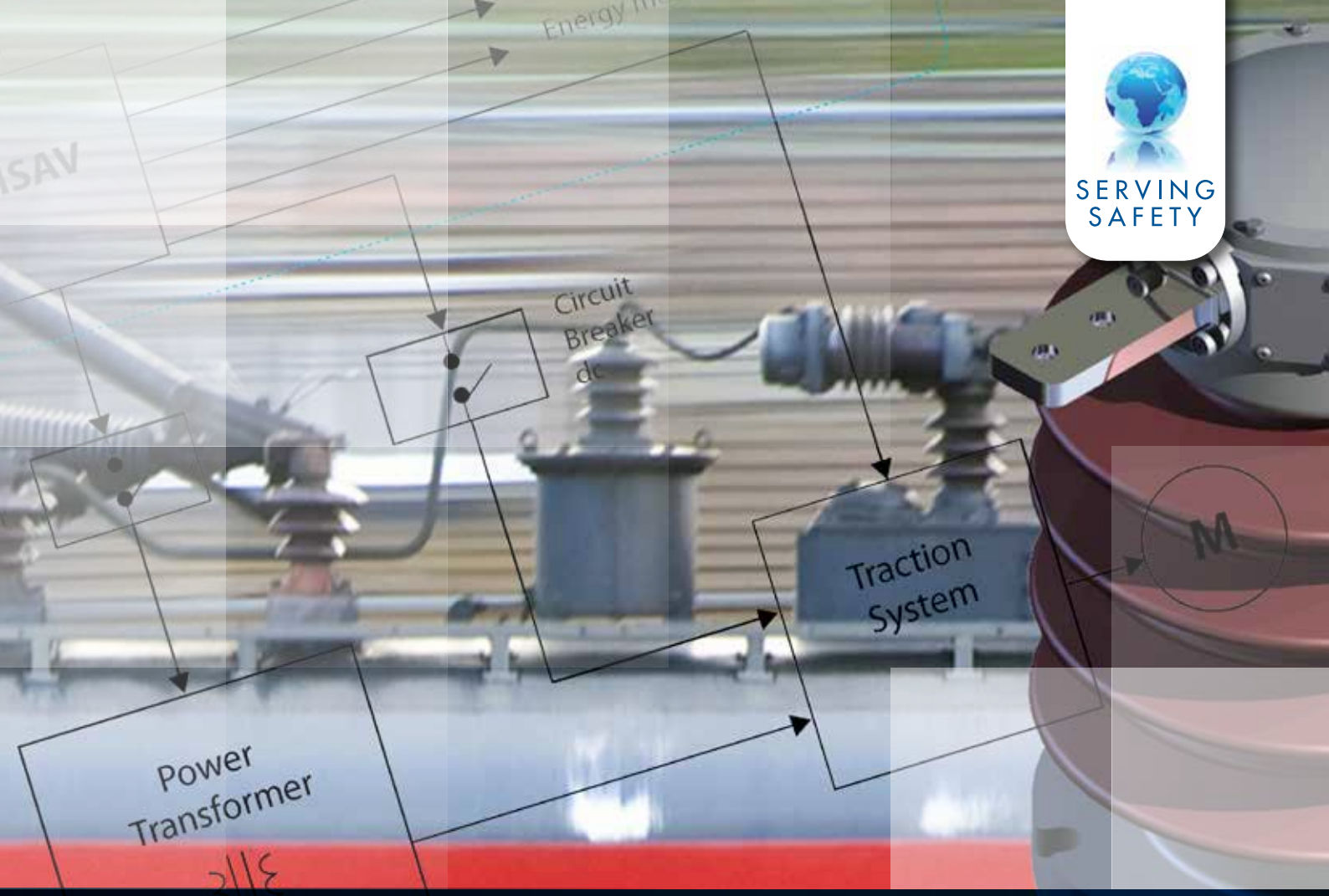


SERVING SAFETY

Mors Smitt Railway Technology

Energy and traction control solutions

Accurate technology for all high voltage and high current measurement applications

