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# **MAINTENANCE AND DIAGNOSTICS MANUAL**

## **MIREL RM1**

Speed Recorder

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Changes:

| Code   | Date       | Description                                     | Approved by   |
|--------|------------|---|---------------|
| 010821 | 21.08.2001 | Document introduction                           | Ing. Horváth  |
| 130215 | 15.02.2013 | Document updated based on technical conditions  | Ing. Šajben   |
| 171018 | 17.10.2017 | Changing of D4 prophylactic checkl conditions   | Ing. Michalec |
| 180115 | 15.1.2018  | Changing of assembly and disassembly conditions | Ing. Michalec |
| 180208 | 8.2.2018   | Changing of D4 conditions for RM1.1             | Ing. Michalec |
| 180411 | 11.4.2018  | Update of terms                                 | Ing. Michalec |
| 180507 | 31.5.2018  | Update conditions for TEST mode                 | Ing. Michalec |
| 181112 | 12.11.2018 | Update of fault codes list                      | Ing. Michalec |
| 190405 | 5.4.2019   | Update of fault codes list                      | Ing. Michalec |

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## Document Definition

This **document defines** the scope, method and conditions for conducting diagnostics and maintenance, conducting operating and maintenance repairs of the MIREL RM1 speed recorder.

This **document is related** to the following documentation:

|     | Number | Version | Name  |
|-----|--------|---------|---|
| [1] | 297RM1 | 150325  | MIREL RM1 - Technical conditions                        |
| [2] | 342RM1 | 180501  | MIREL RM1 - Protocol on completed D3 functional test    |
| [3] | 357RM1 | 180411  | MIREL RM1 - Operating manual                            |
| [4] | 499RM1 | 170118  | MIREL RM1 - Protocol on completed D4 prophylactic check |
| [5] | 547MAP | 160229  | MIREL KAM - Operating manual                            |

The **document** is intended for the following staff:

- Of the manufacturer as reference documentation for the installation, configuration, start up and maintenance of the MIREL RM1 speed recorder
- Of the operator as reference documentation for the installation, configuration, start up and maintenance of the MIREL RM1 speed recorder

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## General Characteristics

The MIREL RM1 speed recorder is equipment specifically designed for use on railway locomotives in all forms of tractive power. The RM1 secures three basic functions: measurement of instantaneous speed, indication of instantaneous speed and additional information, registration of instantaneous speed and other operating and technical data in relation to a time and route-independent scale.

The MIREL RM1 speed recorder is composed of a central processing unit, two indicator devices and two identification devices located at the engineer's stations. The interconnection of individual equipment is via a data line with serial data transmission. Alternatively the RM1 can be operated with only one indicator device or without one. The same applies for the identification devices.

Power for the MIREL RM1 speed recorder is connected to the locomotive's battery source. Configuration of the MIREL RM1 is dependent upon the voltage of the battery source. Service of the speed recorder is performed exclusively from the engineer's station via the identification devices and control elements on the locomotive's control panel. Functionality of the identification instrument may be integrated into the control unit of a cooperating system. No entry into the locomotive's mechanical room or into the central processing unit of the equipment is required to operate the MIREL RM1 speed recorder.

The MIREL RM1 speed recorder is an electronic digital system designed on the basis of the latest electrical components where each instrument is controlled by a separate processor. The components used in the central processing unit meet demanding criteria for reliability and robustness. The central processing unit contains a processor module, power supply, registration module, module for measuring frequency inputs and a module for galvanically isolated digital inputs and outputs. The registration module is designed on the basis of large capacity semiconductor memory chips that ensure the storage of data even if disconnected from the locomotive's battery source for an extended period of time. The indication equipment contains the actual pseudo-analogue indication instrument and a digital indicator of instantaneous speed. The identification equipment comprises a 32-character alphanumeric display and a 12-button keyboard.

The MIREL RM1 speed recorder performs regular self-diagnostics and enables the performance of functional tests to re-test the correct functionality of all control system components and locomotive equipment that works with it. The equipment is maintenance free apart from performing functional tests.

## Configuration of the Equipment

The basic schematic for connecting the components of the MIREL RM1 speed recorder and cooperating equipment on board the locomotive includes:

Basic components:

- Central processing unit 1x
- Indication unit 2 x
- Identification unit 2x

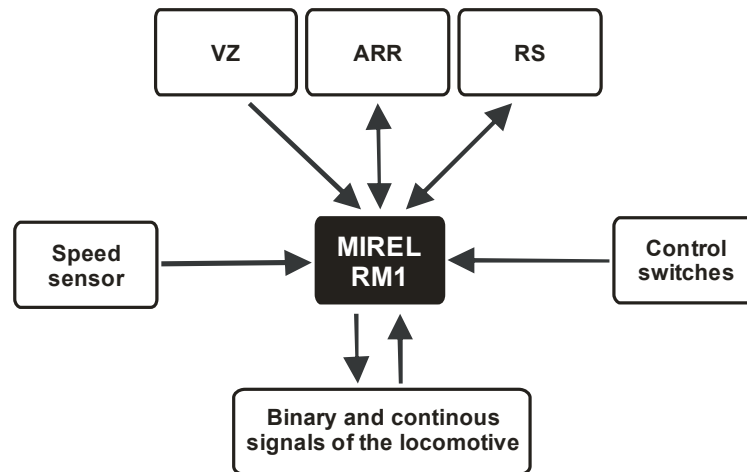
Cooperating equipment:

