INSTYTUT KOLEJNICTWA	TECHNICAL STANDARDS DETAILED TECHNICAL CONDITIONS FOR THE CONSTRUCTION OF THE RAILWAY INFRASTRUCTURE OF THE SOLIDARITY TRANSPORT HUB – DESIGN GUIDELINES	CENTRALNY PORT KOMUNIKACYJNY – SOLIDARITY TRANSPORT HUB POLAND
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TECHNICAL STANDARDS
DETAILED TECHNICAL CONDITIONS FOR THE CONSTRUCTION OF RAILWAY INFRASTRUCTURE OF THE SOLIDARITY TRANSPORT HUB – DESIGN GUIDELINES

VOLUME VII.3

DEVICES FOR THE DETECTION OF ROLLING STOCK FAILURE CONDITIONS (DSAT)

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The list of volumes constituting the detailed technical conditions for the construction of the railway infrastructure of the Solidarity Transport Hub:

Volume A	Introduction to the STH railway standards
Volume I.1	Railway track – layout geometry
Volume I.2	Railway – design of civil structures
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Volume I.4	Railway track – gauge
Volume I.5	Railway track – geotechnical investigations and design
Volume II.1	2 x 25 kV 50 Hz AC overhead catenary system and traction power supply
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Revision of the document “Detailed technical conditions for the construction of railway infrastructure of the Solidarity Transport Hub; Volume XVIII; Security, protection and cybersecurity integrity requirements”:

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1 Introduction

This volume VII of the Technical Standards – Design Guidelines is one of 30 volumes containing a description of detailed technical conditions for construction of railway lines up to a speed of Vmax ≤ 350 km/h.

1) While preparing the Standards, reference documents have been taking into account that can be found in chapter 16.
2) The requirements of the standards are compliant with the applicable legal requirements for the railway system interoperability in the European Union.
3) The Standards were developed taking into account the current state of the art in the scope of designing devices for the detection of rolling stock failure conditions.
4) For issues not regulated in the Standards, the applicable regulations, standards in this scope and technical knowledge shall be applied.
5) Whenever the Standards refer to the “STH railway infrastructure”, “STH railway lines”, etc., the new railway infrastructure, new railway lines or other structures constructed by STH, which may be managed by another railway infrastructure administrator in the future, shall be taken into consideration.

1.1 Technical scope

These guidelines apply to all categories of railway lines managed by STH. The guidelines shall be applied with regard to the devices for the detection of rolling stock failure conditions (dsat) installed on such lines.

These standards cover the basic requirements concerning the devices for the detection of rolling stock failure conditions (dsat). These standards apply to standard-gauge lines and rolling stock with nominal spacing of 1435 mm, speed up to 350 km/h, 25 kV/50 Hz and 3 kV DC overhead catenary system.

1.2 Links to other volumes

The correlations of this Volume are presented in Table 1.

Table 1

Volume No	Volume title	Relation content
IV	Non-OCL power engineering	In the scope of dsat devices power supply
VI	Control command and signalling and ETCS	In the scope of dsat devices cooperation with ERTMS
XI	Electromagnetic compatibility (EMC)	In the scope of electromagnetic compatibility of dsat devices
XVI	Rolling stock	Within the range of the axle box visibility zone

1.3 Definitions of terms used

Infrastructure manager

Infrastructure Manager – an entity responsible for managing the railway infrastructure, its operation, maintenance, renewal or participation in the development of the infrastructure, and in the case of construction of new infrastructure, an entity that commenced its construction as the investor

(as defined in the Railway Transport Act) ***Błąd! Nie można odnaleźć źródła odwołania.***

Rail system

Rail system – a rail network distinguished by functional and technical features and rail vehicles intended to be operated in that network.

(as defined in the Railway Transport Act) ***Błąd! Nie można odnaleźć źródła odwołania.***

Railway infrastructure

The railway infrastructure comprises the following elements, provided that they form a part of a railway line, railway siding or another railway road, or are intended for their management, handling of passenger or goods transport or their maintenance:

1) railway tracks, including switches and crossings of tracks, included rails, grooved rails, guard rails, check rails, guidance rails, switches, frogs and other point switch elements, railway sleepers and stabilisations, minor track superstructure components, ballast bed, including ballast chips and sand;

2) turntables and transfer tables;

3) track substructure, in particular embankments and cuttings, channel and drain systems for the evacuation of water, masonry trenches, curtain walls, vegetation planted to protect slopes;

4) engineering structures: bridges, overpasses, culverts and other bridge structures, tunnels, pedestrian subways and overpasses, retaining walls and slope bracings;

5) control locations, interlocking, including protection, signalling and communication devices on the route, at stations and marshalling yards, devices used for the generation, processing and distribution of electric power for signalling and communication purposes; buildings in which such devices or systems are located; track-side devices for safe train traffic monitoring and for detecting emergency conditions in the rolling stock; rail brakes; devices for heating switches;

6) platforms with infrastructure enabling passengers to reach them on foot or in a vehicle from a public road or a railway station;

7) goods platforms, including those at freight terminals, along with roads for transporting goods to and from public roads;

8) service roads and passages along tracks, enclosure walls, hedges, fencing, fire breaks, snow screens;

9) level crossings and passages at the rail level, including equipment and systems used to ensure road and pedestrian traffic safety;

10) lighting systems for railway traffic and safety purposes;

11) electricity processing and distribution equipment for OCL power supply: substations, power supply cables between substations and contact wires, overhead contact line with supporting structures, third rail with supporting structures;

12) land marked as cadastral plots on which the elements listed in points 1–11 are located.

(as defined in Appendix No. 1 to the Railway Transport Act) ***Błąd! Nie można odnaleźć źródła odwołania.***

dsat device – track and track-side equipment for detecting emergency conditions of rolling stock.

dsat system – includes dsat devices and devices working with them, such as the terminal, the master dsat information system, interfaces with other information systems.

COK sensor (wheel presence sensor) – a sensor activating measurement functions by an approaching train.

CNK sensor (wheel load sensor) – a wheel load measurement sensor.

CTH sensor (brake temperature sensor) – a track device for brake temperature measurement.

CTM sensor (axle box temperature sensor) – a track device for axle box temperature measurement.

DZP (dynamic behaviour of pantographs) – a function to detect abnormal operation of pantographs.

GM function ("hot axle box" function) – a function of the dsat device to detect hot axle boxes while the train is running.

GH function ("hot brakes" function) – a function of the dsat device to detect faulty brakes while the train is running.

OK function ("wheel load" function) – a function to detect exceeded axle loads on the track of a single axle and linear (per 1 running meter of the track), resulting from loading or faulty suspension of the rail vehicle, the function is implemented by measurement of the values of momentary wheel loads when the train is running – the function is not rolling stock weighing.

PD function (**dynamic overload function**) – in dsat devices, a function to detect excessive dynamic impact of the vehicle on the track as a result of the vehicle being out of order; the dynamic overload is an additional contact force applied by the wheel to the rail while the rail vehicle is running, measured as a dynamic component of the vertical wheel force on the rail. Functionally, it replaces the previously used function of "flat places" (PM).

PS function (rolling stock gauge exceeded function) – a function to detect exceeded rolling stock gauge and load.

Rolling stock failure condition – malfunction of the running gear, pantograph of the railway vehicle.

Reference temperature – the value of the ambient temperature or the temperature of the wagon body used as a base value for measurements of hot axle boxes and hot brakes.

1.4 List of abbreviations used

COK – wheel presence sensor;

CNK – wheel load sensor;

CTH – brake temperature sensor;

CTM – axle box temperature sensor;

Dsat – detection of rolling stock failures;

DZP – dynamic behaviour of pantographs (function of dsat devices monitoring the condition of pantographs);

GH – hot brakes (function of dsat devices monitoring the temperature of the brakes);

GM – hot axle boxes (function of dsat devices monitoring the temperature of axle boxes);

GM-R – hot axle boxes differential alarm – informing about an excessive axle box temperature difference in the wheelset;

GRAN-O – axle load limit;

GRAN-L – linear load limit;

GRAN-NNO – limit of unbalanced loads between wheelsets;

GRAN-NNW – limit of unbalanced loads between bogies;

GRAN-NNL/P – limit of unbalanced loads between the right and left side wheels;

NO – axle load;

NL – linear load;

NON – unbalanced loads between wheelsets,;

NNW – unbalanced loads between bogies;

NNL/P – unbalanced loads between the right and left side wheels;

PD – dynamic overload (function of dsat devices monitoring the dynamic interaction between wheelsets and the track);

PS – rolling stock gauge exceeded (function of dsat devices monitoring the rolling stock gauge).

