No.:

154VZ1

Version:

230726

System / Product:

Train Protection System MIREL VZ1

v04

Title:

Maintenance manual, diagnostics v04

Further source and enclosed files:

	File	Description	Pages / Connection
1			
2			
3			

The document form is based on template 2738M:201210

List of document versions:

Version	Description	Compiled by	Validated by	Approved by
000515	Document implementation			Ing. Horváth
001011	Addendum 1			Ing. Horváth
040511	Addendum 2, ŽSR V04, SW 2			Ing. Horváth
060117	Reformatting, addition of MÁV functionality			Ing. Horváth
061102	Modifications after MÁV, ŽSR V06, SW 3 functional tests			Ing. Horváth
070611	Additional of functional test (steps B08, B09, C64)			Ing. Horváth
070618	Change in labelling and order of steps in the functional test, C52 to B17			Ing. Horváth
071210	Changes from ŽSR, ČD test operations			Ing. Horváth
090110	Changes after completion of ŽSR, ČD test operations Expansion of MÁV functionalities to 160 km.h^{-1}			Ing. Horváth
090822	Modifications before approval of V03			Ing. Horváth
110828	Modifications before approval of V04			Ing. Horváth
141119	Modifications before approval of V04 – operational verification			Ing. Horváth
170624	Modification of prophylactic control conditions of D4	Ing. Adamec	Ing. Adamec	Ing. Michalec
180115	Changing conditions of assembly and disassembly	Ing. Adamec	Ing. Adamec	Ing. Michalec

Version	Description	Compiled by	Validated by	Approved by
190111	Completion and Maintenance of Document in Accordance with Technical Conditions	Ing. Praščák	Ing. Horváth	Ing. Michalec
201120	Addition and modification of error codes for MIREL STB and MIREL SHPE	Ing. Grman	Ing. Michalec	Ing. Michalec
221118	Modification of error codes for MIREL STB gateway	Ing. Grman	Ing. Michalec	Ing. Michalec
230215	Segmentation of system error list based on version of MIREL VZ1 Technical Conditions	Ing. Grman	Ing. Michalec	Ing. Michalec
230726	Modification of D1 test specification	Ing. Žilinec	Ing. Michalec	Ing. Michalec

Table of Contents

1 Purpose of the Document

Document specifies standard servicing procedures and activities in course of diagnostics, scheduled and unscheduled train protection maintenance related with maintenance procedure for entire DRV. In actual version it describes train protection diagnostics and maintenance in version v04.

Train protection Maintenance Manual is a document primarily intended for train protection maintenance and service staff. Further, the manual has been intended as a help for implementation of training and checking activity, a help for system incorporation into DRV technology, its activation, testing and implementation of system tests.

Staff engaged in production, assembly, maintenance and diagnostics of MIREL VZ1 train protection must meet following general qualification criteria:

- specialist education in electrotechnics or transport
- demonstrably proven training for mentioned activity, with periodic renewal.

Qualification specification of requirements specific for individual MIREL VZ1 train protection diagnostics and maintenance levels are listed in relevant chapters.

Maintenance and diagnostics manual follows document 153VZ1 MIREL VZ1 Train Protection Operating Manual and 257VZ1 Technical Conditions describing operating functions of train protection and its operating method.

MIREL VZ1 train protection Maintenance Manual doesn´t, under any circumstances, replace any provisions of valid legislative and operating regulations and procedures related with control of driving rail vehicles and/or railway operation control. Valid legislative and operating regulations and procedures have an absolute precedence over present Maintenance Manual.

Document is intended for:

- DRV operator staff carrying out operating, diagnostics and maintenance activities on MIREL VZ1 system,
- System Producer staff trained and authorized to conduct MIREL VZ1 system activities of fitting, activation, testing, tests implementation and maintenance,
- Staff of companies engaged in DRV production, reconstruction and maintenance, which has been trained and assigned to conduct activities of system operation, fitting, testing, diagnostics and maintenance.

Document follows up and refers to documentation below:

Related Documentation

No.		Version	Title
[A1]	153VZ1	221118	MIREL VZ1 Operating manual
[A2]	257VZ1	211203	MIREL VZ1 Technical Conditions
[A3]	547MAP	221123	KAM User manual
[A4]	1997MAP	150701	MAN User manual
[A5]	257VZ1	200401	MIREL VZ1 Technical Conditions

Linked Documentation

No.		Version	Title
[B1]	206VZ1	210816	MIREL VZ1 Protocol from functional test D3
[B2]	498VZ1	200907	MIREL VZ1 Prophylactic inspection protocol
[B3]	460M	170717	Service note

Cited and related standards and specifications

No.	Version	Title and Additional Information
[C1] -	-	-

2 Specification of Document Changes

Version 000515

Document implementation.

Version 001011

Addendum 1 dated 11 October 2000 to the Maintenance and Diagnostics Manual for the MIREL VZ1 train protection system based on requirements for technical security of the system (added in sections: D1 – Start-up self-diagnostic control, D2 – Continuous self-diagnostic control, D4 – Prophylactic control, Fault indication).

Version 040511

Addendum 2 dated 11 May 2004 to the Maintenance and Diagnostics Manual for the MIREL VZ1 train protection system based on the approval of Addendum 1 to the Technical Conditions for Serial Installation of the MIREL VZ1 Train Protection System (257-00-TW-4P-VZ, 5 March 2004).

Version 060117

Incorporation of functionalities based on EVM specifications dated 17 January 2006 on the basis of the Set of Functional Requirements for MÁV Rt On-board Train Protection Systems and Vigilance Equipment (738-06-TW-4P-VZ, 12 January 2006), the Specification of Changes to the MIREL VZ1 Train Protection System - integration of MÁV Rt functions (412-02-FW-4P-VZ, 15 January 2006) and Addendum 2 to the Technical Conditions for Serial Installation of the MIREL VZ1 Train Protection System (257-00-TW-4P-VZ, 16 January 2006).

Version 061102

Document update upon accomplishment of EVM functions test with software version v03.

Version 070611

Supplementation of steps B08, B09, C64 to D3 function test.

Version 070618

Update of designation and sequence of steps C52 through B17 of D3 function test.

Version 071210

Document update resulting from test operation on LS infrastructure.

Version 090110

Modification of functionalities based on LS specifications after completion of test operations for program version v03 and expansion of functionality based on EVM specifications for track speeds of up to 160 $km.h^{-1}$ based on the Set of Functional Requirements for MÁV Rt On-board Train Protection Systems and Vigilance Equipment (738VZ1: 081020).

Version 090822

Document update prior train protection approval in version v03.

Version 110828

Addition of functionalities based on SHP specifications on the basis of the Basic Specifications and SHP Technical Description (1054VZ1: 120910) including the incorporation of comments from operations.

Completion and adjustment of Maintenance and Diagnostics Manual for MIREL VZ1 train protection in accordance with system technical conditions (257VZ1 : 110610). Addition of functionality to support stand-by regime and cooperation with ETCS-type train protection systems.

Version 141119

Document update in extent of changes which have resulted from verification operation of version v04.

Version 170624

Update of conditions for D4 prophylactic inspection.

Version 180115

Update of conditions for fitting and dismantling.

Version 190111

Completion and adjustment of Maintenance and Diagnostics Manual for MIREL VZ1 train protection in accordance with technical conditions of systems (257VZ1: 190121). Completion of procedure for data reading from recording device. Completion of diagnostics and error codes when integrating with MIREL SHPE device.

Version 201120

Update and supplementation of error codes for MIREL STB and MIREL SHPE.

Version 221118

Error code update for MIREL STB.

Update of indication elements on train protection central unit in connection with approval process of INO2019 changes.

Supplementation by System Configuration chapter.

Update of Function Test chapter, Data Readout from Recording Unit chapter and Fitting and Dismantling chapter.

Document form update to actual technical documentation template.

Version 230215

List segmentation of detected system errors based on version of MIREL VZ1 Technical Conditions (257VZ1: 211203 and 257VZ1: 200401).

System Configuration Chapter Update.

Version 23726

Addition of the D1 interval specification also for systems after useful life in chapter 8.1.