- Incremental rotation sensor 1x
- Control switch at engineer's station 2x (or 1x)
- Train control system

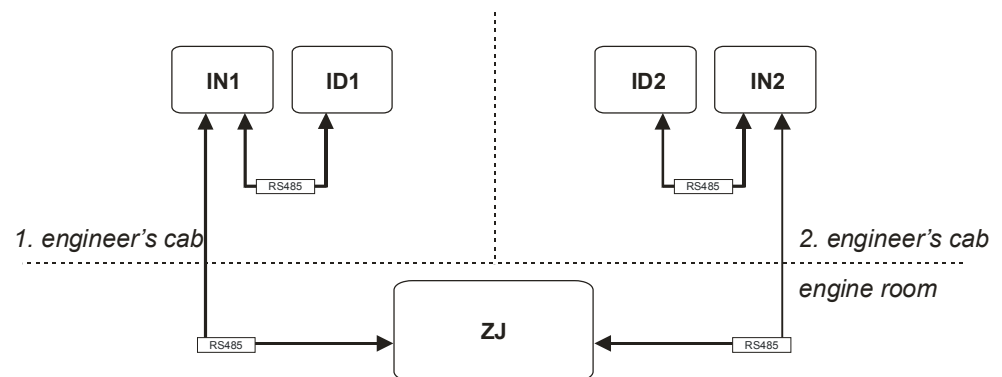
Optional cooperating equipment:

- ARR
- Control system
- etc.

Schematic for connecting the equipment to the locomotive:



Schematic for connecting MIREL RM1 speed recorder units:



Basic block diagram of the test sample

## Central Processing Unit

The central processing unit secures all the operating functions of the MIREL RM1 speed recorder.

- Measuring and filtering impulses from the impulse rotation sensor
- Calculating speed
- Calculating the distance travelled
- Evaluating the distance travelled
- Variables required for registration
- Reading digital and analogue inputs
- Controlling digital outputs
- Communication with the indication and identification units at engineer stations
- Communication with connected cooperating equipment on board the locomotive
- Auto-diagnostics
- Indication on the front panel

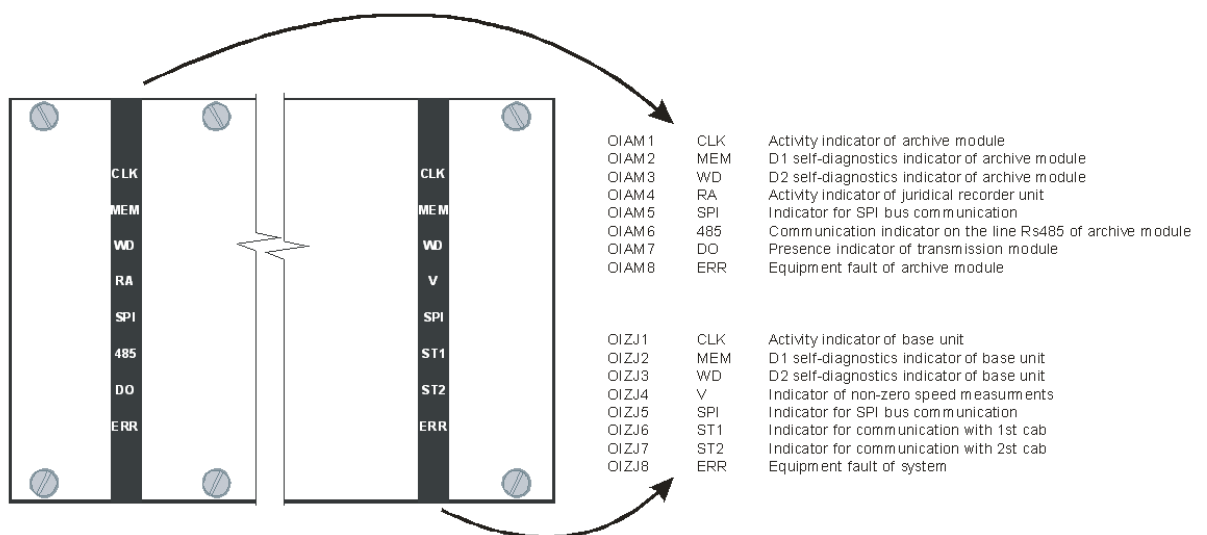
The central processing unit is furnished in two different configurations according to the type of processor and registration module:


- Basic configuration (8 MB registration module capacity), central processing unit type RM1ZJ.0.xxxxx (MIREL RM1 with type marking RM1.0.XXXX)
- Expanded registration module memory (16GB registration module capacity), central processing unit type RM1ZJ.1.xxxx (MIREL RM1 with type marking RM1.1.XXXX).

A more detailed description is given in the 297RM1 technical conditions.