1.5 Purpose and scope of the devices for the detection of rolling stock failure conditions (dsat) application

The devices for the detection of rolling stock failure conditions (dsat) are intended for:

a) ensuring the safety of train traffic by detecting and warning about the occurrence of a running gear failure condition, in particular the detection of rolling stock with hot axle boxes which may cause accidents and railway disasters as well as infrastructure damage, and also intended for monitoring the dynamic condition of the pantograph and the exceedance of the rolling stock gauge.

b) protection of railway infrastructure through:

- detection of rolling stock with wheelset and suspension defects, which may lead to damage of rails and turnouts,
- detection of rolling stock with damaged brakes, which may accelerate rail wear and result in rim slackening and rolling stock derailment,
- detection of rolling stock with exceeded threshold values for axle load on the track, causing accelerated degradation of the railway infrastructure.

Dsat devices may also be an element that supports the rolling stock maintenance process by

enabling the verification of rolling stock parameters.

2 Essential, basic and general requirements for the STH railway infrastructure

Table 2 defines the link between the detailed technical conditions and the essential, basic and general requirements for the STH infrastructure.

Table 2

sub-chapter of this volume defining detailed technical conditions	essential requirements (Railway Interoperability Directive)						basic requirements	general requirements for the STH railway infrastructure			
	1.1. security	1.2. reliability and accessibility	1.3. health	1.4. environmental protection	1.5. technical compliance	1.6. accessibility	2.1. mechanical resistance and stability 2.2. fire safety 2.3. hygiene, health and the environment 2.4. safety and accessibility in use 2.5. protection against noise 2.6. energy economy and heat retention 2.7. sustainable use of natural resources	3.1. oriented towards the needs of the economy	3.2. orientation towards the needs of passengers	3.3. orientation towards the needs of carriers	3.4. compatibility with the railway infrastructure connected with the STH railway infrastructure
3..1	1.1.1. 1.1.2.	1.1.12			1.5.1.						
3.2.	1.1.1. 1.1.2 1.1.8	1.1.12			1.5.1.		2.2.1, 2.3.1, 2.6.1				
3.3 ÷3.6	1.1.1. 1.1.2 1.1.5. 1.1.6.	1.1.12			1.5.1.		2.2.1, 2.3.1, 2.6.1				
3.8	1.1.1. 1.1.2.	1.1.12			1.5.1.						
3.9	1.1.1 1.1.2. 1.1.7.	1.1.12			1.5.1.		2.2.1, 2.3.1, 2.6.1				
3.10	1.1.1. 1.1.2 1.1.5. 1.1.6.	1.1.12			1.5.1.						
3.1.10	1.1.1. 1.1.2. 1.1.3. 1.1.5.	1.1.12			1.5.1.						
3.1.11	1.1.1. 1.1.2. 1.1.3. 1.1.5.	1.1.12			1.5.1.						
3.1.12	1.1.1. 1.1.2. 1.1.3. 1.1.5.	1.1.12			1.5.1.						
3.1.14	1.1.1. 1.1.2. 1.1.3. 1.1.5.	1.1.12			1.5.1.						

3.11	1.1.1. 1.1.2. 1.1.3. 1.1.5.	1.1.12			1.5.1.						

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Cybersecurity

Technical solutions which collect, store, process, make available or transmit data ensuring compliance with the essential requirements with respect to safety (requirements from 1.1.1. to 1.1.11. specified in Volume A of the STH railway standards) and general requirements for the STH rail infrastructure with respect to protection (requirements from 1.1.12. and 1.1.13 specified in Volume A of the STH railway standards) should be designed taking into account cybersecurity, i.e. “security of network and information systems”, which is defined in the Directive concerning measures for a high common level of security of network and information systems as follows:

> “security of network and information systems” means the ability of network and information systems to resist, at a given level of confidence, any action that compromises the availability, authenticity, integrity or confidentiality of stored or transmitted or processed data or the related services offered by, or accessible via, those network and information systems;
>
> *[as defined in Article 4 of Directive 2016/1148]*

Cybersecurity includes two types of threats resulting from unauthorised access to the systems/equipment/networks that collect, store, process, make available or transmit data:

1) physical security threats

   It is necessary to secure systems/equipment/networks against direct access which could enable causing (intentionally or unintentionally) threats to functional safety.

2) IT security threats

   It is necessary to secure systems/equipment/networks against logical access via IT systems/equipment/networks, which could enable causing (intentionally or unintentionally) threats to functional safety.

Cybersecurity defined this way applies both to information systems used for rail transport purposes and to operational systems used for rail transport purposes, but the STH railway standards do not include requirements for information systems, e.g. timetabling systems.

Physical security threats and IT security threats for operational systems for which requirements are defined in the STH railway standards should be addressed by railway operators as part of the risk assessment and by design engineers/manufacturers/contractors as part of threat control. Additionally, it is required for the applied protections to be documented and verified in accordance with the requirements included in Volume XVIII of the STH railway standards.

Cybersecurity within the scope of this volume of the STH railway standards

In the scope covered by this volume of standards, there are networks and information systems whose security could be compromised, as well as technical solutions to collect, store, process, make available or transmit data having impact on security and/or protection. Therefore, they should be protected against physical security and IT security threats in a manner compliant with the requirements of the Information Safety Management System (ISMS) implemented by the STH company.

Information Safety Management Systems (ISMS) include:

a) ensuring that unauthorised persons do not have access to cable networks and equipment (active equipment of networks, computers);
b) monitoring of the location of the above-mentioned resources via video monitoring;
c) control of access to these locations by certified locks or other physical protection mechanisms and their protection by alarm and fire protection systems in case of attempts to violate protections or fire;
d) separation of the information systems of the infrastructure manager and the carriers and the personnel using them from the systems of universal Internet access.

In order to ensure cybersecurity, networks and information systems whose security could be compromised, as well as technical solutions that collect, store, process, make available or transmit data affecting security and/or protection should comply with the requirements of the ISMS implemented by the STH company, in particular with regard to:

1. Placing all equipment of active networks and cable connections in lockable rooms or cabinets with access control, alarm and fire protection in case of an attempt to unauthorised access or fire and video monitoring thereof.
2. Ensuring for all active pieces of equipment in lockable rooms or cabinets environmental conditions required by the equipment (temperature, humidity, etc.) by the air conditioning equipment in order to ensure the continuity of operation of the systems.
3. Ensuring power supply for active equipment of networks and computers from a separate power network with uninterruptible power supply (UPS).
4. Ensuring that a fully accessible Internet connection (e.g. Wi-Fi) is completely separated from the local networks of the infrastructure manager and carriers by separating equipment, cable connections and access devices (routers).
5. Protection of local (LAN) and wide (WAN) area networks in accordance with ISO 27000 series standards, generally applicable regulations (e.g. GDPR) and the Act of 5 July 2018 on the national cybersecurity system.

At the same time, it should be kept in mind that the ISMS will be subject to changes because maintaining the required level of cybersecurity is not possible by one-time fulfilment of requirements of standards since cybersecurity is a process, and not a state. In order to minimise the number and magnitude of cyber threats, the requirements (duties) mentioned in the Act of 5 July 2018 on the national cybersecurity system, in its Chapter 3 for operators of key services and in Chapter 5 for public entities, should be continuously followed in operational processes and only services of digital service providers fulfilling the obligations described in Chapter 4 of that Act should be used.

3 Detailed technical conditions for DSAT devices

3.1 Functional requirements

3.1.1 Rolling stock monitored by dsat devices

Dsat devices shall be adapted to monitor all types of rail vehicles, taking into consideration:

1) type of axle box structure,
2) type of brake design (disc, block type),
3) wheel diameters,
4) wheel gauge for rail vehicle trucks.
5) All wheelsets must be monitored

3.1.2 Basic parameters of railway lines equipped with dsat devices

Technical parameters of dsat devices refer to railway lines adapted to the speed of 350 km/h. Dsat devices shall be installed along straight line sections, where the running of the rolling stock will be without excessive fluctuations and swings, therefore it is not planned that tilting railway vehicles shall require other specialized dsat devices.