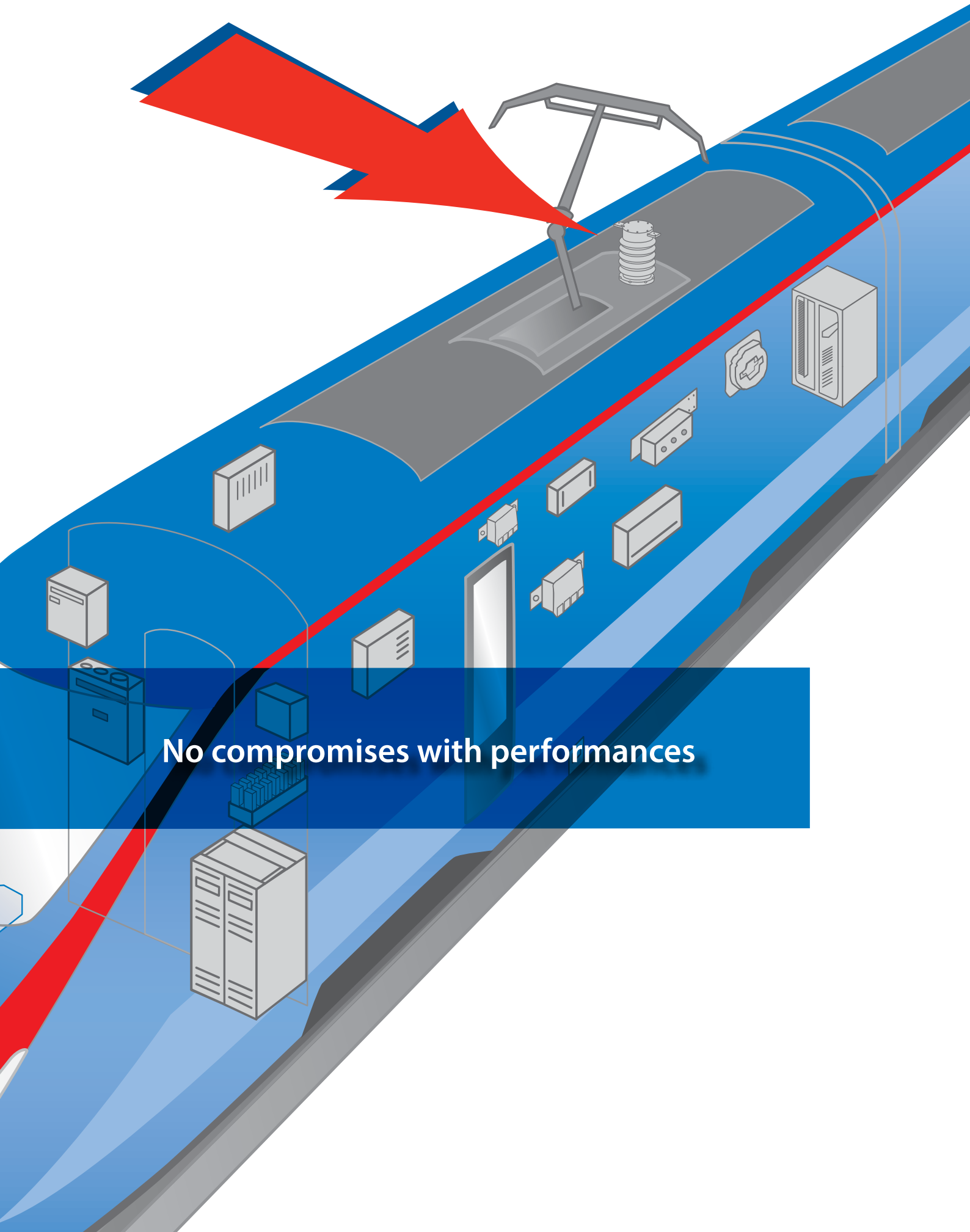
Mors Smitt
A Wabtec Company

SERVING SAFETY

Mors Smitt Railway Technology

Energy and traction control solutions

MSAV sensor range



No compromises with performances

Energy and traction efficiency

SERVING SAFETY

'MSAV is a system to measure high current and high voltage for energy and traction control management, both for new-built and retrofit railway applications'