A set of 16 LED indicators is installed on the front panel of the central processing unit. No control elements are located on the central processing unit and there is no need for the operator to interfere with the central processing unit during operation of the speed recorder. The central processing unit is powered from the locomotive's battery source. Power is provided through a separate breaker dedicated for the speed recorder and installed with other breakers for the locomotive or in another specific location depending on the specific type of locomotive. The other components of the MIREL RM1 speed recorder are powered by the central processing unit.

The indication elements and a 15-pin DB type connector for reading the registration unit are installed on the front panel.





The central processing unit is constructed with a 19" width to comply with the IEC 297 standard for rack-mounted equipment. The height is defined as 3U pursuant to the standard (module U = 44.45 mm). The modules of the central processing unit are installed in an AL cabinet. A 72-pin DD type industrial connector and a 25-pin DB type connector are located on the rear panel. The central processing unit will operate in any position. The central processing 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 Unit

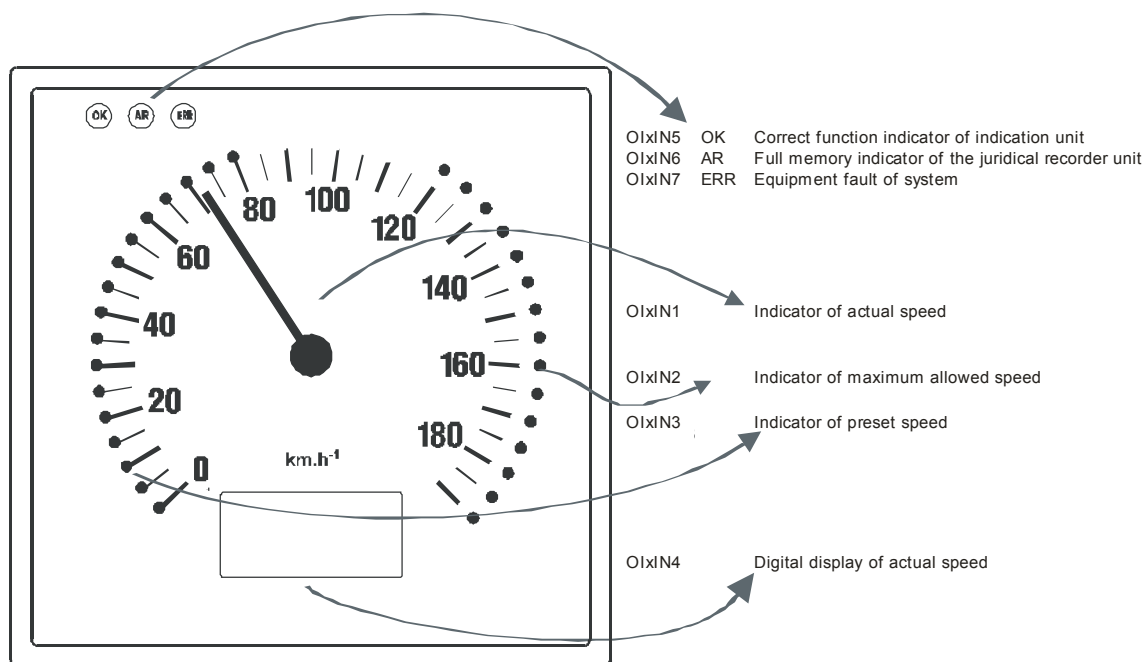
The indication unit ensures that the following data is displayed at the engineer's station:

- Instantaneous speed - a pseudo-analogue gauge, digital indicator
- Maximum allowed speed - red signal (in conjunction with MIREL VZ1)
- Pre-set speed – green signal (in cooperation with the automatic speed regulation module)

The indication unit is a single purpose computer. This computer contains a gauge indicator, number indicator, 2 signals and 3 indication LEDs and a light intensity sensor. The instrument cluster is permanently backlit with brightness regulation. The brightness of the number indicator and the signals themselves is also regulated. The unit is connected to the central processing unit with a four-conductor cable that powers the indication unit and secures data communication between the central processing unit and the indication unit.

The indication unit is constructed in the form of a plastic box intended for integration into the desk at the engineer's station. The indication components are installed on the front face of the box with a 7-position terminal strip located on the back. The equipment can be installed in any suitable manner based on the construction of the locomotive so long as the indication components are visible.

The digital speed indicator for the locomotive displays the instantaneous speed with maximum accuracy thanks to the speed recorder. The function of the pseudo-analogue dial gauge is to provide the operator with an instantaneous indication when checking the instantaneous speed.