3 Applied Designation and Terminology

Active driver cab	Engine driver cab on a rail vehicle with control switch engaged
D1	One-time system diagnostic check
D2	Continuous system diagnostic check
D3	System function test
D4	System prophylactic inspection
DD, DB, Hummel M16	Types of industrial connector pieces on central unit
EVM	Train protection function specification for operation in Hungary
DRV	Driving rail vehicle or driving trailer, eventually
HP	MIREL VZ1 train protection horn
KAM	MAP application module for config of 2nd generation MIREL systems
LS	Train protection function specification for operation in Slovak and Czech Republics
MAP	MIREL Application Manager (software on personal computer)
Maximum design speed	Maximum speed specified by rail vehicle producer, or speed laid down as a maximum one upon a reconstruction
Maximum operating mode speed	Maximum speed laid down for actually active train protection operating mode
Maximum speed derived from transmitted signals, target speed	Rail vehicle maximum speed, allowed for ride at rail line section end with respective signal indication
NO	Signal repeater of MIREL VZ1 train protection
Self-acting halt, emergency halt, train protection intervention	Automatic rail vehicle halt upon train protection intervention by means of directly-acting brake EPV valve opening due to violation of any safety condition
S1	Operational system repair
S2	Service system repair
SHP	Train protection function specification for operation in Poland
SHPE	MIREL SHPE evaluating and checking unit intended to protect a rail vehicle on Polish rail line infrastructure
Predefined speed	Speed specified in accordance with applicable regulations for train set and conditions on rail track as maximum one (as a rule stipulated in railway guide book)
STB	Train protection function specification for STM module operation in standby mode
MIREL STB	MIREL STB function port providing interface between central unit of MIREL VZ1 train protection and ETCS on-board unit
Rail line part of train protection	Stationary part of line-type train protection, operating with a carrier frequency of 50 Hz or 75 Hz, stationary part of point-type train protection of SHP type
VZ, train protection	MIREL VZ1 train protection
ZJ	Central unit of MIREL VZ1 train protection

4 General Characteristics

The MIREL VZ1 train protection system is the mobile unit of the train protection system. It is designed for locomotives operating in Czech Republic, Slovakia, Hungary and Poland. The system is compatible with LS and EVM type track infrastructure. The system cooperates with ETCS and SHP type on-board train protection system equipment. MIREL VZ1 is an open system that may be expanded in the future to accommodate different types of systems used to transmit track information to locomotives.

The MIREL VZ1 train protection system is specifically designed to monitor engineer vigilance, transmit information from track infrastructure to the engineer's cab, check maximum speed with respect to the maximum design speed of the locomotive and the speed set point and receive information from track infrastructure. Other system functions monitor for a match between the selected and actual direction of travel, assess radio commands to remotely stop the locomotive and check the braking of a stopped locomotive.

A complete MIREL VZ1 train protection system includes the central unit, two signal repeaters at both of the engineer's cabs and two signal horns. A serial communication link connects the central unit to the signal repeaters. It is also possible to operate a single signal repeater depending on the required configuration of the system. MIREL VZ1 is configurable for single and double cab locomotives. The system is configurable for locomotives that must transmit information from the track infrastructure to the engineer's cab and for locomotives operated on track without train protection system infrastructure. The MIREL VZ1 train protection system is operable on electric and diesel locomotives and in control cab rolling stock.

The locomotive's on-board battery source is used to power the MIREL VZ1 train protection system. MIREL VZ1 configuration is dependent upon battery source voltage. The train protection system is operated and controlled exclusively from the engineer's cab using the signal repeater and other controls, including dead man's buttons and other controls on the locomotive's control panel. No interference into the mechanical space of the locomotive is required to operate the MIREL VZ1 train protection system.

The MIREL VZ1 train protection system is a digital electronic system designed specifically as secure equipment. Secure operation is ensured by a pair of processor units, a group of special watch-dog circuits, two-channel transmission of information from track infrastructure, and two-channel measurements of speed, travelled distance and direction of travel. The signal repeaters are composed of redundant single-board computers designed specifically for this use. The components used in the central unit meet demanding criteria for reliability and robustness.

The MIREL VZ1 train protection system conducts start-up and continuous self-diagnostic controls and supports a functional test to ensure the proper function of all parts of the MIREL VZ1 train protection system and cooperating functional units. The system is maintenance-free apart from the performance of the functional test and prophylactic control.

5 System Configuration

Complete configuration:

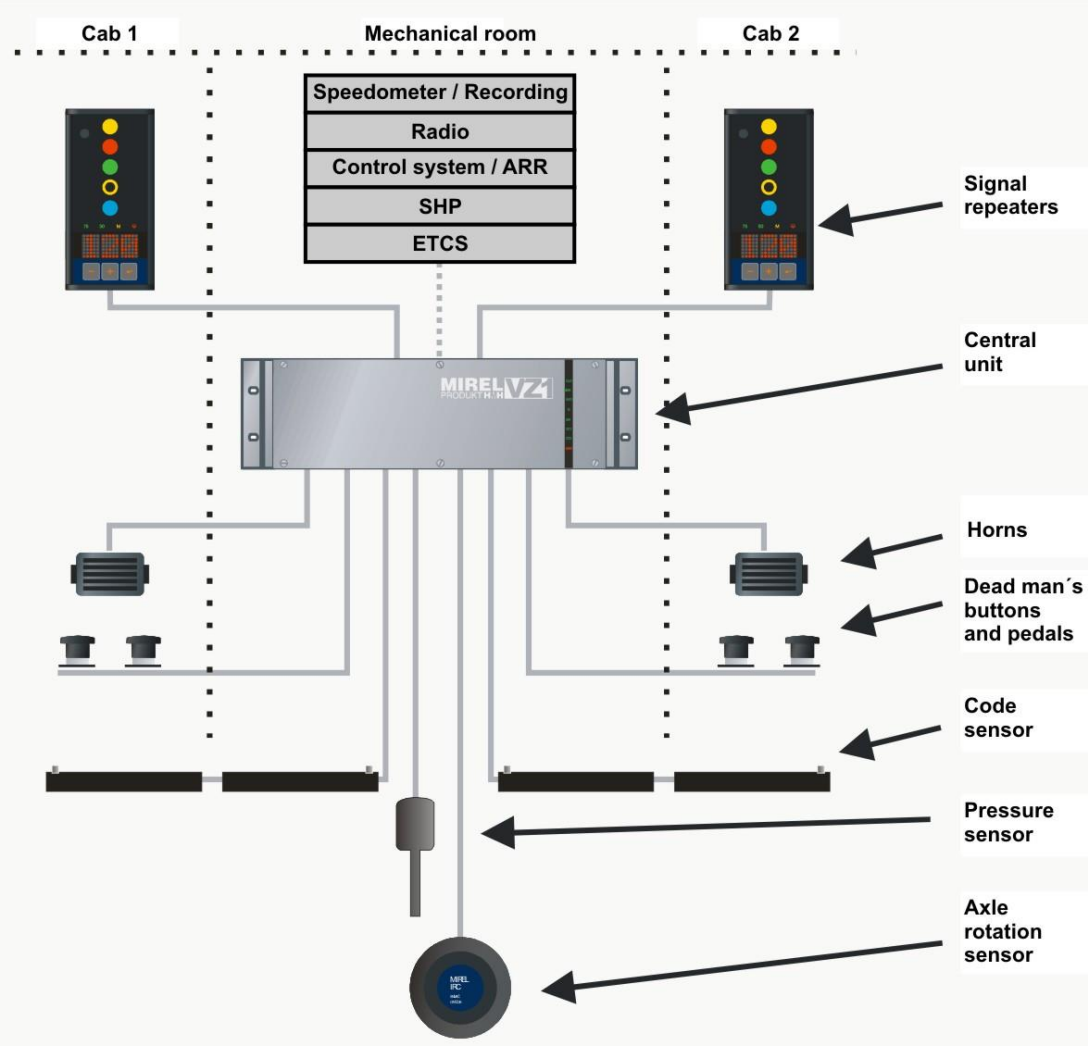
- Central unit 1x
- Signal repeater 2x
- Horn 2x

Required sub-assemblies:

- Dead man's buttons and pedals number/type given by type of locomotive
- Incremental RPM sensor 1x
- Main brake pipe pressure sensor 1x
- Recording equipment 1x

Optional sub-assemblies:

- Track infrastructure signal sensors optional configurations: 4x, 2x, 0x
- Speedomete depending on type of locomotive
- Control system or ARR depending on type of locomotive
- Radio depending on type of locomotive
- SHP system depending on type of locomotive
- ETCS system depending on type of locomotive



Note: System composition diagram is illustrative. Components of system composition can have various design versions.

6 Central Unit

The central unit performs the majority of the safety and operational functions of the MIREL VZ1 train protection system.

- Filtering and decoding transmitted information from track infrastructure
- Filtering and evaluation of the signal from the incremental RPM sensor on the locomotive
- (Measuring speed travelled distance and direction of travel)
- Calculation of safety algorithms
- Monitoring pressure in the main brake line
- Monitoring inputs (control switches, dead man's buttons and pedals, drive controllers, the direct acting brake, direction controllers, traction system switch, etc.)
- Sending outputs (controlling the EPV valve, horns, blue and red indicators, etc.)
- Communication with the signal repeaters
- System diagnostics
- System functional test
- Indicators

8 LED indicators are installed on the front panel of the central unit. No control elements are located on the central unit and there is no need for the operator to interfere with the central unit during operation of the train protection system.

The central unit is powered from the locomotive's battery source. Power is provided through a separate circuit breaker dedicated for the train protection system installed with other breakers for the locomotive or in another specific location depending on the specific type of locomotive. There is no need to turn off the system power circuit breaker under any operating situation. Other MIREL VZ1 train protection system peripherals are powered by the central unit.

The central unit in BOXTUX version is constructed with a 19" width to comply with the IEC 60297 standard for rack-mounted equipment. The design height is a U module = 44.5 mm. Central unit modules are installed in an AL enclosure. Indicators are installed on the front panel. A 72-pin DD-type industrial connector is installed on the rear panel.