The international railway market is focused on minimizing the carbon footprint by optimising the use of natural resources and energy. Deregulation of the railway infrastructure requires a different way of working and tools to support new business models in the railway industry the European EN 50463 standard sets new requirements for energy measurement and the calculation of the interoperability cost of rolling stock.

At the same time new trains require more integrated solutions to simplify the design, to save space and weight.

Accurate sensor technology

Mors Smitt has developed the MSAV sensor range, an innovative integrated voltage and current measurement system. The sensor technology is a patented fibre optic insulation technology.

MSAV key features

The MSAV platform is designed to measure high current and voltage, AC and DC, with a very high level of accuracy fully compliant with the new EN 50463 standard. The maximum errror <1.5% for AC and <2% for DC of the calculated energy consumption is easily obtained with the MSAV solution.

The MSAV can detect catenary, overcurrent and harmonics. The MSAV system is capable to support synchronization of traction management systems.

The patented MSAV technology enable a smaller design leading to significant weight and space savings. The MSAV technology does not require calibration which leads to less commissioning and maintenance cost.

Mors Smitt added value

With the MSAV sensor range, Mors Smitt offers a unique all-in-one modular and scalable solutions for energy measurement and traction control functions.

Our products, solutions and services are focused on reduction of the environmental impact. Mors Smitt is certified according IRIS, ISO9001:2008 and ISO14001.

Mors Smitt
A Wabtec Company

Mors Smitt is part of Wabtec Corporation, the NYSE stock exchange listed, global supplier of highly engineered components and solutions for rail and selected industrial markets. Operations in 17 countries and world wide sales in over 100 countries. Wabtec Corporation holds over 1.200 patents and has world class internal processes based on lean manufacturing and continuous improvement principles (Wabtec Performance System).

Within the Wabtec group Mors Smitt has its own name & identity and is focused on satisfying the needs of customers in the power grid, industry and installation sectors.

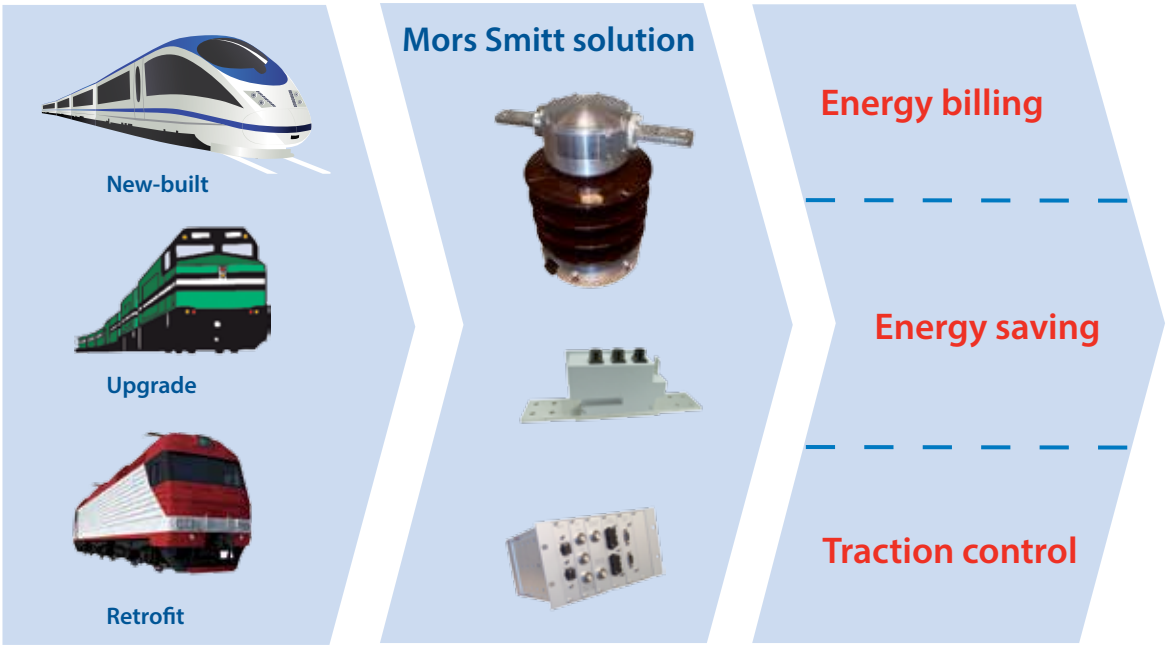
Utrecht, October 2015
Mors Smitt B.V. continuous to improve its products and services. Specifications can be changed without prior notice. No rights can be derived from specifications in this brochure. Changes and printed errors reserved.