3.1.3 Types of rolling stock malfunctions detected by dsat devices

dsat devices shall detect the following rolling stock malfunctions:

1) hot axle boxes – GM function (“hot axle boxes”),
2) hot brakes – GH function (“hot brakes”),
3) rolling stock with axle load exceeded (NO – “axle load”) or with linear load exceeded (NL), unbalanced loads between wheelsets, trucks and wheels (NNO, NNW NNL/P) – OK function
4) excessive dynamic impact of the vehicle on the track, deformations of the wheel rolling surface – PD function (“dynamic overload”),
5) dynamic behaviour of pantographs (DZP),
6) rolling stock gauge (PS) exceeded.

3.1.4 Directions of rolling stock movement

Rolling stock malfunctions mentioned in point 3.1.3 shall be detected by dsat devices when the train is travelling in the direction consistent with and opposite to the principal one, in the case of bidirectional tracks.

3.1.5 Measurement zone

The rolling stock measurement shall be automatically activated upon its entry into the measurement zone.

3.1.6 Impact on other railway infrastructure devices

Functions performed by dsat devices shall be performed without affecting other devices, e.g. systems of railway traffic control equipment which the railway line is equipped with.

3.1.7 Operating and safety conditions

Dsat devices shall meet the technical and functional requirements concerning the operating and

safety conditions for the railway automation equipment specified in the documents determined by the European Commission and adopted for use in the territory of the Republic of Poland.

Dsat devices shall take into account both the requirements for interoperability of railway infrastructure and the requirements for interoperability of rolling stock.

3.1.8 Transmission protocols

Dsat devices shall have a systemic secure data transmission protocol between the base devices and the terminal as well as master systems, preventing the occurrence of distortions on transmission lines.

3.1.9 Stabilization time of dsat devices after cooling

An interruption in the power supply of dsat devices, resulting in a complete cooling of axle box and brake temperature sensors, forces thermal stabilization of equipment. For the devices operated on the railway network, the stabilization time which is dependent on the ambient temperature and type of the device as well as the technical condition of the axle box and brake temperature sensor measurement track, shall be specified by the manufacturer in the technical documentation of the equipment.

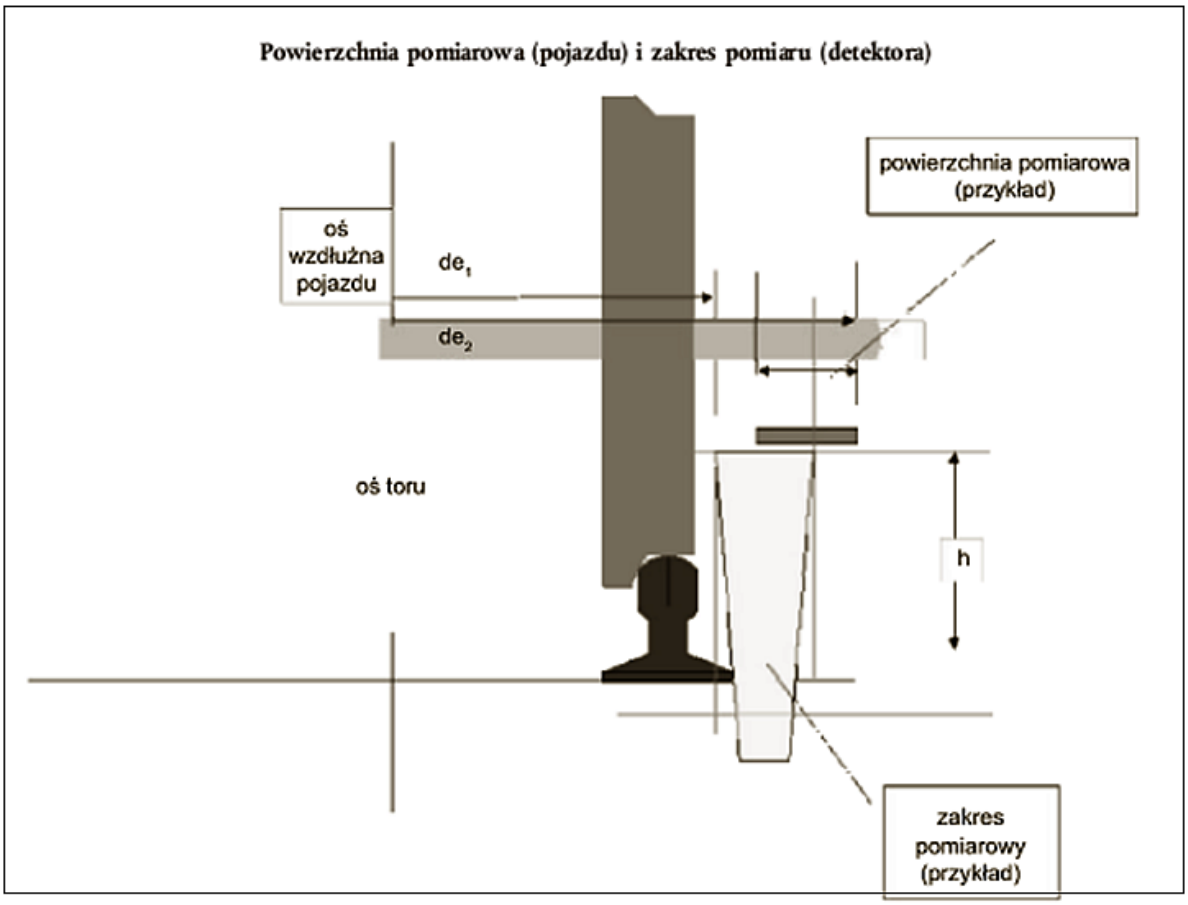
3.1.10 Technical requirements for hot axle box (GM) function

3.1.10.1 Basic requirements for GM function

1) The requirements for the detection of hot axle boxes determining the areas to be observed by temperature sensors are specified in standard PN-EN 15437-1:2009 Railway applications - Axlebox condition monitoring - Interface and design requirements - Part 1: Track side equipment and rolling stock axlebox.
2) The requirements mentioned above shall not apply to vehicles equipped with on-board hot axle boxes detection devices and vehicles with shielded bearings from track-side hot axle boxes detection devices.
3) Hot bearing/axle box sensors shall be based on a measurement using thermal radiation of bearings (axle boxes). The measurement shall be based on multi-beam detectors – simultaneous measurement with at least four beams is preferred.

3.1.10.2 GM measurement surface

1) The measuring range constitutes the characteristics of the hot axle detection system and its location.
2) The measuring surface of the vehicle and the measuring range of the GM detector interact and must coincide. The axle box temperature sensors shall perceive the axle box vertically at right angle (Fig .1).



PL	EN
Powierzchnia pomiarowa (pojazdu) i zakres pomiaru (detektora)	Measuring surface (vehicle) and measuring range (detector)
oś wzdłużna pojazdu	longitudinal axis of the vehicle
de_1	de_1
oś toru	track axis
powierzchnia pomiarowa (przykład)	measuring surface (example)
zakres pomiarowy (przykład)	measuring range (example)

Fig. 1. Vehicle measuring surface and detector measuring range acc. to PN-EN 15437-1:2009

3) The measuring range of the hot axle detection system in the longitudinal plane shall correspond to the longitudinal dimensions of the measuring surface in the range from 80 mm to 130 mm.
4) Limits for the direction along the track axis.

   Outside the 500 mm zone (the centre of this zone is determined by the axis):

   a) no element with a temperature higher than the axle box must be located between the axle box and the sensor, nor within a distance of less than 10 mm from the limit of visibility zone of the linear CTM device (axle box temperature sensor),
   b) solar radiation directly reflected from the bearing casing must be prevented from reaching the CTM sensor.
5) The measuring range of the hot axle box detection system shall enable the measurement of the temperature of the hot measuring surface with a width greater than or equal to 80 mm between:
   a) de1 = 1,040 mm,

b) de2 = 1,120 mm

in relation to the longitudinal axis of the vehicle, at a height between h1 = 260 mm and h2 = 500 mm above the rail head (minimum range) in accordance with standard PN-EN15437-1.