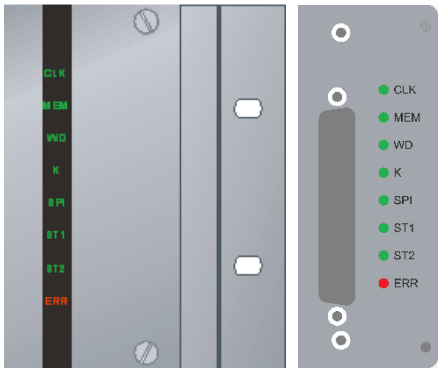
Mechanical design of central unit in BOXTUG version have modules of central unit located in a separate AL-box and is available in two different modifications, depending on assembly orientation. Indication elements are located at front panel, 37-pin connector of DB type, 25-pin connector of DB type, 15-pin connector of DB type and two 10-pin industrial connectors of type Hummel M16.

Structural design of central unit in BOXKOG has central unit modules located in a separate AL-box of modular BOXKOG-type structural system, for easy device fitting in standard 19” cases with height 3U. Indication elements are located at front panel, 37-pin connector of DB type, 25-pin connector of DB type, 15-pin connector of DB type and two 10-pin industrial connectors of type Hummel M16.

The central unit will operate in any position. The central unit is installed inside the locomotive based on the specific type of locomotive. Access to the front panel without requiring any disassembly is sufficient for ordinary operating conditions and when maintenance is required.

Indication elements on central unit front panel

Illustrative picture



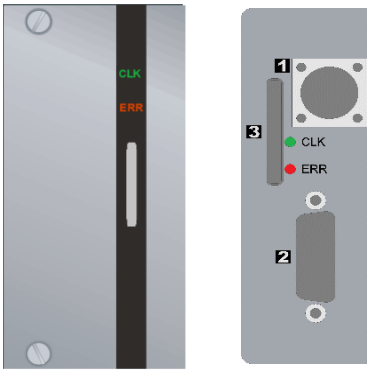
Indication elements on VZ1ZJ.0 VZ1ZJ.1

CLK	ZJ1	Indication of operation
MEM	ZJ2	Indication of D1 diagnostics
WD	ZJ3	Indication of D2 diagnostics
K	ZJ4	Indication of information transfer from line part
SPI	ZJ5	Indication of communication on SPI bus
ST1	ZJ6	Indication of communication with 1st driver cab
ST2	ZJ7	Indication of communication with 2nd driver cab
ERR	ZJ8	System error

Full designation of indicators is OIZJ1 through OIZJ8. In order to achieve transparency of Operating Manual, we shall present abbreviated designation ZJ1 through ZJ8.

Indication elements on recording part of central unit

Illustrative picture



Indication elements on VZ1ZJ.0 VZ1ZJ.1

CLK	ZJ9	Activity indication of recording unit
ERR	ZJ10	Recording unit error

Full designation of indicators is OIZJ9 through OIZJ10. In order to achieve transparency of Operating Manual, we shall present abbreviated designation ZJ9 through ZJ10.

7 Signal Repeater

The signal repeater displays information sent the track infrastructure to the engineer's cab, signals the detected carrier frequency of the signal in the track-side part of the train protection system, signals actions taken by the train protection system and displays maximum speed. It is also used to configure the operating parameters of the train protection system by the operator.

The unit is connected to the central unit with a four-conductor cable that powers the signal repeater and secures data communication between the central unit and the signal repeater.

The signal repeater is installed inside of a stand-alone Al enclosure or is a control panel-mounted device. 4 signal signs, blue light, 4 LED indicators, a three-digit alphanumeric display and three control buttons are installed on the front. A flexible cabling bundle is installed on the bottom of the Al enclosure model and the signal repeater is installed on articulated hinges that may be adjusted to an angle of -30° to +210°. The cabling bundle is installed on the rear of the model installed in the control panel. The signal repeater is installed in a vertical position.

The control switch determines the active cab of the train protection system.

Indicators and controls on the fron panel of the signal repeater

Illustrative picture

	NO1	▪ yellow signal sign in PRE working regime ▪ required brake line pressure reduction in MEN working regime
	NO2	red signal sign
	NO3	green signal sign
	NO4	▪ annulus signal sign in PRE working regime ▪ increased speed regime in MEN working regime
	NO5	vigilance check
	NO6	light intensity sensor
75	NO7	75 Hz carrier frequency
50	NO8	50 Hz carrier frequency
M	NO9	MANUAL / MÁV
	NO10	▪..reduced maximum speed ▪ stopped indicator
	NO11	three-digit alphanumeric display
	NO12	MINUS button
	NO13	PLUS button
	NO14	CONFIRM button

The full names of the indicators are OI1NO1 to OI1NO14 and OI2NO1 to OI2NO14. Abbreviated labels NO1 to NO14 are used in the maintenance manual to make it easier to read. Context makes clear the distinctions between signal repeater models.

8 System Diagnostics

Four levels of MIREL VZ1 train protection system diagnostics

D1	**Start-up diagnostic control**
D2	**Continuous diagnostic control**
D3	**Functional test**
D4	**Prophylactic control**

The first two levels (D1 and D2) are conducted automatically by the system itself. If a fault is detected, the operator is notified of such fact and the system is placed into safe mode. Actions are taken to lock out the system if the discovered fault prevents subsequent operation of the train protection system. System operational repairs (S1) must be conducted when a fault is detected).

A functional test (D3) is conducted by the operator's trained personnel. The functional test checks the overall functionality of the system, meaning the functionality of all indicators and keypads, the functionality of all input and output circuits and cooperation with other equipment on the locomotive (including driving controls, EPV, incremental RPM sensor, pressure sensor, etc.). System operational repairs (S1) must be conducted when a fault is detected. Prophylactic control (D4) of the system is performed periodically by the manufacturer of the train protection system or by other trained persons. In addition to performing the functional test, an in-depth control of the entire system is conducted (measuring input code filters, reading internal variables of the train protection system, checking input/output circuits and checking the devices that work in conjunction with the train protection system). This check is conducted to check the complete functionality of the equipment and for any wear and tear. Operational repairs (S1) or maintenance repairs (S2) are required depending on any faults that may be detected.

Anyone conducting diagnostics of the train protection system must be instructed with regards to occupational safety and must be demonstrably trained to perform such activities with certification to perform the individual levels of MIREL VZ1 train protection system diagnostics.

8.1 D1 – Start-up Diagnostic Control

Purpose:

This control verifies the status, integrity and functionality of the system during start-up. D1 serves as a daily test if the system is continuously in operation for more than 24 hours, or 8 hours for the systems after useful life.

Execution:

The train protection system automatically executes this control without intervention.

Schedule:

Every time the MIREL VZ1 train protection system is switched on with the control repeated after 24 hours, or 8 hours for the systems after useful life, of continuous operation of the system.

Description:

D1 start-up diagnostic control is executed once the system is switched on and diagnoses the functionality of communication inside the central unit, communication between the central unit and signal repeaters, the circuit for signals transmitted from track infrastructure to the on-board equipment, control elements in the engineer's cab and the emergency brake EPV.

D1 start-up diagnostic control is executed every time the system is placed into service and once every 24 hours (daily test) if the system is operated continuously. D1 start-up diagnostic control is executed automatically without intervention on the part of the operator. The control is repeated after the following conditions are met:

- Control is automatically repeated the first time the locomotive stops after 24 hours, or 8 hours for the systems after useful life, have passed since the last time the D1 diagnostic control was last completed
- If the locomotive does not reach a speed of zero within 24 to 28 hours, or 8 to 12 hours for the systems after useful life, of the most recent D1 diagnostic control, the D1 control cannot be repeated and the system detects a fault
- D1 start-up diagnostic control is blocked when the system is operating using EVM specifications in MEN working regime and a speed order of 0 is transmitted until a different speed order is transmitted
- The operator is notified 15 seconds in advance of a repeated D1 start-up diagnostic control by a blinking **D1** code on the signal repeater and acoustic signal ZS10. During this interval, the operator may press the  button to delay the repeat of the D1 start-up diagnostic control for another 15 minutes. If the  button is not pressed, the D1 start-up diagnostic control is automatically started and the control must be completed in full.

The D1 start-up diagnostic control includes check of the circuits for the transmission of signals from track infrastructure to the on-board equipment of the train protection system. When executing this portion of the D1 start-up diagnostic control, the transmission of information from track infrastructure is not active, even if the system is in working regime. The time to check the circuits for signal transmission from track infrastructure is approximately 90 seconds from the start of the D1 control.

The D1 start-up diagnostic control includes a check of the functionality of the EPV on the emergency brake valve. The system activates the opening of the emergency brake EPV two times, which results in two brief drops in air pressure in the main brake pipe. Prerequisites for completing the emergency brake EPV functionality check are completion of the control switch test, switching the control switch in the active cab, releasing the locomotive's direct acting pneumatic brake and the system may not be stand-by regime.