Energy measurement & traction control

The MSAV25000 and MSAV-DC standard versions offer a unique tailor-made solution for new-built and retrofit applications for energy measurement and integrated traction management functions.

Key features

- Energy measurement in one system (EN 50463 and TSI compliant)
- Unique device for all train functions (sensing device, short circuit & overcurrent detection)
- Weight and space saving, simplified schematic
- Simplified roof architecture
- Easy integration on any retrofit and new-built trains
- Outstanding accuracy
- Patented fiber optic technology ensures the highest isolation between high voltage and low voltage interfaces
- Interoperability with all railway rolling stock and network



MSAV25000

MSAV-DC

Remote box

MSAV sensor range

Traction control functions

Traction management

- Catenary detection
- Traction synchronisation
- HV circuit protection
- Harmonic detection
- Analog, digital & logic outputs

See page 9

Energy billing solutions

Energy data handling

- Energy database
- Ground server transmission
- TSI compliant
- EN 50463
- ERESS, Socle, ...

See page 10

Energy saving

Driver advisory system

- Driver assistance
- Energy analysis
- Energy displaying

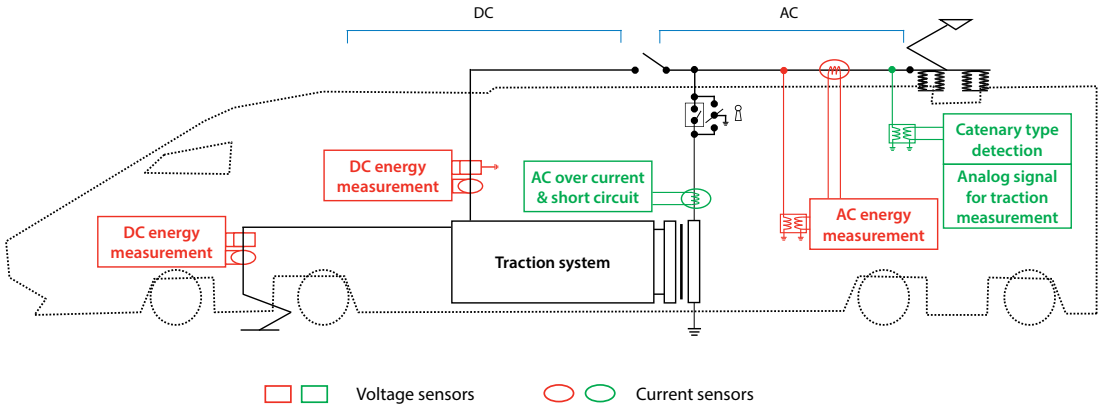
See page 11

Full high voltage sensors

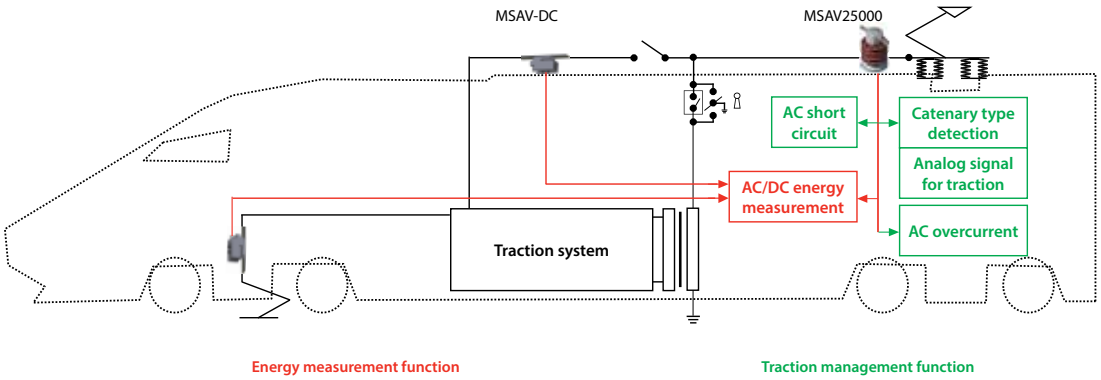
The MSAV sensors provide a proven reliable, accurate and cost effective solution for rolling stock. Based on its capacity of multi-voltage and current measurements, MSAV products can be used as a simple solution for energy measurement implementation on existing rolling stock as well as traction control functionalities for new-built trains (e.g. safety catenary type detection, traction synchronisation protection of the main transformer by overcurrent detection etc.)