3.1.10.3 Range of permissible train speeds

Minimum speed: 3 km/h.

Maximum speed: not less than 350 km/h.

3.1.10.4 Reading duration

The duration of the reading performed by the GM temperature sensor, taking into account the appropriate time of detection of a wheel presence in the zone, must enable undisturbed temperature measurement in the detection zone specified above. The duration of the reading shall be selected by the manufacturer directly in compliance with the measuring method so that the reading duration is not limited by the maximum permissible train speed.

3.1.10.5 Measurement continuity conditions

In order to ensure the GM temperature sensor measurement continuity, it is necessary to ensure that the bearing casing elements and other parts do not obscure the agreed visibility line.

3.1.10.6 Radiation emission

1) Sensors based on the heat radiation measurement method are sensitive to solar radiation, which may, directly or indirectly, through reflection, enter the sensor observation hole.
2) Sensors shall be protected against the effects of solar radiation:
    a) by software-based filtering of disturbances caused by solar radiation, or
    b) by changing the sensor position in the track; changing the sensor orientation relative to the track centerline is permitted.
3) Fixed linear devices and their surroundings must not generate direct or diffuse radiation towards axle box temperature sensors.

3.1.10.7 Location and fixing of sensors

1) Axle box sensors can be mounted to rails or sleepers or can be placed inside sleepers.
2) No precise design conditions for fixing elements have been specified.

3.1.10.8 Dimensions of sensors

The shape and dimension of the axle box temperature sensors are not specified. All elements and related structural elements shall be within the structure gauge (not colliding with the rolling stock gauge).

3.1.10.9 Measurement thresholds

1) The following alarm thresholds are defined for the GM function:

    a) WARNING (OSTRZ) when the bearing (axle box) temperature exceeds the set OSTRZ threshold value above the reference temperature
    b) ALARM (STOP) when the bearing temperature exceeds the set STOP threshold value above the reference temperature
    c) DIFFERENTIAL L-R (STOP [L] [P]) when the temperature difference between the left and right bearing exceeds the set STOP L-P threshold value.

2) Reference temperature is the value of the ambient temperature or the temperature of the wagon body used as a base value for measurements of hot axle boxes.

3.1.10.10 Range and accuracy of GM axle box temperature measurements

In accordance with the requirements of the PN-EN 15437-1 standard, device with GM functions shall detect hot axle boxes in the absolute temperature range from -50°C to 120°C with a measurement accuracy of:

a) within the temperature range from -50°C to 0°C – measurement accuracy of ± 10°C,
b) within the temperature range from 0°C to 15°C – measurement accuracy of ± 10°C,
c) temperature range from 16°C to 20°C – measurement accuracy of± 5°C,
d) within the temperature range from 21°C to 90°C – measurement accuracy of ± 3°C,
e) temperature range from -91°C to 120°C – measurement accuracy of± 5°C,

3.1.11 Technical requirements for hot brakes GH function

Requirements for detection of hot brakes (GH) are not specified in the dedicated standards and TSI.

3.1.11.1 Range of permissible train speeds

1) Minimum speed: 3 km/h.
2) Maximum speed: not less than 350 km/h.

3.1.11.2 Measurement method

Brake temperature (CTH) sensors shall be based on heat radiation measurement method using multi-stream multi-beam detectors.

3.1.11.3 GH measurement surface

The measurement area observed by CTH sensors shall include:

a) wheel flanges – for wagons equipped with brake blocks,
b) brake discs for wagons equipped with brake discs.

3.1.11.4 Measurement continuity

1) The array of sensors and the setting of streams must not interfere with other elements of the track and rolling stock structure.
2) The measuring gantry shall take into account the method of measurement, the distribution of the measuring streams and the permissible speed of the trains.
3) The measurement time shall be determined by the system manufacturer in compliance with the measurement technology. The measurement result shall include the temperature of the measured element as well as information on the element the measurement is conducted on – the flange of the wheel or brake disc.

3.1.11.5 Location and fixing of brake temperature (CTH) sensors

1) It is permitted to use sensors on the external side of the railway tracks and inside the track.
2) Sensors can be attached to sleepers or directly to rails or inside special sleepers.

3) No precise design conditions for sensors and their fixing elements have been specified.
4) The design of the sensors and their fixing elements shall not interfere with the gauge of the track and the gauge of the rolling stock.
5) In general, one GH scanner is used to check one side of the wheelset.
6) In locations where the scanner is exposed to sunlight, it is recommended to use two GH scanners.

3.1.11.6 Radiation emission

Fixed linear dsat devices and their surroundings must not emit direct and diffuse radiation towards GH function sensors.

3.1.11.7 Measurement thresholds

1) The following alarm thresholds are defined for the GH function:
   a) WARNING (WARN) – when the temperature of the rim or brake disc exceeds the set WARN threshold value above the reference temperature,
   b) ALARM (STOP) – when the temperature of the brake rim or disc exceeds the set STOP threshold value above the reference temperature, it is the value of the ambient temperature or the temperature of the wagon body used as the base value for the measurements of the hot axle boxes,
2) Reference temperature is the value of the ambient temperature or the temperature of the wagon body used as a base value for measurements of hot axle boxes.

3.1.11.8 Requirements concerning the accuracy of the GH measurement

Dsat devices with GH function shall detect hot brakes in the absolute temperature range from 100 to 500°C with the measurement accuracy of:

1) ±10°C within the range of 100°C ÷ 400°C inclusive,
2) ±20°C within the range of 400°C ÷ 500°C inclusive.

3.1.12 Technical requirements for wheel load (OK) function

3.1.12.1 Introduction

1) The equipment that performs the OK function enable the axle load of the whole vehicle and the train to be measured during movement. On the basis of the values measured, it is possible to assess the axle load (i.e. NO parameter), the load per track running meter (i.e. NL parameter), unbalanced loads between the NNO wheelsets, unbalanced loads between the NNW trucks, unbalanced loads between the NNL/P right and left wheels.
2) In TSI provisions, no requirements for the OK function have been specified. The requirements shall be specified by the infrastructure manager.

3.1.12.2 Measurement methods

1) It is permitted to use different measurement technologies.
2) The equipment shall be required to measure quasi-static axle load. On the basis of the measurements, it is required to determine the load of the rail vehicle and the load of the entire train.

3.1.12.3 Measuring range

The measuring range depends on the measurement technology used and shall enable registration of axle loads to the extent required by the regulations of the infrastructure manager.

3.1.12.4 Installation in the track

1) It is recommended that the technology used changes the operation and behaviour of the railway track to the smallest extent possible, with particular attention being paid to the dynamics of the railway track.
2) It is recommended to use sensors that can be dismantled during typical maintenance works, such as tamping or grinding of the track.

3.1.12.5 Radiation emission

1) Fixed linear devices and their surroundings must not generate direct electromagnetic or diffuse radiation towards measuring sensors.
2) It is recommended to use sensors which are resistant to the impact of electromagnetic radiation and do not cause emission of such radiation.

3.1.13 Requirements concerning the dynamic behaviour of pantographs (DZP) function

1) The system of detection of dynamic behaviour of pantographs comprises of devices detecting the interaction between the pantograph and the overhead contact line by measuring oscillations generated in the contact line. This enables detection of defects that may cause damage to the pantograph and the contact line.
2) Sensors of dynamic behaviour of pantographs are sensory systems capable of detecting possible load or pull errors, by measuring the amplitude of vibrations and their frequency components.
3) The stationary pantograph measuring station shall measure and evaluate the following parameters:
    a) static load over the entire operating range (static characteristics of the pantograph),
    b) measurement of overlay wear.
4) The measurement errors resulting from the impact of wind on the contact wires shall be taken into account.

   It is recommended to construct the station on an open line with a variable height of contact wires suspension. This station enables estimating the pantograph contact force within a short period of time within the full range of the pantograph operation.
5) The open line devices include two sensory elements consisting of a camera and a backlight screen. These sensors are responsible for measuring the oscillation in the overhead catenary system spans during the passage of a train.
6) As part of the equipment, it is recommended to include a meteorological station in order to monitor weather conditions: temperature, humidity, wind direction and velocity and record the above data during the passage of a train.
7) The criteria for the arrangement of sensors of dynamic behaviour of the pantograph along the line are as follows:
    a) installation of sensors as close as possible to the beginning of the line and entrances to the line,
    b) installation on both main tracks and for both movement directions,
    c) installation of a sensor at a distance from the anchoring of a given section or overhead switch,
    d) installation of a detector at a distance from the places where the train accelerates or decelerates.