D1 start-up diagnostic control includes diagnostics of the input signals from cab controls. The operator is forced to manipulate the controls as notified by four short acoustic signals and the **D1** code on both signal repeaters. If the operator does not perform the defined action with the controls, the train protection system cannot be switched to working regime in either cab. This process involves the following controls:

- Control switch in the cab
- Directional lever or other direction selector

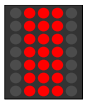
- Input from the pressure switch on the direct acting brake

The operator in the active cab is obliged to conduct the following manipulations of the controls during every D1 control:

- Move the control switch to the OFF position with the control switch in the inactive cab simultaneously in the off position,
- Move the directional lever into the neutral position,
- Move the directional lever into the FORWARD position,
- Move the directional lever into the BACKWARD position,
- Engage the auxiliary brake,
- Release the auxiliary brake.

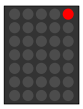
The order of these control manipulations is not fixed and the directional lever changes and the auxiliary brake operation must be performed with the control switch in the on position. Control manipulations are performed in the active locomotive cab.

The procedure for executing the individual diagnostic steps is indicated on the signal repeater by the seven-segment column in front of the D1 code. The given step has not been completed if the segment is still lit. The segment goes out when all given requirements for the specific step have been met. The meanings of the individual segments are as follows:

	Position	Description
	1st row	Signal repeater communicates with the central unit
	2nd row	Both control switches are in their null position
	3rd row	Directional lever in the active cab in null position and 1st direction (forward or backward depending on type of locomotive)
	4th row	Directional lever in the active cab in null position and 2nd direction (backward or forward depending on type of locomotive)
	5th row	Auxiliary brake has performed both functions (engaged, released)
	6th row	Opening the valve in the first part of the EPV test using channel M caused required decrease in pressure in main brake pipe
	7th row	Opening the valve in the second part of the EPV test using channel C caused required decrease in pressure in main brake pipe

Once all of the steps above have been completed, the D1 control indicator on the signal repeater is off and the system switches into working regime.

The locomotive is prevented from moving in any direction if the pressure in the main brake pipe is higher than 3.5 bar during the D1 start-up diagnostic control. If the locomotive moves, the system intervenes by opening the emergency brake EPV and sounding the ZS11 acoustic signal during the time the locomotive is moving. All of the completed steps of the D1 control are then rendered invalid. After the locomotive stops, the acoustic signal switches off and the operator must repeat the entire D1 control in full. The system closes the emergency brake EPV after the completion of the control switch test.



The system checks for the presence of a MIREL STB functional gateway when conducting the D1 start-up diagnostic control. Initiating communication with MIREL STB is indicated by a red dot in the left segment of display NO11. If communication with MIREL STB is not initiated during the execution of the D1 control, the system does not initiate communication with MIREL STB in subsequent operation and works independently.

If train protection system diagnostics detect a system fault (with the exception of a communication fault with the signal repeater in the inactive cab), the system is placed into safe mode and signal repeater displays NO11 in both cabs display **ERR**. The system is placed into safe mode by activating both output channels to control the EPV.

List of tests conducted within start-up diagnostic control:

Program integrity check – the system calculates the checksums in memory containing the saved programs and compares them to the expected values. Memory fault error codes are: **E03, E40, E42, E43, E44, E45** or **E46**. The system is not functional during this test.

Program parameter integrity check – the system calculates the checksums in memory containing the saved program parameters and compares them to the expected values. Memory fault error codes are: **E02** or **E03**. The system is not functional during this test.

Processor working register functionality check – a read and write test for all bit combinations of data in all registers of all processors. The error code for this fault is: **E41.**

RAM functionality check – a read and write test for all bit combinations of data in all memory cells of all processors. The error code for this fault is: **E41.**

Communication check between PMM processor modules and the PMC central unit – the PMM processor module sends a SYNC packet to initiate communication with the PMC processor module. If communication is not initiated within 5 seconds, the error code is: **E06**. The system is functional during this test.

Communication check between the central unit and the signal repeaters – the PMM processor module of the central unit sends a SYNC packet to initiate communication with the signal repeaters. If communication is not initiated with the active station within 5 seconds, the error code is **E04** or **E05**. The system is functional during this test.

Check of transmission routes to monitor information from track infrastructure – the system tests transmission filters, the connections of sensors and the sensors themselves in both transmission channels. The test involves 24 steps. A progression of combinations of the following parameters is defined:

Transmission channel:	M, C
Carrier frequency:	50 Hz, 75 Hz
Transmission route from cab:	ST1, ST2
Signal intensity:	low, moderate, high

The full scope of the transmission route test is only conducted in the full scale if the locomotive is standing in a section of track where there is no signal sign transmission. If the system detects a 50 Hz or 75 Hz carrier frequency in the track circuit, this step of the test is skipped. The error code is: **E07**.

The system is functional during this test. There is no transmission of information from the track infrastructure if the system is switched into PRE or MEN working regime during the execution of the transmission route check.

Emergency brake EPV functionality check – the system executes a check of EPV control using both channels. The test is performed in two steps. The EPV is opened briefly when the locomotive's brake is first released, first using channel M and then channel C. The system evaluates the drop in pressure in the main pipe and compares it to the expected values. The error code: **E08**. The system is functional during this test.

Completion protocol:

Not issued.

Resolving nonconformity:

If any fault is detected during the start-up diagnostic test, simply switch off the circuit breaker for the train protection system for at least 5 seconds and then re-energise the equipment to re-initialise the equipment. **Any fault displayed after re-initialising the equipment prevents subsequent operation of the train protection system.** Operational repairs (S1) are required.

8.2 D2 – Continuous Diagnostic Control

Purpose:

This control verifies the status, integrity and functionality of the system during its operation.

Execution:

The train protection system automatically executes this control without intervention by the operator or maintenance.

Schedule:

During the operation of the train protection system.

Description:

The train protection system executes continuous diagnostics using both watchdog circuits comparing evaluations of channels M and C in the central unit, comparing the indicator and control channel in the signal repeaters and conducting other continuous tests that check for proper operation of the train protection system. The train protection system continuously compares the results of the main (PMM) and comparison (PMC) processor module. Continuous self-diagnostics detect a system fault in the event of differences and place the train protection system into safe mode. Communication between the central unit and the signal repeaters is another operation that the train protection system diagnoses continuously. The train protection system blocks subsequent operation in the event of a serious communication fault involving the signal repeater in the active cab (where the control switch is on). If a communication fault is detected in the signal repeater at the inactive cab, the system will continue to operate in a limited scope and operational repairs are required.

Tests conducted during continuous self-diagnostic controls:

Watchdog circuit test – both processor modules of the central unit and all signal repeater modules are equipped with a pair of watchdog circuits. One monitors the proper operation of the processor itself and the second monitors the operation of the processor in cooperation with the other circuits. Watchdog circuits monitor the proper operation of the processors, correct execution of the program, timer activity and the functionality of processor interruption systems. The watchdog circuits operate with a time base of 16 ms and 100 ms. When a watchdog fault is detected, the given functional block is re-initialised and an error message is generated for the entire system. The error code for a fault involving a processor module (PMM, PMC) of the central unit is **E01**. The error code for a fault involving a signal repeater indicator module is **E03**. The error code for a fault involving a signal repeater control module is **E50**.

Integrity test of defined operating parameters – the central unit and the signal repeater permanently monitor for consistency between defined parameters and the valid parameters in the central unit. This concerns the selected working regime and the defined train speed setting. The time limit for matching the defined and valid parameters is 1 second. If the parameters are inconsistent during system operation (e.g., there is a communication fault between the central unit and a signal repeater) or if the central unit does not confirm the accepted newly set parameters within the defined period of time, the system detects an integrity fault of the defined parameters and the corresponding error code is **E31** or **E03**. Evaluation channels M and C in the central unit mutually compare the active working regime. A fault is detected if the active working regime is inconsistent between channels M and C for longer than 3 seconds and the error code is **E27**. The active working regime in both channels is permanently tested against the configuration permissions for the specific train protection system application. The system detects a fault if the active working regime is not consistent with the configured permissions (prohibited for the given configuration) and the error code is **E28**.

Communication functionality test – each unit continuously monitors the functionality of data communication on the RS485 link. The system reports a communication fault if the PMC processor module or any signal repeater module does not receive the correct data packet from the PMM module after more than 5 seconds. The system also reports a communication fault if the PMM processor module does not receive the correct response packet from any other module after 50 attempts. The system detects one of the following error codes: **E04, E05, E06, E03, E50, E51** or **E00**. If a MIREL STB functional gateway is detected during the start-up of the system, the train protection system checks the functionality of communication

with the functional gateway during system operation. A loss of channel M communication with the MIREL STB functional gateway is considered a fault and the error code is **E80**. A loss of channel C communication with the MIREL STB functional gateway is considered a fault and the error code is **E81**. Should a MIREL SHPE cooperating device be enabled in the system by the configuration, the train protection checks the functionality of their communication during entire further system operation. In case of communication loss between MIREL SHPE device and M-channel, the system detects and indicates error **E85**. In case of communication loss between MIREL SHPE device and C-channel, the system detects and indicates error **E86**.