With the validated, smart and independent functional integration of the energy measurement and traction control functions, the MSAV solution allows space and weight saving for new-built rolling stock by reducing the amount of equipment needed.

Yesterday: several sensors for same AC or DC catenary measurements



Today: just MSAV25000 and MSAV-DC for all high voltage measurements



Traction control functions

Multi-voltage AC/DC traction units need high voltage measurement for several train functions. Mandatory for energy measurement, they are also used on several applications for traction control, protection an monitoring, which is usually done by several sensors measuring the same current and voltage value.

Catenary detection

This function recognises the AC or DC catenary type and detects the voltage presence with high level of safety for traction management and configuration. Dedicated 25 kV 50 Hz, 15 kV 16 Hz 2/3 and DC logic outputs are activated with relevant catenary.

Signal for traction inverter synchronisation (sensing device)

This function triggers the traction inverter synchronisation, based on one or more analog voltage or current outputs proportional to the AC catenary voltage.

Overcurrent detection logic function (QLM relay)

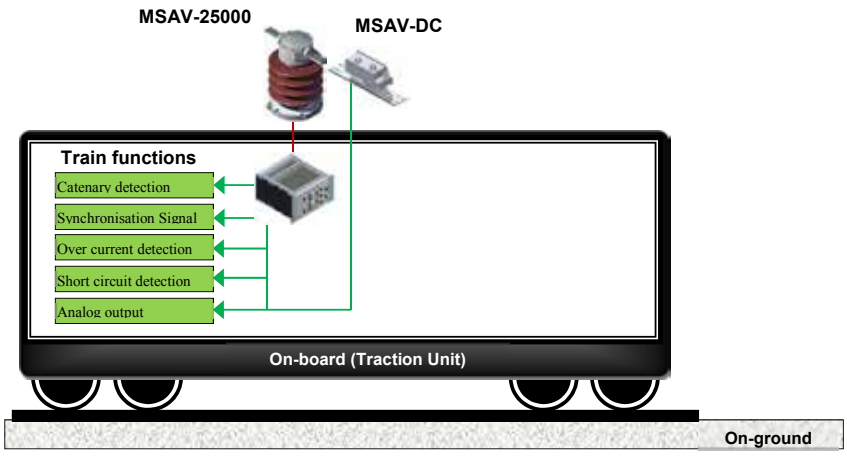
This function protects the main transformer by detecting the limited current threshold. Its logic output is used by the train management system as an input to open the main circuit breaker and to stop the current flow.