3.1.14 Requirements concerning the rolling stock gauge exceeded (PS) function

1) The rolling stock gauge exceeded (PS) function enables determining with some degree of accuracy whether the rolling stock or load exceeds the rolling stock gauge.

2) The gauge monitoring device consists of three optical distance sensors, each of which is responsible for checking one of the train edges (side edges and roof).
3) Rolling stock or load exceeding the gauge of one of the edges from this area causes the sensor to send an alarm signal.
4) The PS sensors shall be installed in front of the entrance to the tunnels at a distance enabling the train to be safely stopped before the entrance to the tunnel, when it is detected that the gauge is exceeded.
5) PS sensors shall be installed in locations where trains run at a constant speed without scheduled braking or acceleration.

3.2 Defining threshold values by dsat devices

Dsat devices shall define threshold values for individual functions which inform that the value of the parameter monitored has reached a set value. It shall be possible to redefine defined threshold values.

3.2.1 Thresholds for the “Hot axle boxes” GM function

Two axle box temperature thresholds have been defined:

1) warning threshold (OSTRZ),
2) alarm threshold (STOP).

The condition (OSTRZ) indicated by the device informs that further operation of the rolling stock may result in changes in the parameter value up to the alarm value (STOP).

The alarm state (STOP) signalled by the device informs that the state of the rolling stock may lead to a direct hazard to the safety of train traffic.

3.2.2 Thresholds for the “Hot axle boxes – differential” GM-R function

One threshold defined to indicate that the temperature difference between the right and left axle box is exceeded: alarm threshold (STOP).

The alarm state (STOP) signalled by the device informs that the state of the rolling stock may lead to a direct hazard to the safety of train traffic.

3.2.3 Thresholds for the “Hot brakes” GH function

Two brake temperature thresholds have been defined:

1) warning threshold (OSTRZ),
2) alarm threshold (STOP).

The condition (OSTRZ) indicated by the device informs that further operation of the rolling stock may result in changes in the parameter value up to the alarm value (STOP).

The alarm state (STOP) signalled by the device informs that the state of the rolling stock may lead to a direct hazard to the safety of train traffic.

3.2.4 Thresholds for the “Dynamic Overload” PD function

Two thresholds have been defined:

1) warning threshold (OSTRZ),
2) limit threshold (GRAN).

The following states signalled by the equipment: Warning (OSTR) and limit (GRAN), indicate that the values of monitored parameters have exceeded the set values.

3.2.5 Thresholds for the “Wheel load” OK function

For the OK function, the thresholds shall be defined separately for locomotives and other rolling stock.

The following thresholds are used:

1) NO axle load threshold value (GRAN-O),
2) NL linear load threshold value (GRAN-L),
3) unbalanced load between NNO wheelsets NN (GRAN-NNO),
4) unbalanced load between sets of NNW trucks (GRAN-NW),
5) unbalanced load between right and left side NNL/P wheels (GRAN-NNL/P)

The threshold states GRAN-O and GRAN-L signalled by the equipment indicate that the permitted value of a monitored parameter specified for a given line has been exceeded.

3.2.6 Alarm threshold values for individual functions

Alarm threshold values in dsat devices are determined by the infrastructure manager taking into account the rolling stock specification and the permissible load.

For temperature thresholds, the values of the alarm threshold values may be absolute or relative values, taking into account the reference temperature. The reference temperature is the value of the ambient temperature or the temperature of the wagon body used as the base value for the measurements.

3.3 Design requirements

The design of dsat devices shall enable:

a) detection of rolling stock malfunctions in automatic mode,
b) signalling of rolling stock malfunction detection information at the operating personnel terminal,
c) measuring train speed and determining its direction of movement,
d) device autonomous operation, with data transmission from the base device to the cooperating terminal,
e) device network operation with possible transmission of data concerning the tracking of adverse phenomena occurring in the rolling stock,
f) regular calibrations of devices by the personnel being non-obligatory,
g) diagnostics and maintenance, alteration and extension operations,
h) extension with additional measuring functions,
j) user's ability to define the level and number of alarm thresholds for all functions performed.

3.4 Data archiving requirements

Dsat devices shall enable recording and archiving of all events and faults, with the date and time of their actual occurrence. The archiving time shall be determined by the infrastructure manager.

3.5 Train length requirements

The devices shall record the results of train detection with a maximum axle number of at least 500.

3.6 Requirements for device performance tests

1) Tests detecting and signalling possible malfunctions in the operation of the components, including: wheel presence sensors (COK), axle box temperature scanners (CTM sensors),

brake temperature sensors (CTH), wheel load sensors (CNK), pantograph dynamic behaviour sensors, exceeded gauge sensors, trackside controller, base device and data transmission shall be performed:

- automatically after each passage of a rolling stock,
- at the request of the operating personnel,
- at set time intervals.

3.7 Requirements concerning RAMS parameters

RAMS parameters for dsat devices are specified by the infrastructure owner in consultation with the manufacturer of dsat devices on the basis of the PN-EN 50126 standard.

3.8 Environmental conditions

1) Dsat devices shall be adapted to the following environmental operating conditions:
   a) climate class – T2 according to PN-EN 50125-3; temperature range for:
      – track device (in the track),
      – base (in a container),
      – terminal unit (in the room),
   b) pressure class – A2, and adopted change dynamics of 0.5 ÷ 1.0 kPa/s, also forced by the passing rolling stock, according to PN-EN 50125-3,
   c) humidity – for climate class T2 according to PN-EN 50125-3,
   d) wind gusts – class W2 and SW2 according to PN-EN 50125-2,
   e) rain, hail and snow precipitation, ice formation, lightnings – on the basis of the adopted climatic class acc. to PN-EN 50125-3,
   f) pollution level – M according to PN-EN 50125-3,
   g) fire hazard – external – appropriate for the climate zone; internal – appropriate for the operation of electrical equipment with voltage up to 1 kV – fire protections of class F10 defined according to PN-EN 50125-2:2003, the container of the base unit shall be equipped with fire protections based on an aerosol system or equivalent,
   h) vibrations and impacts on the devices of the track unit – according to the standard depending on the place of installation (track, railway sleeper, track substructure, zone 1, 3 m), according to PN-EN 50125-3.
2) The containers of the device equipment shall ensure an IP56 protection rating at least.
3) The devices shall be resistant to devastation, theft and shall be equipped with a burglary alarm systems in the trackside room of the base unit with notifications displayed at the terminal station.

3.9 Electrical requirements for dsat devices

3.9.1 Power supply of dsat devices

Electrical requirements and rules for power supply of dsat devices, in accordance with the requirements presented in Volume IV, Non-traction power engineering. Ensuring power supply for dsat devices according to the requirements of Volume IV, point 3.1. b, category 3.

3.9.2 Electromagnetic compatibility

The requirements concerning electromagnetic compatibility are included in Volume XI Electromagnetic compatibility (EMC).

Dsat devices shall meet the conditions of electromagnetic compatibility:

a) devices shall be appropriately certified and approved for operation with a 3 kV DC and 25 kV AC overhead catenary system,

b) radio interference emitted by the devices should be limited to levels tolerated by the environment and other co-operating equipment. On the basis of PN-EN 50121-4, the emission level is assumed in relation to EN 50081-2:1993 for devices of the track unit, class B, for the base unit, class A.

c) radio interference emitted by the devices should be limited to levels tolerated by the environment and other co-operating equipment. On the basis of PN-EN 50121-4, the emission level is assumed in relation to EN 50081-2:1993 for devices of the track unit, class B, for the base unit, class A.

d) devices shall be resistant to electromagnetic disturbances and electrostatic discharges, overvoltages coming from external power sources, including the impact of electric traction – shall be equipped with a system overvoltage protection. According to PN-EN 50121-4, criterion B was adopted: resistance to disturbances of devices, i.e. devices in closed casings, input/output systems of signals and power supply sources in relation to the impact of the overhead catenary system, voltage peaks, electrostatic discharges and electromagnetic field impulses. In order to minimize disturbances for the devices of the base unit, modular universal surge arresters of class I + II + III (B + C + D) are recommended – in accordance with PN-IEC 61643-1 standard – for protection against all kinds of surges and against direct impact of lightning current, electrical systems and equipment installed in small facilities (containers, cabinets).