## Identification Unit

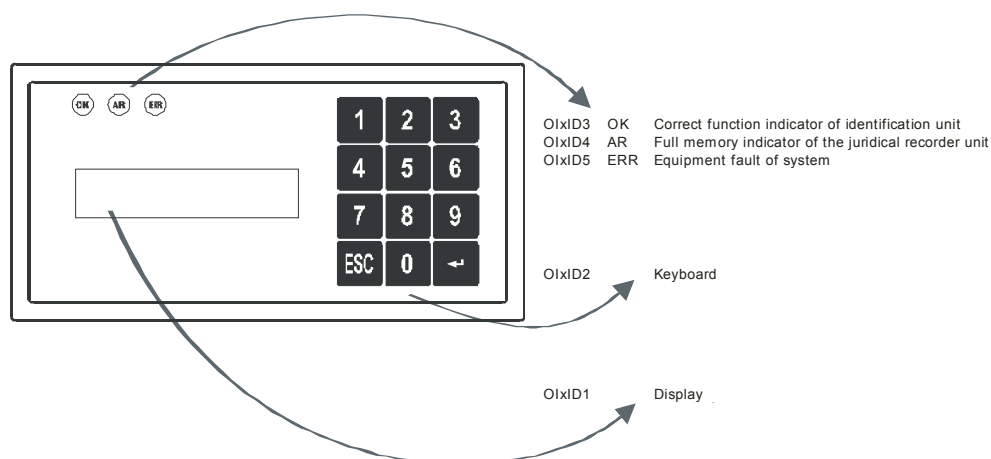
The identification unit is used to enter the engineer's data and to provide alpha-numeric information on the display. The identification unit can also be used to display the following, in addition to the login prompt:

- Instantaneous speed - numeric information
- Maximum speed - numeric information
- Pre-set speed - numeric information
- Calendar date and time in hours, minutes and seconds
- Total distance travelled in km
- Total daily distance travelled in km
- Percentage of used recording registration capacity
- Entering the engineer's identification number
- Entering the train number
- Entering train weight <sup>1)</sup>
- Entering the carrier identification number <sup>1)</sup>
- Entering the operating mode <sup>1)</sup>

<sup>1)</sup> only for the configuration with expanded memory in the registration module (MIREL RM1 with type marking RM1.1.XXXX)

The identification unit is a single purpose computer. It contains a 32-character alpha-numeric display (2 x 16 characters), 12-button keyboard, 3 LED indicators and a light intensity sensor. Display and LED brightness is regulated. The unit is connected to the central processing unit with a four-conductor cable that powers the identification unit and secures data communication between the central processing unit and the identification unit.

The identification unit is constructed in the form of a plastic box intended for integration into the desk at the engineer's station. The indication elements and the keyboard are located on the front side. A 7-position terminal strip is located on the rear side. The identification unit can be installed in any suitable manner based on the construction of the locomotive so long as the indication components are visible and the keyboard is accessible.



## Equipment Diagnostics

### **Diagnostics of the MIREL RM1 speed recorder is conducted at four levels**

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**D1 Start-up self-diagnostic test of the equipment**

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**D2 Continuous self-diagnostic checks**

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**D3 Functional test**

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**D4 Prophylactic check**

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The first two levels (D1 and D2) are conducted automatically by the equipment itself. If a fault is detected, the operator is notified of such fact and the equipment is placed into safe mode. If the discovered fault prevents subsequent activity of the speed recorder, actions are taken to prevent subsequent operation. Operational repairs of the equipment (S1) must be conducted in the event a fault is detected. Maintenance repairs (S2) must be conducted in the event of a repeated fault.

The functional test (D3) of the equipment is conducted by staff trained by the operator. The functional test checks the overall functionality of the equipment, meaning the functionality of all indication elements and keyboards, the functionality of all input and output circuits and cooperation with other equipment on the locomotive (including driving controls, impulse rotation sensors, etc.). Operational repairs of the equipment (S1) must be conducted when a fault is detected. Maintenance repairs (S2) must be conducted in the event of a repeated fault.

Prophylactic check (D4) of the equipment is performed periodically by the manufacturer of the speed recorder or by another entity or individual trained and authorized to conduct such checks. In addition to performing the functional test, an in-depth control of the entire equipment is conducted (measuring input filters, reading variable readouts from the speed recorder, checking input/output circuits and checking the devices that work in conjunction with the speed recorder). This check is conducted in order to verify the complete functionality of the equipment and for any wear and tear. Service repairs (S2) must be conducted if a fault is detected.

Every person conducting diagnostics of the speed recorder must be instructed with regards to occupational safety and must be verifiably trained to perform such activities with proof of certification to perform the individual levels of equipment diagnostics.

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## D1 – Start-up self-diagnostic check of the equipment

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### **Executed:**

By the speed recorder automatically and without any intervention by the operator or maintenance

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### **Schedule:**

Every time the MIREL RM1 speed recorder is powered on

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### **Description:**

The speed recorder is placed into operation when the locomotive's battery source is powered up. Every time the speed recorder is powered up, it conducts the D1 self-diagnostic test, which checks the integrity of the equipment itself, correct configuration parameters and the basic functionality of the equipment. The self-diagnostic test itself takes around 1 second to complete. The D1 self-diagnostic test is executed automatically and no intervention on the part of the operator is needed.

Tests conducted within the start-up self-diagnostic check:

**Program integrity check** – the equipment calculates the checksums in memory containing the saved programs and compares them to the expected values. The equipment will display the error messages **E02**, **E08** or **E09** if a memory error is detected. The equipment is not functional during this test.

**Configuration parameter integrity check** – the equipment calculates the checksums in memory containing the configuration parameters and compares them to the expected values. The equipment will display the error messages **E33** or **E08** if a memory error is detected. The equipment is not functional during this test.

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### **Completion protocol:**

Not issued.

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### **Resolving any discovered faults:**

If any fault is discovered during the start-up self-diagnostic test, simply switch off the breaker for the speed recorder for at least 1 second and then re-energize the equipment to re-initialize the equipment. **If the fault is displayed after re-initializing the equipment, the fault is such that it prevents subsequent activity of the speed recorder.** Operational repairs (S1) are required.