Train protection system intervention integrity test – the system continuously compares the results of channels M and C of the central unit with a frequency of 10 Hz. A fault is detected if there is a difference in results when monitoring train protection system intervention for longer than 5 seconds and the error code is **E10**.

Maximum permitted speed evaluation integrity test – the system continuously compares the results of channels M and C of the central unit with a frequency of 10 Hz. A fault is detected if the difference in speed exceeds 5 $km.h^{-1}$ when evaluating maximum permitted speed for longer than 180 seconds and the error code is **E14**.

Signal sign transmission integrity test – the system continuously compares the results of channels M and C of the central unit with a frequency of 10 Hz. A fault is detected if the difference in the results when decoding transmitted signal signs or speed orders exists for longer than 20 seconds and the error code is **E15**.

Speed measurement test – speed measurements are completed using the four-channel incremental RPM sensor. Actual instantaneous speed is calculated from measurement channels 1, 2 and 3 and 4 in both evaluation channels (M and C). The calculated speeds are compared and every evaluation channel works with the higher of the two calculated speeds. A fault is detected if the difference between the measured speeds is larger than 20 pulses from the sensor and the error code is **E20**. The mutual comparison of results in both evaluation channels continues. A fault is detected if the difference in the speeds measured by channels M and C is greater than 2 $km.h^{-1}$ for more than 10 seconds and the error code is **E25**.

Pressure measurement test – the pressure sensor in the main brake pipe is connected to the system by a 4-20 mA current circuit. The system continuously tests the upper and lower limits. A fault is detected if the limit values are exceeded and the error code is **E24**. The mutual comparison of results in both evaluation channels continues. A fault is detected if the difference in the pressure measured by channels M and C is greater than 0.2 bar for more than 20 seconds and the error code is **E26**. The final main brake pipe pressure test checks for conformity between pressure and the movement of the locomotive. A fault is detected if pressure in the main brake pipe is less than 0.5 bar and the locomotive accelerates to more than 10 km/h and the error code is **E12**.

Actual direction of travel evaluation test – the conformity of direction of travel measurements are checked in the same way as speed measurements. The error code is **E21** if the evaluated directions do not match for a period of 3 seconds.

EPV check during train protection system intervention – the EPV valve is opened using channel M if train protection system intervention is activated. The decrease in pressure in the main pipe is then measured and compared to the expected values. EPV opening is activated using channel C and if there is low pressure in the main pipe, a fault is detected and the error code is **E11**. The expected pressure drop values are pressure of less than 4.5 bar within 5 seconds and pressure of less than 3.5 bar within 10 seconds.

Incremental RPM sensor power test – the system uses a comparator to test the power to the incremental RPM sensor. A fault is detected if the current draw is too low (power loss) or too high (short circuit) and the error code is **E22**.

Main pipe pressure sensor power test – the system uses a window comparator to test the pressure sensor supply voltage. A fault is detected if voltage is too low or too high and the error code is **E23**.

Test of decoding and processor execution of instructions – the proper decoding and executing of the applied sub-set of the instruction file of processes is tested by triggering a special diagnostic part of the program, which is conducted cyclically in 4 branches with a comparison of results. A period of 100 ms is

required to conduct a single cycle. The testing period for all input data bit combinations is 26 s. A fault is detected in decoding and executing instructions and the error code is **E30**.

D1 start-up self-diagnostic control completion test – an error is detected if the complete scope of D1 control is not completed within 4 hours from the moment the train protection system is switched on and the error code is **E09**.

D1 start-up self-diagnostic control restart test – an error is reported if the system is unable to restart D1 start-up self-diagnostic control within 24 to 28 hours of the most recent test (if the locomotive has not stopped completely) and the error code is **E32**.

Signal sign indicator test – information from the signal repeater indication and control module is compared in the PMM and PMC processor modules of the central unit to detect any nonconformity between the indicated signal sign and the blue light. The error code is **E52**.

Signal repeater button test – information from the signal repeater indication and control module is compared in the PMM and PMC processor modules of the central unit to detect any fault in the signal repeater buttons. The error code for a  button fault is **E53**. The error code for a  button fault is **E54**. The error code for a  button fault is **E55**. The system detects an unprompted intervention if the confirmation button  on the signal repeater is improperly operated and the error code is **E56**.

MIREL STB functional gateway fault detection – detection is conducted autonomously of the actual functional gateway. The train protection system displays applicable error codes in the range from **E60** to **E74**.

Error detection of MIREL SHPE device – detection is carried out autonomously by device proper. Train protection realizes the indication of respective error code in range from **E90** to **E93**.

Configuration parameter integrity check – the system calculates the checksums in memory containing the configuration parameters and compares them to the expected values. The error code for a memory fault is **E33**. Evaluation channels M and C in the central unit mutually compare configuration chains. A fault is detected if the configuration chains are inconsistent between channels M and C for longer than 10 seconds and the error code is **E34**.

Check of stand-by regime control inputs – the system detects any incorrect combinations of stand-by regime control inputs depending on the configuration permissions and the error code is **E82**.

Status check of recording equipment – the system checks the communication status and internal status of recording equipment depending on configuration permissions. The error code is **E83**.

SHP interface test – the system checks the status of the digital interface with the SHP system depending on the configuration permissions. The train protection system detects an error if an incorrect combination of digital inputs is detected from the SHP system and the error code is **E84**.

Processor module restart test – a fault is detected if an uncontrolled repeated start of either of the processor modules, PMM or PMC, in the central unit occurs during the operation of the train protection system; the error code is **E17**. The error code if an uncontrolled restart of the indicator module on the signal repeater in the active cab occurs during operation of the train protection system is **E18**. The error code if an uncontrolled restart of the control module on the signal repeater in the active cab occurs during operation of the train protection system is **E19**.

Completion protocol:

Not issued.

Resolving nonconformity:

If any fault is discovered during the continuous self-diagnostic test, simply switch off the circuit breaker for the train protection system for at least 5 seconds and then re-energise the equipment to re-initialise the equipment. **Any fault displayed after re-initialising the equipment prevents subsequent operation of the train protection system.** Operational repairs (S1) are required.

8.3 D3 – Functional Test

Purpose:

This test verifies the basic functionality and integrity of the operated system. It also verifies interaction with track infrastructure, the odometer system and the locomotive brake system and verifies the functionality of the operator interface.

Execution:

The train protection system operator's trained personnel or other demonstrably authorised and trained persons.

Schedule:

Function test has to be carried out when activating system, changing system configuration, upon any substantial system change and subsequently regularly every 6 months, with a 1-month tolerance period.

The first deadline for conducting a D3 functional test commences on the date on which the system is commissioned on the locomotive.

Execution of the D4 prophylactic control is a substitute for the D3 functional test.

The six-month term re-starts if an unplanned D3 functional test is executed.

Description:

The functional test serves to ensure proper operation of all basic functions of the train protection system. The functional test comprises 3 sections:

A. Preparation and basic functionality
B. Functionality of defined parameters
C. Diagnostic TEST regime

The special diagnostic TEST regime is used by the train protection system to perform Section C of the functional test. This regime is selected in the cab by pressing the  button and engaging the control switch. The locomotive must be completed stopped and the system must be in ZAV regime or in a state where D1 self-diagnostics are not under way. Press  to complete a step and move to the next in Section C. Press  to return to the previous step. Press  to activate the given system output in the current step. Switch off the control switch to terminate the TEST regime.

Analogue input parameters (speed and pressure in the main pipe) are controlled with the system in ZAV regime or in a state where D1 self-diagnostics are not under way. Pressing  and  simultaneously shows the speed of the locomotive with precision of 1 $km.h^{-1}$ on the NO11 display, while pressing  and  simultaneously displays the pressure in the main brake pipe with accuracy of 0.1 bar on the NO11 display. MIREL VZT test equipment is required to conduct the full scope of the D3 functional test.

Document 206VZ1 has the methodology and template protocol for conducting the D3 functional test on the MIREL VZ1 train protection system.

Completion protocol:

The completion protocol for the functional test must contain the following details:

- Date and site
- Serial number of the system and the central unit
- The number of the locomotive on which the equipment is installed
- The name of the person who conducted the test
- The result of the functional test (no faults / with faults)
- A description of all faults must be provided
- The signature of the person who conducted the test

Resolving nonconformity:

Operational repairs of the system (S1) must be conducted when a fault is detected.

8.4 D4 – Prophylactic Control

Purpose:

This control involves the in-depth verification of the status, integrity and functionality of the system with respect to safety and reliability and verification of the status and interface between the system and the locomotive. It includes conducting D3 functional testing.

Execution:

Manufacturer-trained personnel or other persons demonstrably authorised and trained by the manufacturer explicitly for this purpose.

Schedule:

In case that the previous D4 prophylactic control was performed in the Basic range, the following D4 prophylactic control is performed after 24 months with a tolerance of 2 months.

If the previous D4 prophylactic control was performed in the Extended range, the following D4 prophylactic control is performed during the major repair of locomotive. In specific cases, if the periodicity of the major locomotive repairs exceeds 10 years, the prophylactic D4 control must be carried out no later than 120 months.