Short circuit detection

This function protects the main transformer by detecting short circuit current establishment. Its dynamic analog output proportional to the collecting current is analysed by the train management system to open the main circuit breaker and to stop the current flow.

Harmonics detection

This function detects perturbation rejected by the train to the catenary to protect the signalling system. Its dynamic output proportional to the voltage output is analysed by the train management system to detect harmonics levels.



For both MSAV25000 and MSAV-DC sensors, additional outputs can be included for external signal processing functionalities e.g. by TCMS.

Additional outputs

Analog outputs proportional to catenary current and voltage measurement can be added for other customer functions upon request.

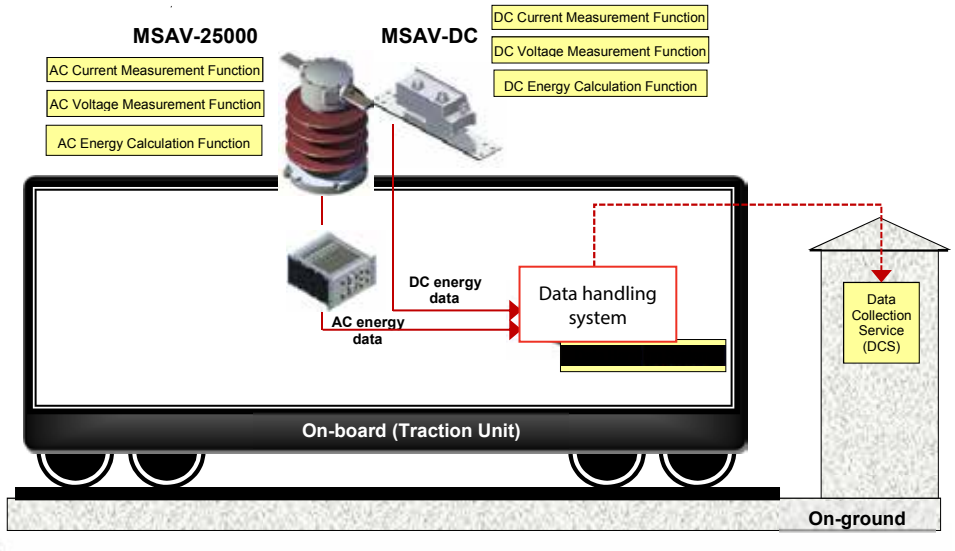
Energy billing solution

The energy measurement system is covered by the new European standard EN 50463, which defines all technical requirements for main use of energy billing purpose.

Compliancy with the EN 50463 standard allows interoperability by fulfilling the Technical Specification for Interoperability (TSI) derived from the European directive.

The MSAV25000 and MSAV-DC sensors calculate active and reactive energy consumption during traction and regeneration during breaking by the train.

The MSAV25000 and MSAV-DC sensors send the energy data to the data handling system for storage or for transmission to a ground server.