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## D2 – Continuous self-diagnostic check of the equipment

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### **Executed:**

By the speed recorder automatically and without any intervention by the operator or maintenance

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### **Schedule:**

Continuously when the speed recorder is operational

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### **Description:**

The speed recorder conducts continuous self-diagnostic checks using the two watchdog circuits and conducts other diagnostic tests. If a serious fault in communicating with the indication or identification unit at the active station (the station at which the control switch is on) is detected the speed recorder will prevent subsequent operation. The equipment can operate in a limited manner if the communication fault involves the indication and identification units at the inactive station. The speed recorder requires operational repairs in such case.

Tests conducted during continuous self-diagnostic checks:


**Watchdog test** – the processor module in the central processing unit, the registration module and each indication and identification unit is 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 of the given equipment. The 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-initialized and an error message is generated for the entire component. The error code for a fault involving the processor module of the central processing unit is **E01**. The error code for a fault in the active indication unit is **E08**, while a fault in the active identification unit is indicated as code **E09**.

**Configuration parameter integrity check** – the equipment calculates the checksums in memory containing the configuration parameters and compares them to the expected values. The equipment will display the error messages **E33** or **E08** if a memory error is detected. The equipment is functional during this test.

**Communication check between processor module of the central processing unit and the registration module** – the registration module transmits a message to start communication with the processor module of the central processing unit. If communication is not started within 100 seconds the error code is **E34**. The equipment is functional during this test.

**Communication check between the central processing unit and the indication and identification units** – the processor module of the central processing unit transmits a SYNC message to start communication with the indication and identification units. If communication is not started at the active station within around 4 seconds, the error code that is displayed is **E04**, **E05**, **E06** or **E07**. The equipment is functional during this test.

**Communication functionality test** – each unit continuously monitors the functionality of data communication on the SPI and RS485 links. If successful communication is not noted on the communication lines for a period of longer than around 4 seconds and error code is displayed. The equipment will indicate one of the following error codes: **E04**, **E05**, **E06**, **E07**, **E08**, **E09** or **E34**.



**Date check in the registration module** – the equipment tests the correctness of data from the registration module and indicates an **E40** error when a fault involving real time is discovered.

**Speed measurement test** – speed measurements are completed using the four-channel incremental rotation sensor. Instantaneous speed is calculated from measurement channels 1, 2, 3 and 4. The calculated speeds are compared and the two highest calculated speeds are used by the system. If the difference between the calculated speeds is larger than 5 km.h<sup>-1</sup> for 3 second the equipment displays the **E20** error code.

**Actual direction of travel evaluation test** – compliance with regards to the actual direction of travel is also tested, the same as for speed measurements. If the evaluated directions do not match for 3 seconds the equipment displays the **E21** error code.

**Incremental rotation sensor power test** – the equipment uses a comparator to test the power to the incremental rotation sensor. If the voltage exceeds the permitted range, the equipment indicates the **E22** error code.

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**Completion protocol:**

Not issued.

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**Resolving any discovered faults:**

If any fault is discovered during the start-up self-diagnostic test, simply switch off the breaker for the speed recorder for at least 1 second and then re-energize the equipment to re-initialize the equipment. **If the fault is displayed after re-initializing the equipment, the fault is such that prevents subsequent activity of the speed recorder.** Operational repairs (S1) are required.

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## D3 – Functional test

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### **Executed:**

By trained staff of the speed recorder operator

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### **Schedule:**

Regularly at 6-month intervals with a tolerance of  $\pm 1$  months. Execution of the prophylactic check is a substitute for the functional test. The functional test must be executed at least 3 times in the 24-month cycle for the prophylactic check. The six-month term re-starts if an unplanned functional test is executed.

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### **Description:**

The goal of the functional test is to ensure proper operation of all basic functions of the speed recorder. The functional test is completed based on the methodology described in the following document: 342RM1 depending on the requisite modifications based on the system configuration.

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### **Completion protocol:**

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

- Date and time
  - Location
  - The serial numbers of all components of the speed recorder
  - The number of the locomotive on which the equipment is installed (if so installed)
  - The name and position of the person who conducted the test
  - The result of the functional test (no defects / with defects)
  - A description of all faults must be provided
  - The signature of the person who conducted the test
- 

### **TEST operating mode activation for basic configuration (RM1.0.XXXX):**

In the identification operation mode, the acknowledgement button is held on ID and control switch is operated.

The selection of the individual steps of the system functional test is possible via the Identification Unit buttons. The next step of the functional test can be selected press the button 0, the previous step press the ESC button. Perform the test step if necessary by pressing the ENTER button.

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### **TEST IN operating mode activation for configuration with expanded memory (RM1.1.XXXX):**

The test operating mode is activated so far, as within 2s from power supply start the steering control switch is switched ON and OFF.

The selection of the individual steps of the system functional test is possible via the Identification Unit buttons. The next step of the functional test can be selected press the button 0, the previous step press the ESC button. Perform the test step if necessary by pressing the ENTER button. Switching between individual test steps of the indication unit occurs automatically.