The first deadline for a D4 prophylactic control commences on the date of the final check conducted during the removal of the central unit and the signal repeaters of the MIREL VZ1 train protection system from the manufacturer's warehouse. If these components are not removed from stock simultaneously, the deadline begins on the earliest of these dates.

Commissioning, or recommissioning of all components out of service for more than 12 months, must occur if the entire system, its central unit or any MIREL VZ1 train protection system signal repeater is out of service for more than 12 months. Commissioning must be conducted in the scope corresponding to assembly level Z2 at a minimum. The term "out of service" means that the central unit or the signal repeater is not installed on the locomotive or in a test situation or is installed but the system is not powered up over such period of time.

The new interval commences if an unplanned D4 prophylactic control is performed.

If D4 prophylactic control is not completed in full within a single service stop or at different time intervals on the central unit, signal repeaters as well as system interaction with the locomotive, then the new interval for D4 prophylactic control begins on the day on which the first portion of the D4 control was conducted.

Place of inspection:

Prophylactic inspection D4 of the MIREL VZ1 system can be carried out in one of ways as shown below :

- on drive railway vehicle (DRV)
- Prophylactic device inspection shall be carried out in the Producer´s service centre. The prophylactic inspection of system cooperation with DRV shall be carried out on DRV. Device assembly and –disassembly doesn´t form an integral part of the D4 prophylactic inspection.

Description:

The execution of D4 prophylactic control is subject to the provisions of a specific internal procedure issued by the manufacturer for in-depth checks of the system. The methodology for performing the D4 prophylactic control is adapted to the different installation conditions for individual classes of locomotives on which the MIREL RM1 VZ1 train protection system is installed. D4 prophylactic control may be conducted in the standard scope or in an expanded scope for version v04. Any future installations with conditions and difference that have an impact on the scope and procedure for executing the D4 prophylactic control shall be incorporated into D4 prophylactic control methodology.

Document 498VZ1 has the methodology and template protocol for conducting the D4 prophylactic control on the MIREL VZ1 train protection system.

D4 prophylactic control is only conducted in full. In full means that prophylactic control was conducted on the central unit, the signal repeaters and system interaction with the locomotive.

Completion protocol:

The completion protocol for the prophylactic test must contain the following details:

- Date of completion or the completion dates for the individual sections
- Place or places of performance
- The serial numbers of the system and the individual components
- The number of the locomotive on which the equipment is installed
- The name and position of the person who conducted the test
- The results of the prophylactic control
- A description of findings, nonconformity, faults, problems and deficiencies if identified
- Signature of the person who conducted the test

Resolving nonconformity:

If a fault is detected, operational repairs (S1) of the system or maintenance repairs (S2) are required depending on the nature of the detected problem.

9 System Maintenance

All train protection system components are maintenance-free. No component needs to be replaced, tuned, or otherwise configured at any time.

Two levels of MIREL VZ1 train protection system maintenance

S1	Operational repairs
S2	Maintenance repairs

Operational repairs (S1) are conducted by the operator's trained personnel. A Repair is performed if any train protection system faults are detected by any level of diagnostics (D1 to D4) or in connection with a fault indicated during operation of the train protection system. Operational repairs serve to remedy faults in cabling, power and connections to peripheral equipment on the locomotive. Operational repairs do not involve any interference inside the central unit or the signal repeaters in the system.

Maintenance repairs (S2) are performed by the manufacturer or persons trained and authorised by the manufacturer. Maintenance repairs are conducted if a fault cannot be resolved by performing operational repairs (S1). Maintenance repairs are always conducted on the basis of replacement (replacing the central unit or signal repeater and subsequent repair by the manufacturer). Maintenance repairs are designed to remedy faults in the central unit and signal repeaters of the train protection system.

Anyone conducting maintenance on the train protection system must be instructed with regards to occupational safety and must be demonstrably trained to perform such activities with certification to perform the individual levels of MIREL VZ1 train protection system maintenance.

9.1 S1 – Operational Repairs

Execution:

The train protection system operator's trained personnel or other demonstrably authorised and trained persons.

Schedule:

If any train protection system faults are detected by any of the diagnostic controls (D1 to D4) or in connection with a fault indicated during operation of the train protection system.

Description:

Operational repairs serve to remedy faults in:

- Power to the central unit
- Power to the signal repeaters
- Cabling
- Connection of the incremental RPM sensor
- Connection of the pressure sensor in the main brake pipe
- Code sensor connections
- Connectors
- Connections of input and output circuits
- Dead man's button connections
- Mechanical anchors

The portions of the D3 functional test that can be of assistance in more precisely determining the exact faults involved should be performed before proceeding to S1 operational repairs. Faults involving the central unit of the train protection system or the signal repeaters are resolved by replacing the specific component. Personnel must have approved technical and installation documentation for the system, in addition to the maintenance manual, when conducting operational repairs and must follow the provisions of such documentation for the given class of locomotive.

S2 maintenance repairs are required on the train protection system if S1 operational repairs do not resolve all faults. D3 functional test of the system must be completed if the S1 operational repairs remedy all faults.

All operational repairs must be documented in the maintenance sheet. The maintenance sheet template is provided in document 460M.

Record – maintenance sheet:

The maintenance sheet for operational repairs must contain the following details:

- Date, time and place
- The serial number of the system and the repaired components
- The number of the locomotive on which the system is installed
- The name of the person conducting the operational repairs
- Description of the faults that have been resolved and their root causes (if known)
- Description of the faults that could not be resolved by operational repairs
- The serial numbers of the removed and installed components
- The signature of the person who conducted the repairs

9.2 S2 – Maintenance Repairs

Execution:

Personnel trained by the manufacturer.

Schedule:

Perform when the train protection system has faults that cannot be remedied by operational repairs S1.

Description:

Maintenance repairs serve to remedy faults in :

- The central unit of the train protection system
- Signal repeaters
- Train protection system horns
- Cooperation between the train protection system and cooperating equipment and other components of the locomotive that could not be remedied with S1 operational repairs

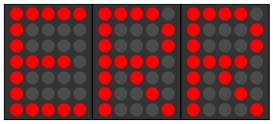
The D3 functional test must be completed after the maintenance repairs and a record for such test must be completed. All maintenance repairs must be documented in the maintenance sheet. The maintenance sheet template is provided in document 460M.

Record – maintenance sheet:

The completion protocol for maintenance repairs must contain the following details:

- Date, time and place
- The serial number of the system and the repaired components
- The number of the locomotive on which the equipment is installed
- The name of the person conducting the maintenance repairs
- Description of the faults that have been resolved and their root causes (if known)
- The serial numbers of removed and installed components (if applicable)
- The signature of the person who conducted the repairs

10 Faults



Train protection faults are divided into two groups. Specifically, there are faults that prevent subsequent use of the train protection system and faults that restrict subsequent use of the train protection system. The system is automatically switched into safe mode when a fault that prevents subsequent use of the system is detected; the EPV opens and the emergency brake is activated. The **ERR** (ZJ8) indicator lights on the front panel of the central unit. When a fault occurs, the operator should first switch off the train protection system circuit breaker for at least 5 seconds and then switch it back on to re-initialise the train protection system. If the fault appears again, the locomotive operator should not take any additional action to remedy the fault.

After re-initialising the system, it should be noted that the system operates using the pre-set operating parameters.

For more precise troubleshooting, the error code can be displayed by pushing the button (NO14) on the signal repeater in the active cab showing a fault to bring up with numbered system error code. List of errors as detected by system within the diagnostic tests framework, is provided in two tables. Each table is related to the respective version of MIREL VZA Technical Conditions.

List of errors excluding further operation of train protection, which are related to MIREL VZ1 Technical Conditions in version 211203 (257VZ1))	
E00	permanent loss of communication between signal repeater main module and central unit
E01	error detected by monitoring WD-type circuits of central unit
E02	EEPROM memory error of central unit
E03	combined error of signal repeater main module at active driver´s cab: ■ error detected by WD-type monitoring circuits ■ error of FLASH, EEPROM, RAM memories ■ errors of decoding and of processor instruction execution ■ communication error ■ integrity error of pre-set parameters
E04	communication error between central unit and signal repeater main module at 1st driver´s cab
E05	communication error between central unit and signal repeater main module at 2nd driver´s cab
E06	communication error between M- and C- channels of central unit
E07	error of code-sensing transfer path detected by one-time D1 diagnostics
E08	EPV error detected by one-time D1 diagnostics
E09	non-execution error of D1 diagnostic test within 4 hours after switch-on of system
E10	intervention integrity error of processor modules in central unit
E11	EPV error upon intervention of train protection – insufficient pressure drop in main brake line
E12	DRV movement with insufficient pressure in main brake line
E14	error of maximum speed evaluation integrity
E15	error of evaluation integrity regarding transmitted signal aspect according to LS specification or speed command according to EVM specification
E17	start-up error of central unit processor modules
E18	start-up error of signal repeater main module at active driver´s cab
E19	start-up error of signal repeater control module at active driver´s cab
E20	measurement error of actual speed
E21	evaluation error of actual travel direction
E22	powering error of incremental speed sensor
E23	powering error of pressure sensor in main line
E24	pressure measurement error in main line