3.10 Requirements for dsat devices design

3.10.1 Architecture of dsat devices and system

1) The main dsat devices consists of track and trackside equipment which can be divided in terms of structure and functionality into two units:

a) track unit – used to obtain information on the condition of rolling stock elements,

b) base unit – used to measure and analyse information on the condition of rolling stock elements from the track unit.

2) Track and trackside dsat devices cooperates with the terminal unit used for processing and archiving measurement data, which presents the results of checks of the diagnosed rolling stock on the monitor and optionally using a printer.

3) The terminal unit shall connect via interfaces with the DSAT Master Information System and other information systems specified in point 3.10.4.14.

4) The DSAT Master Information System enables:

a) notification of the failure state detection results in the additional users' rolling stock,

b) making selected information available only to authorized users,

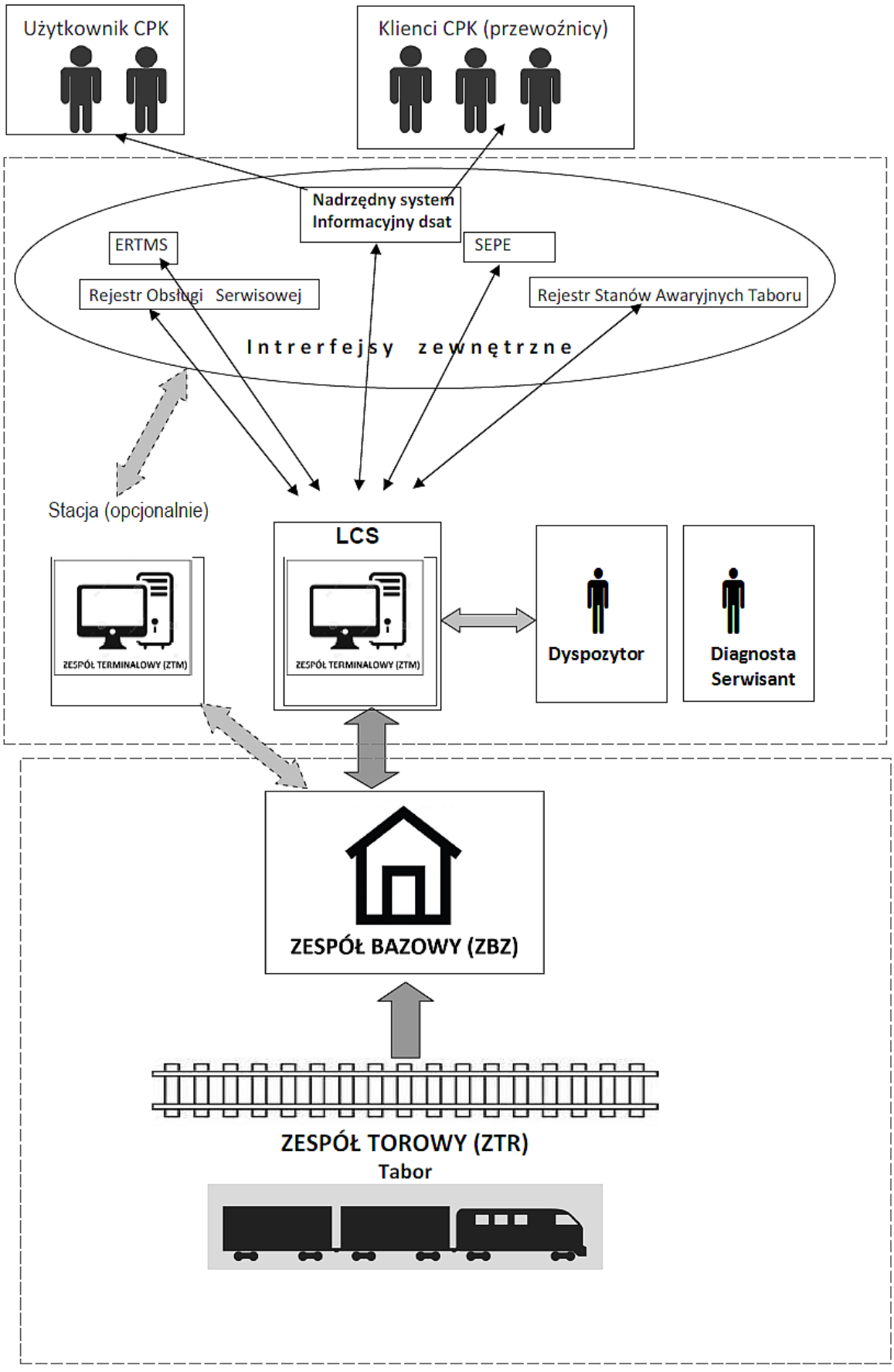
c) centralization of information collection,

d) remote access and exchange of information with other systems.

5) Information from the DSAT Master Information System shall be transmitted to the STH dispatching room and headquarters and to a selected extent to the clients (carriers).

6) The design of dsat devices of the basic layer enables implementation of several measuring functions in a single device (one measuring zone).

The diagram of the dsat device and system is presented in Fig. 2.


Użytkownik CPK
Klienci CPK (przewoźnicy)
Nadrzędny system Informacyjny dsat
ERTMS
SEPE
Rejestr Obsługi Serwisowej
Rejestr Stanów Awaryjnych Taboru
Intrerfejsy zewnętrzne
Stacja (opcjonalnie)
LCS
ZESPÓŁ TERMINALOWY (ZTM)
ZESPÓŁ TERMINALOWY (ZTM)
Dyspozytor
Diagnosta
Serwisant
ZESPÓŁ BAZOWY (ZBZ)
ZESPÓŁ TOROWY (ZTR)
Tabor

PL	EN
Użytkownik CPK	STH user
Klienci CPK (przewoźnicy)	STH clients (carriers)
Nadrzędny system Informacyjny dsat	Dsat Master Information System
ERTMS	ERTMS
Rejestr Obsługi Serwisowej	Maintenance Service Register
SEPE	SEPE
Rejestr Stanów Awaryjnych Taboru	Rolling Stock Failure State Register
Interfejsy zewnętrzne	External interfaces
Stacja (opcjonalnie)	Station (optional)
ZESPÓŁ TERMINALOWY (ZTM)	TERMINAL UNIT (ZTM)
LCS	LCS
Dyspozytor	Dispatcher
Diagnosta Serwisant	Diagnostic Technician
ZESPÓŁ BAZOWY (ZBZ)	BASE UNIT (ZBZ)
ZESPÓŁ TOROWY (ZTR)	TRACK UNIT (ZTR)
Tabor	Rolling stock

Fig. 2. Dsat system architecture

3.10.2 Track unit requirements

3.10.2.1 Measurement zone

1) The track unit consists of sensors and auxiliary elements used for measurement, device activation and transmission of metering information to the base unit.
2) The metering zone of dsat devices is located between sensors installed in the track, which automatically activate the measurement.

3.10.2.2 Track unit location

1) In accordance with the PL-EN 15437-1:2009 standard, the track unit shall be installed on a straight track or on a track with an arc radius of more than 10,000 m and at least 500 m before switches and crossings.
2) The track unit shall be placed on a straight track section at a distance of at least 800 m to the nearest curve, elevation or crossing.
3) Track equipment with OK and PD functions may not be installed on a track with a slope greater than 6 ‰.
4) The track unit must not be installed in the service braking zone immediately before the scheduled train stops so that the temperature of the brake blocks and discs does not trigger alarms.
5) Install the track unit on a stable track, in good condition on concrete sleepers.
6) Permissible track deflection within the track unit – maximum 13 mm.
7) The location of the track unit shall enable the location of the base unit at the required distance from the track.
8) The location of the track unit shall enable safe stopping of the train after detecting alarm conditions.

9) The location of the track unit shall take into account the maintenance stations or junction signal boxes on which it will be possible to shut down the faulty rolling stock and assess the technical condition of the rolling stock by the technical personnel.

10) The track unit may not be installed before the tunnel entrances – at a distance smaller than the double braking distance required on the line.