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### **Resolving any discovered faults:**

Operational repairs of the equipment (S1) must be conducted when a fault is detected. Maintenance repairs (S2) must be conducted in the event of a repeated fault.

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## D4 – Prophylactic check

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### **Executed:**

Trained manufacturer staff, or another trained person for this purpose, provably authorized by manufacturer.

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### **Schedule:**

If the previous D4 prophylactic check was performed in the Base Range, the following D4 prophylactic control is performed after 24 months with a tolerance of 2 months. If a previous D4 prophylactic check was carried out in an Extended Range, the following prophylactic D4 check is performed on the main repair of vehicle. In specific cases, if the periodicity of the major vehicle repairs exceeds 10 years, the prophylactic D4 check must be carried out at the latest 120 months. D4 prophylactic control in the Extended Range can only be performed for the RM1.1 registration speedometer version.

The first term of prophylactic check D4 begins with the date of the checkout, when the components of system are removed from the manufacturer's store. If the components of system are not removed at the same time, the term D4 prophylactic check begins with the first one.

In the case of unplanned D4 prophylactic check, a new interval begins to run.

If the D4 prophylactic check is not performed as a whole within a one single service, but at different times on the individual components of the system, including verification of system compatibility with the locomotive, the counting of the new D4 prophylactic check interval begins to run according to the D4 section that was performed first.

If the MIREL RM1 speed recorder is placed out of service for a period of longer than 12 months, the D4 prophylactic check must be completed in full before the equipment can be placed back into service. The term "out of service" means that the speed recorder (or its components) are not installed on any locomotive or are installed but no power has been connected to the equipment.

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### **Place of performance:**

The D4 prophylactic check of the MIREL RM1 system can be done in one of the following ways:

- on the locomotive
  - prophylactic check of the equipment will be performed in the manufacturer's service center. Prophylactic check of system compatibility with the locomotive will be performed on the vehicle. Prophylactic check D4 does not include assembly or disassembly of equipment.
- 

### **Description:**

The execution of the prophylactic check is subject to the provisions of a specific internal procedure issued by the manufacturer for in-depth checks of the equipment. The methodology for performing the D4 prophylactic check is adapted to the different installation conditions for individual classes of locomotives on which the MIREL RM1 speed recorder has been installed. Any future installations with conditions and differences that have an impact on the scope and procedure for executing the D4 prophylactic check shall be incorporated into the methodology used for conducting the D4 prophylactic check.

The prophylactic check is only conducted in full. The D4 prophylactic check involves the complete verification of the equipment in terms of metrology. All of the components that are affected by the accuracy of speed measurements are checked. The prophylactic check does not include verification of the proper settings for the diameter of the measured axle.



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**Completion protocol:**

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

- Date and time
- Location
- Serial number of the speed recorder
- 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 check
- A description of all faults must be provided
- The signature of the person who conducted the test

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**Resolving any discovered faults:**

Operational repairs of the equipment (S1) must be conducted when a fault is detected. Maintenance repairs (S2) must be conducted in the event of a repeated fault.

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## Equipment Maintenance

All components of the speed recorder are maintenance-free. No component needs to be replaced, tuned, or otherwise configured at any time.

### **MIREL RM1 speed recorder maintenance involves two levels**

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S1 Operational repairs

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S2 Maintenance repairs

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Operational repairs (S1) are conducted by trained operator staff. An inspection is performed if any speed recorder defects are detected by any of the diagnostic checks (D1 to D4) or in connection with a defect indicated during operation of the speed recorder. The goal of operational maintenance is to remedy defects in cabling, power connections, connections to cooperating equipment on the locomotive, etc. During the maintenance inspection no intervention inside the central processing unit, indication unit or identification unit takes place. Maintenance repairs (S2) must be conducted in the event of a repeated fault.

Maintenance repairs (S2) are performed by the manufacturer or an individual or entity trained and authorized by the manufacturer. Maintenance repairs are conducted if a defect cannot be resolved by performing operational repairs (S1). Maintenance repairs are always conducted on the basis of replacement (replacing the central processing unit or identification unit and subsequent repair by the manufacturer). The goal of the maintenance repairs is to remedy defects in the central processing unit of the speed recorder and in the indication and identification units.

Every person conducting maintenance of the MIREL RM1 speed recorder must be instructed with regards to occupational safety and must be verifiably trained to perform such activities with proof of certification to perform the individual levels of equipment maintenance.

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## S1 – Operational repairs

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### **Executed:**

By trained staff of the speed recorder operator

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### **Schedule:**

If any speed recorder defects are detected by any of the diagnostic checks (D1 to D4) or in connection with a defect indicated during operation of the speed recorder.

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### **Description:**

The goal of operational repairs is to remedy defects in:

- Power to the central processing unit
- Power to the indication and identification units
- Cabling
- Connection of the incremental rotation sensor
- Connectors
- Connections of input and output circuits
- Mechanical anchors

The portions of the D3 functional test that can be of assistance in more precisely determining the exact defects involved should be performed before proceeding to S1 operational repairs. Defects involving the central processing unit of the central processing unit, the indication unit or the identification unit are resolved by replacing the specific component. Staff must have approved technical documentation for the equipment when conducting operational repairs and must follow the provisions of this technical documentation and the maintenance module during such work.