E25	actual speed integrity error between M- and C- channels
E26	pressure integrity error in main line between M- and C- channels
E27	integrity error of pre-set operating mode between M- and C- channels
E28	integrity error of required operating mode – requirement for prohibited operating mode
E30	error of decoding and processor instruction execution of central unit
E31	integrity error of set operating parameters
E32	error of repeated D1 diagnostic test start-up
E33	integrity error of train protection configuration data
E34	integrity error of configuration data between M- and C- channels
E35	validity error of D4 diagnostic test
E36	error of system real time setting
E40	central unit FLASH memory error
E41	central unit RAM memory error
E42	software integrity error – UNI section
E43	software integrity error – LS section
E44	software integrity error – EVM section
E45	software integrity error – SHP section
E46	software integrity error – STB section
E50	combined error of signal repeater control module at active driver´s cab ■ error detected by WD-type monitoring circuits ■ error of FLASH, EEPROM, RAM memories ■ errors of decoding and of processor instruction execution ■ communication error
E51	error of central unit communication with signal repeater control module at active driver´s cab
E52	signal aspect indication integrity error on signal repeater at active driver´s cab
E53	functional error of  signal repeater button at active driver´s cab
E54	functional error of  signal repeater button at active driver´s cab
E55	functional error of  signal repeater button at active driver´s cab
E56	error of unrequired termination of system intervention
E60	combined error of STBM or STBC blocks of MIREL STB gateway: ■ error detected by WD-type monitoring circuits ■ FLASH, EEPROM memory errors – checksums ■ RAM – R/W memory error ■ errors of decoding and execution of processor instructions ■ stack error ■ error of data areas range in EEPROM and RAM ■ real time system error ■ EEPROM memory update error ■ integrity of UNI software block – checksums ■ configuration data integrity error ■ power supply error of communication lines KL1 (bus KZ1) and KL2 (bus KZ0)
E61	integrity loss of active MIREL STB gateway mode and operating mode of MIREL VZ1 system.
E62	integrity loss of: ■ STM_CMD command (command for MIREL VZ1 system) between channels M and C of MIREL STB gateway ■ exposed binary outputs between channels M and C of MIREL STB gateway ■ configuration bytes of MIREL STB gateway between M and C channels ■ configuration of the active interface for controlling STM module (active binary and communication interface)
E63	communication error between MIREL STB gateway with MIREL VZ1 system
E64	communication error between MIREL STB gateway with ETCS system

E65	integrity loss of command from ETCS or VCS: ■ required active mode (DA) for more than 1 national system and configurationally, switching to STB-I mode is not allowed even during operations ■ MIREL is in active mode (DA) and ETCS requests fault state (FA) or MIREL has fault state (FA) and ETCS requests active mode (DA)
E66	integrity loss of generated safety-relevant messages between M and C channels of MIREL STB gateway
E67	integrity loss of MIREL STB binary outputs
E68	combined error of STBGW block of MIREL STB gateway: ■ errors detected by WD-type monitoring circuits ■ error detected by software restart ■ FLASH memory error – checksums ■ RAM – R/W memory error ■ stack error ■ power supply error of communication lines ■ error of communication on KZ0 communication bus ■ errors of decoding and execution of processor instructions ■ error of internal parameters ■ integrity of UNI software block – checksums ■ real time system error ■ archive error in FRAM memory ■ error of communication with FRAM memory ■ error of communication with MVB module ■ error of free loop
E69	communication error between M- and C- channels of MIREL STB gateway
E70	communication error with STBGW block of MIREL STB gateway
E71	integrity error of configuration parameters from STBGW block
E72	integrity loss of state two MIREL STB gateways in function master/slave: ■ wrong CRC in data part of security packet of the function f_MS ■ incorrect state of status bits of security packet of the function f_MS ■ mismatch between NID_STMSTATE and NID_STMSTATEORDER variables
E73	communication error between gateways MIREL STB master and slave: ■ non-updated security packet timestamp of the function f_MS ■ malfunction of security packet of the function f_MS
E74	error of external communication interface including the master/slave function: ■ failure of an inactive gateway (E68, E70, E71, E74) evaluated by an active MIREL STB gateway
E80	communication error of central unit with M-channel of MIREL STB gateway
E81	communication error of central unit with C-channel of MIREL STB gateway
E82	integrity error of standby mode control binary inputs
E83	combined error of recording unit ■ communication error with MIREL BB recording device ■ internal error of MIREL BB recording device ■ communication error with MIREL SPIO recording device gateway ■ internal error of MIREL SPIO recording device gateway
E84	integrity error of binary interface with SHP system
E85	communication error of central unit with M-channel of MIREL SHPE generator
E86	communication error of central unit with C-channel of MIREL SHPE generator
E90	combined error of MIREL SHPE generator ■ error detected by WD-type monitoring circuits ■ errors of decoding and of processor instruction execution ■ error of internal communication with peripheral circuits ■ error of FLASH, EEPROM, RAM memories ■ error of power supply
E91	integrity error between M- and C- channels of MIREL SHPE generator
E92	communication error of MIREL SHPE generator
E93	antenna error of MIREL SHPE generator

Error codes that are detected in the STBC block of the MIREL STB gateway are registered by the registration device in the range from 160 to 174. Error codes that are detected in the STBC block of the MIREL

SHPE generator are registered by the registration device in the range from 190 to 193. Indication on signal repeater is always in the range according to the table.

List of errors excluding further operation of train protection, which are related to MIREL VZ1 Technical Conditions in version 200401 (257VZ1)	
E00	permanent communication loss between signal repeater main module and central unit
E01	error detected by WD-type watchdog circuits of central unit
E02	central unit EEPROM-Error
E03	compound error of signal repeater main module at active driver cab ■ error detected by WD-type watchdog circuits ■ FLASH, EEPROM, RAM memories error ■ errors of encoding and execution of processor instructions ■ communication error ■ integrity error of set parameters
E04	communication error between central unit and signal repeater main module at 1st Driver cab
E05	communication error between central unit and signal repeater main module at 2nd Driver cab
E06	communication error between channels M and C of central unit
E07	error of code scanning transmission path detected by D1-one-time diagnostics
E08	EPV error detected by D1-one-time diagnostics
E09	error of failed D1 diagnostic test accomplishment within 4 hours after system powering
E10	integrity error of processor modules intervention in central unit
E11	EPV error during train protection intervention – insufficient pressure drop in main brake pipe
E12	DRV movement with insufficient pressure in main brake pipe
E14	integrity error of maximum speed evaluation
E15	integrity error of transmitted signal evaluation pursuant to LS specification or speed command pursuant EVM specification
E17	run-up error of central unit processor modules
E18	run-up error of signal repeater main module at active driver cab
E19	run-up error of signal repeater check module at active driver cab
E20	error of actual speed measurement
E21	Evaluation error of actual ride direction
E22	power supply error of incremental axle speed sensor
E23	power supply error of pressure sensor in main pipe
E24	error of pressure measurement in main pipe
E25	actual speed integrity error between channels M and C
E26	main pipe pressure integrity error in main pipe between channels M and C
E27	Integrity error of pre-set operation mode between channels M and C
E28	integrity error of requested operating mode – request for a not permitted operating mode
E30	error of decoding and of processor instruction execution
E31	integrity error of set operating parameters
E32	error of repeated D1 diagnostic test start
E33	integrity error of train protection config data
E34	integrity error of config data between channels M and C
E35	D4 diagnostic test validity error
E36	setting error of system real time
E40	central unit FLASH memory error
E41	central unit RAM memory error
E42	software integrity error – UNI section

E43	software integrity error – LS section
E44	software integrity error – EVM section
E45	software integrity error – SHP section
E46	software integrity error – STB section
E50	compound error of signal repeater check module at active driver cab ■ error detected by WD-type watchdog circuits ■ FLASH, EEPROM, RAM memories error ■ errors of decoding and of processor instruction execution ■ communication error
E51	communication error between central unit and signal repeater check module at active driver cab
E52	indication integrity error of signal by signal repeater at active driver cab
E53	function error of pushbutton  at active cab signal repeater
E54	function error of pushbutton  at active cab signal repeater
E55	function error of pushbutton  at active cab signal repeater
E56	error of unrequested system intervention termination
E60	compound error of MIREL STB port – channel M ■ error detected by WD-type watchdog circuits ■ FLASH, EEPROM, RAM memories error ■ errors of decoding and of processor instruction execution
E61	integrity error of requested operating mode by MIREL STB port – channel M and actual operating mode of MIREL VZ1 operating mode
E62	integrity error of requested operating mode between channels M and C of MIREL STB port detected by channel M
E63	compound communication error of MIREL STB port – channel M ■ communication error between MIREL STB port and MIREL VZ1 system ■ communication error between channels M and C
E64	compound communication error of MIREL STB port – channel M with ETCS
E65	compound error of ETCS system command detected by MIREL STB port – channel M ■ ETCS requires DA status for more than a single STM module ■ ETCS requires FA status for all STM modules
E70	compound error of MIREL STB port – channel C ■ errors detected by WD-type watchdog circuits ■ FLASH, EEPROM, RAM memories errors ■ errors of decoding and of processor instruction execution
E71	integrity error of requested operating mode by MIREL STB port – channel C and actual operating mode of MIREL VZ1 system
E72	integrity error of requested operating mode between channels M and C of MIREL STB port detected by channel C
E73	compound communication error of MIREL STB port – channel C ■ communication error between MIREL STB port and MIREL VZ1 system ■ communication error between channels M and C
E74	compound communication error of MIREL STB port – channel C with ETCS
E75	compound error of ETCS system command detected by MIREL STB port – channel C ■ ETCS requires DA status for more than a single STM module ■ ETCS requires FA status for all STM modules
E80	error of communication with MIREL STB port – channel M detected by MIREL VZ1 system
E81	error of communication with MIREL STB port – channel C detected by MIREL VZ1 system
E82	integrity error concerning binary inputs of standby mode control
E83	compound error of recording equipment
E84	error of interface integrity with SHP system
E85	error of communication with MIREL SHPE generator – channel M, detected by MIREL VZ1 system
E86	error of communication with MIREL SHPE generator – channel C, detected by MIREL VZ1 system