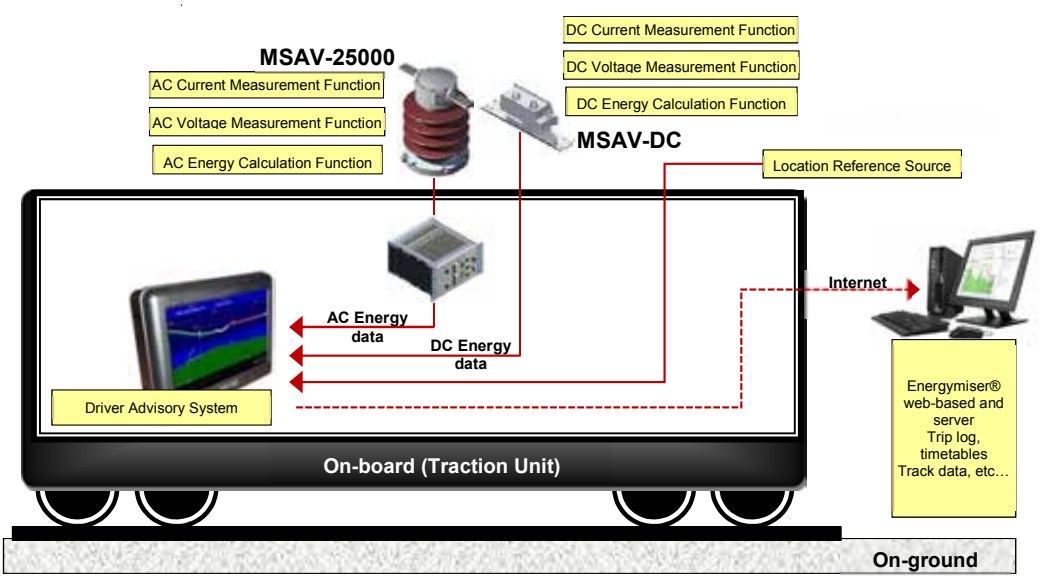


In addition to billing purposes, savings can also be achieved by the high accuracy performances on energy calculations defined in the EN 50463 standard.

Realtime driver information on energy consumption offers important cost savings and supplies an efficient tool to complete improvements in the driver behaviour program.

The Train Advisory System takes in account the energy consumption, route configuration, remaining and target arrival times allowing energy efficiency with respect of the timetable.

Our system with its realtime energy output is fully compatible with the existing TTG Driver Advisory System ENERGYMISER® (DAS), which has already proven significant results in energy cost reduction (and is already in service in the UK).



Overview

MSAV25000

Functions

- AC voltage measurement function (VMF) according EN 50463
- AC current measurement function (CMF) according EN 50463
- Energy calculation function (ECF) according EN 50463
- AC type catenary detection
- AC overcurrent detection
- AC traction synchronisation

Catenary voltage according EN 50163

- 25000 VAC 50 Hz
- 15000 VAC 16 Hz 2/3
- 3000 VDC
- 1500 VDC

Nominal current

- In up to 900 A AC
- Remote box outputs

Energy billing and saving

- 2x ethernet output for energy data to DHS and DAS
- Diagnostic through ethernet communication

Traction control
- Analog current or voltage output for synchronisation signal
- Logic output for catenary type detection
- Logic output for over current detection
- Logic output for diagnostic

Optional outputs
- Analog ± 50 mA outputs
- RS485 output for train management system

Accuracy according EN 50463 for ethernet outputs
- < 1.5 % error for AC energy output

Synchronisation signal characteristics
- Voltage or current analog signal for catenary values
- Maximum delay 300 µs
- Phase measurement accuracy ± < 30 µs
- Class 1 according IEC 60044

Logic output for catenary type detection
- Equivalent to SIL2 level (10-7)

Insulation according EN 50124-2
- Category OV4-PD4
- Electrical shock 170 kV
- Dielectric 75 kV, 50 Hz, 1 min

Power supply
- 24 V, 72 V or 110 VDC

Operating temperature
- Ambient operating -40 °C...+65 °C (upon request -50 °C for insulator)

IP rate
- IP 65 for insulator
- IP 44 for remote box

Weight
- Total weight 35 kg

Dimensions
- Insulator 450 x 320 mm (height x diameter)
- Remote box 272 x 135 x 185 mm

Installation
- Rooftop mounting for insulator
- Cabinet mounting for remote box

MSAV-DC

Functions
- DC voltage and DC current measurement function according EN 50463
- Energy calculation function according EN 50463

Catenary voltage according EN 50163
- 750 VDC
- 1500 VDC
- 3000 VDC

Nominal current
- In up to 3300 A

Outputs
- DC energy (consumed, regenerated): Ethernet

Accuracy according EN 50463 for ethernet outputs
- < 2 % error for DC energy output

