Ish – shunt rated current; Ush – voltage drop on shunt under rated current.	A	$I_{max} = \pm \frac{0.4 \cdot I_{sh}}{U_{sh}}$
Measured values sampling period	mks	50
Current measuring accuracy, max, of Ish	%	0.5
Voltage measuring accuracy, max, of measuring range	%	0.5
Insulation strength between measuring module power circuit and power supply circuit, minimum	kV	10 (30)*
Measured values		
		• Current (current channel) • Voltage (voltage channel) • Power (calculated) • Energy (calculated) • Test current (Line tester channel)
External signals		
Number of high speed digital outputs	pc.	5
Digital outputs designation		Signals issuing is set individually for each output under one or several protection functions tripping
Number of digital inputs	pc.	5
Digital inputs designation		Set individually for each input: • HSCB condition control, • external opening signal, • timesync.
Power supply		
Rated operating voltage	V	⎓5; 12; 24 ; 48, 110; 220 ≂110; 220
SMTN-3 system max consumed power, max	W	15
Permissible voltage long-term tolerances	%	-15…+10
Communication interfaces		
Data transfer interface		Ethernet
Data transfer protocols		WEB technologies ModBus TCP/IP
Reliability		
Mean Time Between Failures (MIL-HDBK-217F)	hours	100 000
Total average lifetime (under condition of the required technical maintenance activities provision)	years	25

Name of parameter		Value
Design		
Protection degree of modules in acc. with DIN VDE 0470 and EN 60529 or IEC 529		IP3X
Cooling		natural, air
Type of modules mounting		DIN-rail (TH 35, EN 50022)
Protection functions		
Code ANSI	50 76 59 27 49 BF	• Instantaneous overcurrent • Overcurrent protection • Current rate of rise protection • Current increment directional protection • Overvoltage protection • Undervoltage protection • Thermal protection • Breaker failure
Period of data processing by protective functions algorithms	mks	50
Number of settings groups		2
Measuring and logging functions		
Measured values		• Current • Voltage • Power • Energy • HSCB tripping counter • Test Current (Line tester Channel)
Number of recorded oscillograms under emergency event** occurrence	pc.	2 • “Fast track” • “Slow track”
Emergency oscilligraph records coverage width		• Current curve; • Voltage curve; • Digital inputs and outputs state diagram; • Astronomical time; • Type of tripped protection.
Emergency oscilligraph records coverage depth	points	2048 (for each measured value)
Signals sampling frequency in “Fast track” record	kHz	20
Signals sampling period in “Slow track” record	Hz	10
“Fast track” record time coverage depth	ms	100
“Slow track” record time coverage depth	s	100
Prehistory *** record time coverage depth in “Fast track” record	points	Set 0 - 2048
Prehistory *** record time coverage depth in “Slow track” record	points	Set 0 - 2048
Number of emergency oscillograph stored records		200
Local human interaction interfaces		
		LCD touch-screen or LED indication and control element
Operating conditions		
Ambient temperature range	°C	+1…+60
Relative air humidity, under temperature (Upper value)	%	60, 20°C (80, 25°C)

* - depending on measuring module design, for application in city electric transport with traction network voltage up to 1000 V or for application in railway transport with traction network voltage up to 4000 V
**- one of protections tripping is considered to be emergency event
*** - prehistory is a diagram of measured values up to emergency event occurrence

Traction network monitoring and protection system type tests

Name of parameter	Normative	Note
Electric tests	IEC 255-5	-
EMC compliance tests		
Radio interference voltage on power supply terminals	IEC 60255-25	Frequency range: (0.15 – 30) MHz
Radio interference field intensity	IEC 60255-25	Frequency range: (30 – 6000) MHz Measuring distance: 3 m
Electrostatic discharge tolerance (EDS)	IEC 60255-26 IEC 60255-22-2 IEC 61000-4-2	8 kV — air discharge 6 kV — contact discharge
Radiated electromagnetic field immunity	IEC 60255-26 IEC 60255-22-3 IEC 61000-4-3	Frequency range: 80 – 1000 MHz, Field intencity: 10 V/m Performance criterion A
Nanosecond pulses immunity	IEC 60255-26 IEC 255-22-4 (class 4)	Test pulses amplitude: - power supply line – 4 kV - connecting lines – 2 kV Pulse repetition frequency – 5 kHz Test pulse: 5/50 ns Performance criterion A
Microsecond pulse interference immunity	IEC 60255-26 IEC 60255-22-5 IEC 61000-4-5	Test pulse: 1,2/50 mks Test pulses amplitude: - power supply line: «two-wire» –± 2 kV «earth-return» –± 4 kV - connecting lines: «two-wire» –± 2 kV «earth-return» –± 4 kV Performance criterion B
Conducted interference immunity, inducted by radio-frequency electromagnetic field	IEC 60255-26 IEC 61000-4-6	Frequency range: 0,15 – 80 MHz Interference voltage: 10 V Performance criterion A
Power frequency magnetic field immunity	IEC 61000-4-8	Magnetic field intensity: 30 A/m Performance criterion A
Pulse magnetic field immunity	IEC 61000-4-9	Magnetic field intensity: 300 A/m Performance criterion A
Mechanic tests		
Sinusoidal vibration influence immunity	IEC 60068-2-6 IEC 60255-21-1	Frequency: 10-100 Hz; Acceleration amplitude 10 m/s2 (1 g) Scanning rate: 1 octave/min Duration: 20 cycles. In 3 orthogonal axes - Performance criterion A
Single-impacts immunity	IEC 60068-2-27 IEC 60255-21-2	Acceleration amplitude - 100 m/s2 (10g); Pulse duration –2-20ms, Impacts repetition frequency – (1-3) impact/sec. 3 impacts per each of 6 directions
Long-term impacts immunity	IEC 60068-2-27	Acceleration amplitude – 30m/s2 (3g); Pulse duration –2-20ms, 1000 impacts per each of 6 directions

Name of parameter	Normative	Note
Climatic tests		
Db test: Damp heat	IEC 60068-2-30	1 cycle, 24 hours +55 °C Off condition (transportation and storage)
A test: Cold	IEC 60068-2-1	-10 °C Holding: 72 h. (Ae test)
B test: Dry heat	IEC 60068-2-1	+60 °C Holding: 72 h. (Be test)

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