11) The track unit must be installed in a continuous welded rail. There must be no bus contacts in the measuring zone, especially those with classic connections.

3.10.3 Base unit requirements

1. The base unit is used to measure and process signals from the track unit.
2. The devices of the base unit may be installed in:
   a) a metal container,
   b) a concrete container,
   c) a container made of other materials with appropriate approvals,
   d) a trackside room.
   e) metal containers shall be painted with special paint or coated with a sun reflective or heat-retardant coating and shall permit entry by a maintenance technician, easy access to components for repair or replacement.

   f) Location and installation of the container shall be adapted to local conditions, the container design shall enable installation on the spot footings, in case of installation in floodplains.
3. The base unit shall be located at a distance of not less than 5 m and not more than 12 m, measured from the edge of the container to the inside of the rail foot nearest to the container.
4. The location of the base unit shall enable efficient access and transport of components as well as enable performance of scheduled maintenance activities.
6. The container in which the base device is installed shall enable entry of maintenance personnel and free access to all components and the possibility of their quick replacement.
7. The base device container shall have:
   a) efficient drainage system,
   b) lighting,
   c) electric heating and/or air conditioning (optional depending on container type)
   d) burglar alarm,
   e) electric shock protection and overvoltage protection,
   f) protection against harmful impact of electromagnetic fields,
   g) earthing of the container,
   h) fire alarm and extinguishing system,
   j) power supply backup equipment.
8. The minimum backup time of the UPS is:
   - 30 minutes for the operation mode,
   - 8 hours for standby mode.

3.10.4 Terminal unit requirements

1) The terminal unit is used to process and archive measurement data, presents the results of checks of the diagnosed rolling stock on the monitor and optionally using a printer.
2) The terminal unit consists of:
    a) computer set,
    b) modems,
    c) emergency power supply,
    d) alarm signalling equipment,
    e) printers (optional).
3) The terminal unit software shall perform the following functions:
    a) record rolling stock failure states,
    b) maintain electronic documentation of the dsat devices,
    c) audible and visual signalling of the rolling stock detected damage,
    d) summary presentation of data from the last 6 months,
    e) generate a measurement report on the monitor screen and optionally as a printout from the printer.
4) The measurement report shall contain:
    a) subsequent number of train travels per day,
    b) station name and number,
    c) track No,
    d) direction of travel,
    e) train travel time (date, hour, min),
    f) place of installation and currently performed measuring functions of dsat devices,
    g) ambient temperature
    h) indoor temperature (in the base unit container),
    i) train speed,
    j) number of axles per train,
    k) detected exceeded failure states of the rolling stock, including:
        - level,
        - axle number counted from the beginning,
        - axle number counted from the end of the train,
        - system self-test results.

The absence of identified alarms shall be confirmed with a message.

5) It shall be possible to enter event identification descriptions agreed with the user, e.g. data concerning the numbers of trains and wagons in which failure states were detected, to the terminal unit.
6) It shall be possible to transmit information from the terminal unit in the form and scope specified in the technical documentation of the equipment manufacturer.
7) The terminal unit shall be located:
    a) in a room with a microclimate ensuring 20÷70% humidity and a temperature of 5÷40^{o}C
    b) in a place enabling its observation and continuous supervision by the personnel,
    c) at a station fulfilling the basic principles of work ergonomics.
8) The distance of the terminal from the base unit shall enable the operating personnel, in case damage to the rolling stock is detected, to take actions to notify the driver of the damaged rolling

stock detection and its possible shutdown.

9) It is permitted to connect several terminal units to one base unit, depending on operational needs, with full or limited functionality depending on operational needs.

10) Dsat devices interacting with two terminals (e.g. located at the boundary of two LCSs) shall be capable of automatically switching the transmission of information on detected rolling stock failure states to the terminal located in the LCS area which the train is approaching, so that the dispatcher can make a decision to stop the train and then a possible decision to switch off the damaged rolling stock on the station nearest to this one.

11) The terminal unit shall have an open architecture enabling, through a fixed transmission protocol, cooperation with the network dispatching and technical supervision systems.

12) Dsat devices shall be capable of temporarily switching the transmission of information on detected rolling stock failure states from the LCS terminal to the time-activated local terminal.

14) The dsat terminal shall cooperate with the following information systems:
    a) DSAT Master Information System,
    b) Rolling Stock Failure State Register,
    c) Maintenance Service Register.
    d) SEPE system
    e) ERTMS system,
    f) DSAT Master Information System of other infrastructure managers (at the interface with them)

15) The Rolling Stock Failure State Register shall collect and archive information on detected rolling stock failure states.

16) The Maintenance Service Register collects and archives information on faults detected in dsat devices.

17) Information on detected rolling stock failure states by means of the ERTMS system shall be communicated directly to the driver of the train in which they were detected.

3.11 Requirements concerning the arrangement of dsat devices

1) Dsat devices are used in configurations that perform the following functions: GM/GH, GM/GH/PD/OK, DPZ, PS.

2) When arranging the devices, the following shall be taken into account:
    a) type of railway line,
    b) maximum permissible speed on a given line,
    c) train traffic intensity,
    d) protection of the railway network against the entry of rolling stock in poor technical condition from the railway networks of other Managers.

3) When arranging equipment with PD and OK measuring functions, the following factors must be taken into account:
    a) installation of devices at the beginning of the line, at the entrance to the route,
    b) installation on access lines in order to protect the line (applies to a line with a V > 120 km/h.
    c) the distance between devices on the line is given in Table 3.

4) Devices with GM and GH measuring functions shall be installed at constant intervals to enable temperature changes of axle boxes and brakes to be tracked during train movement. The

distance between GM and GH devices on the line is given in Table 3.

5) The length of intervals shall take into account the case of a single device damage and signalling of hazardous condition on the next one – assuming an acceptable level of risk of an accident at a distance between subsequent devices.
6) The location of dsat devices shall take into account a convenient location for stopping and shutting down the damaged rolling stock, at stations where it is possible to assess the technical condition of the rolling stock by technical personnel and where there will be no disturbances in the traffic of trains.
7) The device and its terminal were located in the same area of remote railway traffic control.
8) The location of dsat devices with DPZ function is determined by the infrastructure manager on the basis of the criteria presented in chapter 3.1.13.
9) The dsat devices with the PS function shall be located before tunnel entrances at a distance specified by the infrastructure manager so that the train can be safely stopped before entering the tunnel.

Table 3. Arrangement of dsat devices with GM,GH.PD,OK functions

Line speed	Location of dsat devices with functions	
	GM,GH	PD,OK
V>200km/h	every 30±5 km	at the entrance to the line and every 100 ± 20 km
V 120÷200km/h	every 40 ±10 km	at the entrance to the line and every 130 km ±20
V < 120 km/h	every 50 ±10 km	at the entrance to the line and every 130 km ±20

3.12 Cybersecurity requirements for dsat devices

Design and operation of dsat devices shall meet the cybersecurity requirements developed by the infrastructure manager on the basis of the PN-EN ISO/IEC 27001:2017-06 standard.

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4 Reference documents

4.1 Legal documents

[1] Ustawa z dnia 28 marca 2003 r. o transporcie kolejowym. Dz.U.2020.1043.

[2] Lista Prezesa Urzędu Transportu Kolejowego w sprawie właściwych krajowych specyfikacji technicznych i dokumentów normalizacyjnych, których zastosowanie umożliwia spełnienie zasadniczych wymagań dotyczących interoperacyjności kolei; Warszawa, dnia 19 stycznia 2017 r.

[3] 987 Rozporządzenie Ministra Transportu i Gospodarki Morskiej z dnia 10 września 1998r. w sprawie warunków technicznych, jakim powinny odpowiadać budowle kolejowe i ich usytuowanie.