Insulation according EN 50124-2
- Category OV4-PD4
- Dielectric test between primary and secondary circuit 12 kV, 50 Hz, 1 min
- Dielectric test between primary and secondary circuit 25 kV, 50 Hz, 1 s for catenary fail top event

Power supply
- 24 V, 72 V or 110 VDC

Operating temperature
- Ambient operating -40 °C...+65 °C (upon request -50 °C)

IP rate
- IP 65

Weight
- 12 kg

Dimensions
- Busbar 100 x 20 x 500 mm
- Box 162 x 271 x 100 mm

Installation
- Rooftop or cabinet mounting

Test references

To ensure the highest quality and performance of our MSAV sensors, Mors Smitt has carried out extensive qualification and validation tests in laboratories, on train testbenches and onboard trains.

All performed tests, demanded in the EN 50463 standards, have been sucessfully passed and documented. To prove the robust design of the MSAV, highly accelerated life tests in combination with temperature and vibration tests have been performed and passed.

Executed and successfully passed tests:

- Shock & vibration test according EN 61373
- Short circuit test according IEC 60077
- Solar radiation according EN 50125-1
- IP protection test EN 60529
- Cooling test according EN 50155 §10.2.3
- Dry heat test according EN 50155 §10.2.4
- Wet heat test according EN 50155 §10.2.5
- Low temperature storage test according EN 50155 §10.2.14
- Dielectric test according IEC 60077 §9.3.3 and EN 50155 §10.2.9
- Electrical shock test according IEC 60077
- Electrical functional test, current sensor according EN 50155 §10.2.2
- Electrical functional test, voltage sensor according EN 50155 §10.2.2
- Functional test (relay, test input,….) according EN 50155 §10.2.2
- Accuracy definition according EN 50463-2
- Compatibility with meter according EN 50463
- EMC test according EN 50121-3-2
- Thermic test according STME001
- HALT test (combination test T° and vibrations)

Moreover, successful multi-voltage locomotive test validations have also been achieved for complete system MSAV25000 with:

- Energy measurement function
- Catenary detection AC/DC
- Traction synchronisation
- Voltage driver display
- Overcurrent detection logic function (QLM relay)

References

Selected by major operators and carbuilders in Europe, the MSAV systems are used in several train projects. Ensuring a high level of confidence for decisionmakers to choose the best proven solutions for energy saving requirements.

Alstom PP simple deck trains
(1000 trainsets)

CAF EMU

Bombardier PHD double deck trains
(860 trainsets)

KVSZ - EMU

ZLNE locomotives

Concept validated on Alstom new AGV
high speed train

Concept validated on Alstom multi-voltage
locomotive Prima II

MSAV -> your benefits

SERVING SAFETY

Modularity

Energy management function
- TSI & EN 50463 compliant
- High accuracy level and lifetime
- Digital and analog outputs
- New-built and retrofit solution

Traction management functions
- Analog, digital and logic outputs
- Management and protection functions
- Configurable outputs

Proven solution

Existing references on major European fleets
- Energy management functions
- Traction management functions

Extended testing procedures
- EN 50463
- High accelerated life test (HALT)
- Meteological laboratory
- Trial

30 years availability

Cost effective solution

Maintainability

Easy installation and maintenance:
- Compact and light solution for simple roof installation
- Calibration free
- Performance re-verification easily done onboard with low voltage tools
- Installation in 2-3 hours
- Separate functional board on remote box for better diagnostic and replacement

Safety

High galvanic separation between primary and secondary circuits.
- 75 kV (MSAV25000), 12 kV (MSAV-DC) dielectric strength
- 170 kV peak transient voltage
- OV4-PD4 according EN 50124

100% functional tested.

SERVING SAFETY

Mors Smitt Railway Technology

Energy and traction control solutions

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