S2 maintenance repairs must be conducted on the speed recorder if the defects cannot be resolved with S1 operational repairs. A functional test of the equipment must be completed if the S1 operational repairs remedy the defects.

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### **Completion protocol:**

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

- Date and time
- Location
- Serial number of the speed recorder
- The number of the locomotive on which the equipment is installed (if so installed)
- The name and position of the person who conducted the operational repairs
- Description of the defects that have been resolved and their causes (if known)
- Description of the defects that could not be resolved by the operational repairs
- The serial numbers of the removed and installed components
- The signature of the person who conducted the repairs

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## S2 – Maintenance repairs

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**Executed:**

Trained manufacturer staff

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**Schedule:**

If speed recorder defects occur that cannot be remedied with operational repairs

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**Description:**

The goal of the maintenance inspection is to remedy defects in:

- The central processing unit of the speed recorder
- Indication and identification units
- Cooperation between the speed recorder and peripheral equipment and other components of the locomotive that could not be remedied with the S1 operational repairs

The D3 functional test must be completed after the maintenance repairs and a protocol on the completion of such test must be issued.

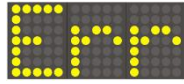
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**Completion protocol:**

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

- Date and time
- Location
- Serial number of the speed recorder
- The serial number of locomotive on which the equipment is installed (if so installed)
- The name and position of the person who conducted the maintenance repairs
- Description of the defects that have been resolved and their causes (if known)
- The serial numbers of removed and installed components if any components are replaced
- The signature of the person who conducted the repairs

## Fault Signalling



Speed recorder faults are divided into two groups. Specifically these groups are faults that prevent subsequent use of the speed recorder and faults that restrict subsequent use of the speed recorder.

In the case of a **fault that prevents subsequent use of the speed recorder**, the equipment on the front panel on the indication unit and on the identification unit indicates a fault (ERR). In the case of any such fault, the operator should first switch off the breaker for the speed recorder for at least 1 second and then switch the breaker back on in order to re-initialize the speed recorder. A serious fault will not be cleared in this manner and the error message will be displayed again.

A numbered code indicating the fault in the equipment is displayed on the identification unit in order to more clearly define the exact reason for the fault in the equipment.

Faults that prevent subsequent use of the speed recorder:

|            |   |
|------------|---|
| <b>E00</b> | Permanent loss of communication between the central processing unit and the indication unit or identification unit  |
| <b>E01</b> | Watchdog failure  |
| <b>E02</b> | Program integrity fault (FLASH and EEPROM memory integrity)   |
| <b>E04</b> | Communication error between central processing unit and indication unit at the 1st station  |
| <b>E05</b> | Communication error between central processing unit and indication unit at the 2nd station  |
| <b>E06</b> | Communication error between central processing unit and identification unit at the 1st station  |
| <b>E07</b> | Communication error between central processing unit and identification unit at the 2nd station  |
| <b>E08</b> | General failure of active indication unit <ul style="list-style-type: none"> <li>■ Watchdog failure</li> <li>■ Program integrity fault (FLASH and EEPROM memory integrity)</li> <li>■ Indication unit communication fault</li> <li>■ Fault in integrity of configuration parameters</li> </ul>  |
| <b>E09</b> | General failure of active identification unit <ul style="list-style-type: none"> <li>■ Watchdog failure</li> <li>■ Program integrity fault (FLASH and EEPROM memory integrity)</li> <li>■ Identification unit communication fault</li> </ul>  |
| <b>E10</b> | Combined module error in BBC at position A <ul style="list-style-type: none"> <li>■ Start-up error of watchdog circuits</li> <li>■ Program integrity error (FLASH and EEPROM memory integrity)</li> <li>■ Integrity error of configuration parameters</li> <li>■ Communication error between module and central unit</li> </ul> Error of communication with control system on CAN bus |
| <b>E11</b> | Combined module error in BBC at position B <ul style="list-style-type: none"> <li>■ Start-up error of watchdog circuits</li> <li>■ Program integrity error (FLASH and EEPROM memory integrity)</li> <li>■ Integrity error of configuration parameters</li> <li>■ Communication error between module and central unit</li> </ul> Error of communication with control system on CAN bus |
| <b>E12</b> | Communication error between central unit and BBC-A gateway  |
| <b>E13</b> | Communication error between central unit and BBC-B gateway  |
| <b>E20</b> | Speed measurement fault   |