4.2 Normative documents

[1] PN-EN 15437-1:2009 Kolejnictwo -- Monitorowanie stanu maźnicy – Wymagania dotyczące interfejsu i projektowania -- Część 1: Urządzenia przytorowe i maźnice pojazdów szynowych

[2] PN-EN 50121-1:2015-10 Zastosowania kolejowe -- Kompatybilność elektromagnetyczna -- Część 1: Postanowienia ogólne

[3] PN-EN 50121-1:2017-06 Zastosowania kolejowe -- Kompatybilność elektromagnetyczna -- Część 4: Emisja i odporność urządzeń sterowania ruchem kolejowym oraz telekomunikacji

[3] PN-EN 50122-1:2011 Zastosowania kolejowe -- Urządzenia stacjonarne -- Bezpieczeństwo elektryczne, uziemianie i sieć powrotna -- Część 1: Środki ochrony przed porażeniem elektrycznym

[4] PN-EN 50122-2:2011 Zastosowania kolejowe -- Urządzenia stacjonarne -- Bezpieczeństwo elektryczne, uziemianie i sieć powrotna -- Część 2: Środki ochrony przed skutkami prądów błądzących powodowanych przez systemy trakcji prądu stałego

[5] PN-EN 50122-3:2011 Zastosowania kolejowe -- Urządzenia stacjonarne -- Bezpieczeństwo elektryczne, uziemianie i sieć powrotna -- Część 3: Oddziaływanie wzajemne systemów trakcji prądu przemiennego i stałego

[6] PN-EN 50124-1:2017-09 Zastosowania kolejowe -- Koordynacja izolacji -- Część 1: Wymagania podstawowe -- Odstępy izolacyjne powietrzne i powierzchniowe dla całego wyposażenia elektrycznego i elektronicznego

[7] PN-EN 50124-2:2017-09 Zastosowania kolejowe -- Koordynacja izolacji -- Część 2: Przepięcia i ochrona przeciwprzepięciowa

[8] PN-EN 55011:2016-05 Urządzenia przemysłowe, naukowe i medyczne -- Charakterystyki zaburzeń o częstotliwości radiowej -- Poziomy dopuszczalne i metody pomiaru

[9] PN-EN 55024:2011 Urządzenia informatyczne -- Charakterystyki odporności -- Poziomy wymagane i metody pomiarów

[11] PN-EN 60950-1:2007 Urządzenia techniki informatycznej -- Bezpieczeństwo -- Część 1: Wymagania podstawowe

[12] PN-EN 61000-4-2:2011 Kompatybilność elektromagnetyczna (EMC) -- Część 4-2: Metody badań i pomiarów -- Badanie odporności na wyładowania elektrostatyczne

[13] PN-EN 61000-4-3:2007 Kompatybilność elektromagnetyczna (EMC) -- Część 4-3: Metody badań i pomiarów -- Badanie odporności na promieniowane pole elektromagnetyczne o częstotliwości radiowej

[14] PN-EN 61000-4-4:2013-05 Kompatybilność elektromagnetyczna (EMC) -- Część 4-4: Metody

badań i pomiarów -- Badanie odporności na serie szybkich elektrycznych stanów przejściowych

[15] PN-EN 61000-4-5:2014-10 Kompatybilność elektromagnetyczna (EMC) -- Część 4-5: Metody badań i pomiarów -- Badanie odporności na udary

[16] PN-EN 61000-4-6:2014-04 Kompatybilność elektromagnetyczna (EMC) -- Część 4-6: Metody badań i pomiarów -- Odporność na zaburzenia przewodzone, indukowane przez pola o częstotliwości radiowej

[17] PN-EN 61000-4-8:2010 Kompatybilność elektromagnetyczna (EMC) -- Część 4-8: Metody badań i pomiarów -- Badanie odporności na pole magnetyczne o częstotliwości sieci elektroenergetycznej

[19] PN EN 61000-4-9:1998 Kompatybilność elektromagnetyczna (EMC) -- Metody badań i pomiarów -- Badanie odporności na impulsowe pole magnetyczne

[20] PN-EN 61000-4-11:2007 Kompatybilność elektromagnetyczna (EMC) -- Część 4-11: Metody badań i pomiarów -- Badania odporności na zapady napięcia, krótkie przerwy i zmiany napięcia

[21] PN-EN 61000-4-29:2004 Kompatybilność elektromagnetyczna (EMC) -- Część 4-29: Metody badań i pomiarów -- Badanie odporności na zapady napięcia, krótkie przerwy i zmiany napięcia występujące w przyłączu zasilającym prądu stałego

[22] PN-EN 61000-6-2:2019-04 Kompatybilność elektromagnetyczna (EMC) -- Część 6-2: Normy ogólne -- Norma dotycząca odporności w środowiskach przemysłowych

[23] PN-EN 61000-6-4:2008/A1:2012 Kompatybilność elektromagnetyczna (EMC) -- Część 6-4: Normy ogólne – Norma emisji w środowiskach przemysłowych

[24] PN-HD 60364-4-442:2012 Instalacje elektryczne niskiego napięcia -- Część 4-442: Ochrona dla zapewnienia bezpieczeństwa -- Ochrona instalacji niskiego napięcia przed przepięciami dorywczymi powstającymi wskutek zwarć doziemnych w układach po stronie wysokiego i niskiego napięcia

[25] PN-HD 60364-4-443:2016-03 Instalacje elektryczne niskiego napięcia -- Część: 4-443: Ochrona dla zapewnienia bezpieczeństwa -- Ochrona przed zaburzeniami napięciowymi i zaburzeniami elektromagnetycznymi -- Ochrona przed przejściowymi przepięciami atmosferycznymi lub łączeniowymi

[26] PN-HD 60364-4-444:2012 Instalacje elektryczne niskiego napięcia -- Część 4-444: Ochrona dla zapewnienia bezpieczeństwa -- Ochrona przed zakłóceniami napięciowymi i zaburzeniami elektromagnetycznymi

[27] PN-HD 60364-5-54:2011 Instalacje elektryczne niskiego napięcia -- Część 5-54: Dobór i montaż wyposażenia elektrycznego -- Układy uziemiające i przewody ochronne

[28] PN-HD 60364-5-534:2016-04 Instalacje elektryczne niskiego napięcia -- Część 5-534: Dobór i montaż wyposażenia elektrycznego -- Odłączanie izolacyjne, łączenie i sterowanie -- Urządzenia do ochrony przed przejściowymi przepięciami

[29] PN-EN 62305-1:2011 Ochrona odgromowa - Część 1: Zasady ogólne

[30] PN-EN 62305-2:2012 Ochrona odgromowa - Część 2: Zarządzanie ryzykiem

[31] PN-EN 62305-3:2011 Ochrona odgromowa -- Część 3: Uszkodzenia fizyczne obiektów i zagrożenie życia

[32] PN-EN 62305-4:2011 Ochrona odgromowa -- Część 4: Urządzenia elektryczne i elektroniczne w obiektach

[33] PN EN 62561 (seria) Elementy urządzenia piorunochronnego (LPSC) -- wszystkie części: Wymagania dotyczące przewodów i uziomów

[34] PN-EN 61643-11:2013-06 Niskonapięciowe urządzenia ograniczające przepięcia -- Część 11: Urządzenia ograniczające przepięcia w sieciach elektroenergetycznych niskiego napięcia -- Wymagania i metody badań

[35] PN EN 61643-21:2004 Niskonapięciowe urządzenia ograniczające przepięcia -- Część 21:

Urządzenia do ograniczania przepięć w sieciach telekomunikacyjnych i sygnalizacyjnych -- Wymagania eksploatacyjne i metody badań

[36] PN-EN 60728-11:2011 Sieci kablowe służące do rozprowadzania sygnałów: telewizyjnych, radiofonicznych i usług interaktywnych -- Część 11: Wymagania bezpieczeństwa

[37] PN-EN 50125-3:2003 Zastosowania kolejowe -- Warunki środowiskowe stawiane urządzeniom -- Część 3: Wyposażenie dla sygnalizacji i telekomunikacji

[38] CLC/TS 50238-2:2015 Railway applications - Compatibility between rolling stock and train detection systems - Part 2: Compatibility with track circuits

[39] CLC/TS 50238-3:2019, Zał. S-02 Railway applications - Compatibility between rolling stock and train detection systems - Part 3: Compatibility with track circuits

[40] Załącznik S-02 Załącznik S-02 do Listy Prezesa UTK, o której mowa w art. 25d ust. 1 ustawy z dnia 28 marca 2003 r. o transporcie kolejowym. Dopuszczalne parametry zakłóceń dla urządzeń sterowania ruchem kolejowym, 2017-01-19

[41] PN-EN ISO/IEC 27001:2017-06 Technika informatyczna -- Techniki bezpieczeństwa -- Systemy zarządzania bezpieczeństwem informacji – wymagania

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