E90	compound error of MIREL SHPE generator – channel M ■ errors detected by watchdog circuits ■ errors of decoding and of processor instruction execution ■ errors of internal communication with peripheries circuits ■ errors of FLASH, EEPROM, RAM memories ■ power supply errors
E91	error of integrity between channels M and C of MIREL SHPE generator – channel M
E92	error of MIREL SHPE generator communication – channel M
E93	error of MIREL SHPE generator antenna – channel M
E95	compound error of MIREL SHPE generator – channel M compound error range identical like with **E90**
E96	error of integrity between channels M and C of MIREL SHPE generator – channel C
E97	error of MIREL SHPE generator communication – channel C
E98	error of MIREL SHPE generator antenna – channel C

The EPV does not open and the emergency brake does not activate in the event of a fault that restricts subsequent use of the system. No fault is indicated on the front panel of the central unit or on the signal repeater. In this case, the fault involves the signal repeater in the inactive cab. These faults only restrict the operation of the train protection system to the cab in which the signal repeater that is operating normally is installed.

All faults detected during operations in ZAV working regime while in motion are classified as faults restricting subsequent use of the system. These faults are then reclassified depending on type into faults preventing subsequent use of the system after the vehicle is stopped. The EPV is opened after the locomotive has stopped due to the detection of a fault in ZAV regime.

Errors limiting further operation of train protection, as indicated on signal repeater at inactive driver cab	
E00	general fault of signal repeater primary module in the active cab ■ fault detected by WD-type watchdog circuits ■ FLASH, EEPROM, RAM memory fault ■ faults in decoding and processor execution of instructions ■ communication fault

11 System Configuration

11.1 General Principles and Procedures

Configuration of MIREL VZ1 train protection is carried out by means of a diagnostic computer with installed MAP application manager with KAM module.

Diagnostic computer shall be connected to train protection or to interacting registration speedometer MIREL RM1 by one of alternatives listed in Connection of Configured Devices in 547MAP KAM User Manual.

Establishing of communication between diagnostic computer and train protection system is indicated on diagnostic computer display and by means of indication light ZJ5 at front panel of central unit.

Configuration setting is carried out on diagnostic computer by means of MAP application manager in KAM module. Service, maintenance and operation staff follows in course of system configuration User Manual 547MAP for KAM software comprising binding rules, safety notices and system configuration procedures.

Upon execution of entry, reading and correctness verification of train protection config parameters in accordance with 547MAP, it is necessary to verify proper operation of train protection in extent listed below:

- central unit indicates operation by means of indicators ZJ1 and ZJ9,
- central unit doesn´t indicate system error by means of indicators ZJ8 and ZJ10,
- execution of D3 function test in accordance with protocol 206VZ1.

If config parameter have been set in course of S2 service repair, function test is carried out by the maintenance staff which fits the repaired equipment at DRV.

11.2 Setting of Configuration Parameters

General principles and procedures listed in Chapter 11.1 must be complied with when setting configuration parameters.

A complete train protection configuration comprises setting as follows:

- Config parameter sets
- DRV serial No.
- Scanned axle diameter
- MIREL VZ1 system functionality

Competence of a given service workplace can be, depending on actual needs, limited only to some of a.m. items. This means that it isn´t possible to configure all parameters on the given workplace.

11.2.1 Scanned Axle Diameter Setting

General principles and procedures listed in Chapter 11.1 must be complied with when setting scanned axle diameter.

Periodicity of scanned axle diameter setting is specified by Operator´s regulation. Said maintenance regulation lays down procedure of setting a new diameter, but doesn´t specify procedures and rules indicating when the new diameter setting has to be carried out.

12 Data reading from recording equipment

Depending on the configuration of the system, one of the options for integrating the registration device is directly via the RS485 communication bus, using a recording module integrated into the VZ1ZJ base unit device.

In the case of configuring a system with hardware of base unit with replaceable storage medium of the recording module, this registered data module is accessible from the front panel of the base unit. Removing the memory card is done by pushing it and then pulling it out of the slot. To return the memory card, insert it into the slot and push the card fully in.

Upon data download, memory card replacement and train protection powering, the proper train protection operation must be verified in extent described below:

- central unit indicates operation by means of indicators ZJ1 and ZJ9
- central unit doesn´t indicate any system error by means of indicators ZJ8 and ZJ10

The system time for registration is set automatically when the system is configured, according to the time on PC which the configuration is performed with. For a more detailed specification of the time setting conditions during system configuration, see the document 547MAP.

The presentation of the recorded data from the removable storage medium is performed in the MAP programming environment using the MAN module. A detailed specification is given in 1997MAP.

If data registration is implemented by an interacting unit connected to train protection, then relevant technical documentation of registration unit producer must be adhered to when downloading data and evaluating them.

13 Installation and Disassembly

After performing the assembly steps, it is necessary to carry out the D3 Test .

Central unit installation and removal in version VZ1ZJ.0

The central unit is mounted using 4 M6 bolts along the sides of the front panel. A 72-pin DD connector with 2 locking latches and a DB connector are located on the rear wall of the central processing unit. The battery source of the locomotive must be switched off or the circuit breaker for the train protection system must be switched off when installing and removing the train protection system. The installation procedure follows:

- Connect the 72-pin DD connector
- Close the latches on the connector
- Connect the DB connector
- Position in the desired location
- Install and fasten the mounting bolts

Reverse this procedure to remove.

Fitting and Dismantling of Central Unit in Version VZ1ZJ.1

Central unit is structurally fastened with 4 M6 bolts on front panel sides. Indication elements, 37-pin DB-type connector piece, 25-pin DB-type connector piece,15-pin DB-type connector piece and a pair of 10-pin industrial connectors of Hummel M16 type are situated on front panel. When fitting and dismantling, the vehicle battery power source or train protection circuit breaker must be disconnected. Fitting procedure is as described below:

- positioning into a proper position
- fitting and fastening of mounting bolts
- fitting of DB-type connector pieces and their securing with safety bolts
- fitting of Hummel M16-type connectors

Dismantling is carried out in reverse order of steps.

Fitting and Dismantling of Signal Repeater with Rear Installation

The signal repeater is inserted into an enclosure in the locomotive control panel and is secured with a pair of mounts. A terminal strip is located on the rear of the unit for connecting electrical cabling. The battery source of the locomotive must be switched off or the train protection system circuit breaker must be switched off when installing and removing a signal repeater. The installation procedure follows:

- Install the unit into the metal enclosure
- Install the mounts
- Connect cabling to terminal strip on the unit
- Position the enclosure in the desired position
- Mount the enclosure to the control panel in the cab (depending on type of locomotive)

Reverse this procedure to remove.

Fitting and Dismantling of Signal Repeater with Front Installation

Signal repeater is structurally inserted into a covering part in driving rail vehicle board and is fastened with a pair of fixation bolts. A terminal box for connection of electrical cables is situated on units rear side. When fitting and dismantling, the vehicle battery power source or train protection circuit breaker must be disconnected. Fitting procedure is as described below:

- cables wiring into unit´s terminal box
- insertion of unit into cover sheet
- securing of unit by means of fixation bolts

Dismantling is carried out in reverse order of steps.

Installation and removal of a stand-alone model horn

The horn is mounted on hinges secured with 2 M4 bolts. A terminal strip is installed on the rear of the enclosure. The battery source of the locomotive must be switched off or the circuit breaker for the device must be switched off during installation and removal. The installation procedure follows:

- Connect the terminal strip on the rear of the enclosure
- Position in the desired location
- Install and fasten the mounting bolts

Reverse this procedure to remove.

Fitting and Dismantling of Horn with Rear Installation

Identical procedure like with signal repeater with rear installation

Fitting and Dismantling of Horn with Front Installation

Identical procedure like with signal repeater with front installation

14 Notes