|            |   |
|------------|---|
| <b>E21</b> | Fault in assessment of actual direction of travel   |
| <b>E22</b> | Power fault in incremental rotation sensor  |
| <b>E23</b> | Power fault in analogue input   |
| <b>E24</b> | Sensor fault, analogue input 1  |
| <b>E25</b> | Sensor fault, analogue input 2  |
| <b>E33</b> | Fault in integrity of configuration parameters  |
| <b>E34</b> | Communication fault in SPI link   |
| <b>E40</b> | Incorrect date fault in registration module   |
| <b>E41</b> | General card fault in external equipment in position A  |
| <b>E41</b> | Combined module error in EXIO / BBC cooperating device at position A <ul style="list-style-type: none"> <li>■ Start-up error of watchdog circuits</li> <li>■ Program integrity error (FLASH and EEPROM memory integrity)</li> <li>■ Integrity error of configuration parameters</li> <li>■ Error of communication with control system on CAN bus</li> </ul> Error of communication with diesel oil consumption system |
| <b>E42</b> | Combined module error in EXIO cooperating device at position B <ul style="list-style-type: none"> <li>■ Start-up error of watchdog circuits</li> <li>■ Program integrity error (FLASH and EEPROM memory integrity)</li> <li>■ Integrity error of configuration parameters</li> </ul> Error of module communication with module on EXIO-A position   |
| <b>E43</b> | Combined module error in EXIO cooperating device at position C <ul style="list-style-type: none"> <li>■ Start-up error of watchdog circuits</li> <li>■ Program integrity error (FLASH and EEPROM memory integrity)</li> <li>■ Integrity error of configuration parameters</li> </ul> Error of module communication with module on EXIO-A position   |
| <b>E44</b> | Combined module error in EXIO cooperating device at position D <ul style="list-style-type: none"> <li>■ Start-up error of watchdog circuits</li> <li>■ Program integrity error (FLASH and EEPROM memory integrity)</li> <li>■ Integrity error of configuration parameters</li> </ul> Error of module communication with module on EXIO-A position   |
| <b>E45</b> | Error of communication between registration module with cooperating device  |
| <b>E50</b> | Watchdog fault in the registration module   |
| <b>E51</b> | Communication parameters integrity error of registration module   |
| <b>E52</b> | Error of initialization or entry on SD-card of the registration module  |
| <b>E53</b> | Real-time circuit error of the registration module  |

In the case of a **fault that restricts subsequent use of the speed recorder** there is no indication on the front panel of the central processing unit or on the indication and identification units at the active station. Such faults involve the indication and identification units at the inactive station. These faults restrict the activity of the speed recorder at the station at which the indication and identification units are operating correctly.

Faults restricting the subsequent use of the speed recorder are indicated on the indication or identification units of the inactive station:

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**E00**

General fault in the indication or identification unit

- Watchdog fault in the indication or identification unit
  - Memory fault in the indication or identification unit
  - Permanent loss of communication between the central processing unit and the indication unit or identification unit
  - Communication fault involving the indication or identification unit
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## Equipment Configuration

Configuration of the MIREL RM1 speed recorder is executed using a portable diagnostic computer with the MIREL KAM configuration installed. The computer is connected to the central processing unit of the speed recorder. The MIREL ATM transmission module (SPI link) or KABUSB reduction (USB interface) is used. Communication between the diagnostic computer and the speed recorder is displayed on the computer screen. The user manual provided for the MIREL KAM software suite guides the actual configuration of the equipment (547MAP).

The complete configuration of the speed recorder contains:

- An identifier for the set of configuration parameters (a detailed description of the set of configuration parameters is provided in the installation documentation for the given class of locomotives with the name "Configuration and Commissioning of Equipment for Class ... Locomotives")
- The serial number of the locomotive
- The diameter of the wheel on the monitored axle of the locomotive
- The interval for lubricating flanges (this function is available in MIREL RM1 speed recorder firmware v.2 and higher)

The competencies of the specific maintenance site may be limited based on current needs to a specific set of the points listed above. This means that not all of the parameters can be configured at the given site.

The periodicity for configuring the diameter of the wheel on the monitored axle of the locomotive is defined by the operator's regulations. This maintenance regulation defines the procedure for defining such new diameter but does not define the procedure and rules to be followed to configure the new diameter.



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## Installation and Removal of the Equipment

After performing the assembly operations, perform the D3 functional test.

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### Installation and Removal of the Central Processing Unit

The central processing unit is secured with four (4) M6 bolts along the sides of the front panel. A 72-pin DD connector with 2 securing anchors 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 breaker for the speed recorder must be switched off when installing and removing speed recorder equipment. The installation procedure follows:

- Connection of the 72-pin DD connector
- Closure of the securing anchors on the connector
- Connection of the DB connector
- Positioning in the desired location
- Installation and fastening of the installation bolts

Removal uses the reverse of this procedure.

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### Installation and Removal of the Indication Unit

The indication unit is placed inside the cover of the desk at the engineer's station in the locomotive and is secured using a pair of fixing elements. 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 breaker for the speed recorder must be switched off when installing and removing the speed recorder. The installation procedure follows:

- Installation of the unit into the metal cover
- Installation of the fixation elements
- Connection of cabling to terminal strip on the unit
- Positioning of the cover into the desired position
- Securing the cover to the desk at the engineer's station (depending on type of locomotive)

Removal uses the reverse of this procedure.

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### Installation and Removal of the Identification Unit

The identification unit is placed inside the cover of the desk at the engineer's station in the locomotive and is secured using a pair of fixing elements. 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 breaker for the speed recorder must be switched off when installing and removing the speed recorder. The installation procedure follows:

- Installation of the unit into the metal cover
- Installation of the fixation elements
- Connection of cabling to terminal strip on the unit
- Positioning of the cover into the desired position
- Securing the cover to the desk at the engineer's station (depending on type of locomotive)

Removal uses the reverse of this procedure.



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## Notes