Český metrologický institut

Type Approval Certificate

No. 0111-CS-C007-13

Revision 2

Czech Metrology in accordance with the Law of metrology No. 505/1990 Coll. as amended

approved

automatic instrument for high speed control weighings in motion type UnicamWIM

under observation of technical data referred to in Annex of this Certificate.
This revision replaces all previous versions in full wording.

Type approval mark: **TCM 128/11 - 4831**

Applicant: **CAMEA, spol. s r.o.**
Karásek 2290/1m
621 00 Brno
Czech Republic
IČ: 60746220

Manufacturer: **CAMEA, spol. s r.o.**
Czech Republic

Valid until: **4 May 2031**

Information on judicial remedies:
The judicial remedies against this decision are available to the applicant through Czech Metrology Institute to Czech Office for Standardization, Metrology and Testing within 15 days since the receipt of this Certificate.

Description:
Essential characteristic, approved conditions special conditions, examination results including technical drawings and schemas are set out in the technical test report appertaining to this certificate. The certificate comprises the front page and the technical test report. Certificate totally has 13 pages.

Český metrologický institut
-3-

Brno, 8 December 2021

Ing. František Staněk, PhD.
Deputy Director for Legal Metrology

Technical test report

In accordance with: Measure of general nature number 0111-OOP-C010-15 laying down metrological and technical requirements for specified measuring instruments, including test methods for type approval and verification of specified measuring instruments: **"Automatic instruments for high-speed control weighing of road vehicles in motion"**.

1 Description of the instrument and purpose of use

The instrument is designed for control during high-speed weighing of road vehicles in motion (hereinafter referred to as an instrument or measuring system), **type UnicamWIM.** The instrument is intended for measuring the total weight of the vehicle and the load on the axle or group of axles, or other parameters of the vehicle required by a special regulation, directly while the vehicle is driving on its route.

1.1 Principle of operation

The instrument processes signals from load cells/sensors built into the road at the measuring area. The physical principle is the conversion of the force exerted by the vehicle wheel on the sensor to an electric charge Q and subsequent transmission of the charge to the device and its conversion into an electrical signal or by changing the electrical resistance R of the strain gauge load cell and thus changing the electrical voltage at the load cell. The change in electrical voltage $\Delta u(t)$ directly corresponds to the change in force $\Delta F(t)$ acting on the load cell.

The instrument forms an automatic measuring system. Its composition is schematically shown in Figure 1 below and may include various configurations. The individual components and configurations are described in section 2.

2 Composition of the instrument - measuring system

- Load cells installed in the road
- Vehicle identification equipment
- Measuring unit - unit for data collection, digitization and processing
- Optical vehicle identification equipment
- Image documentation unit
- Evaluation unit
- Software equipment
- Recording equipment
- Interface for auxiliary devices

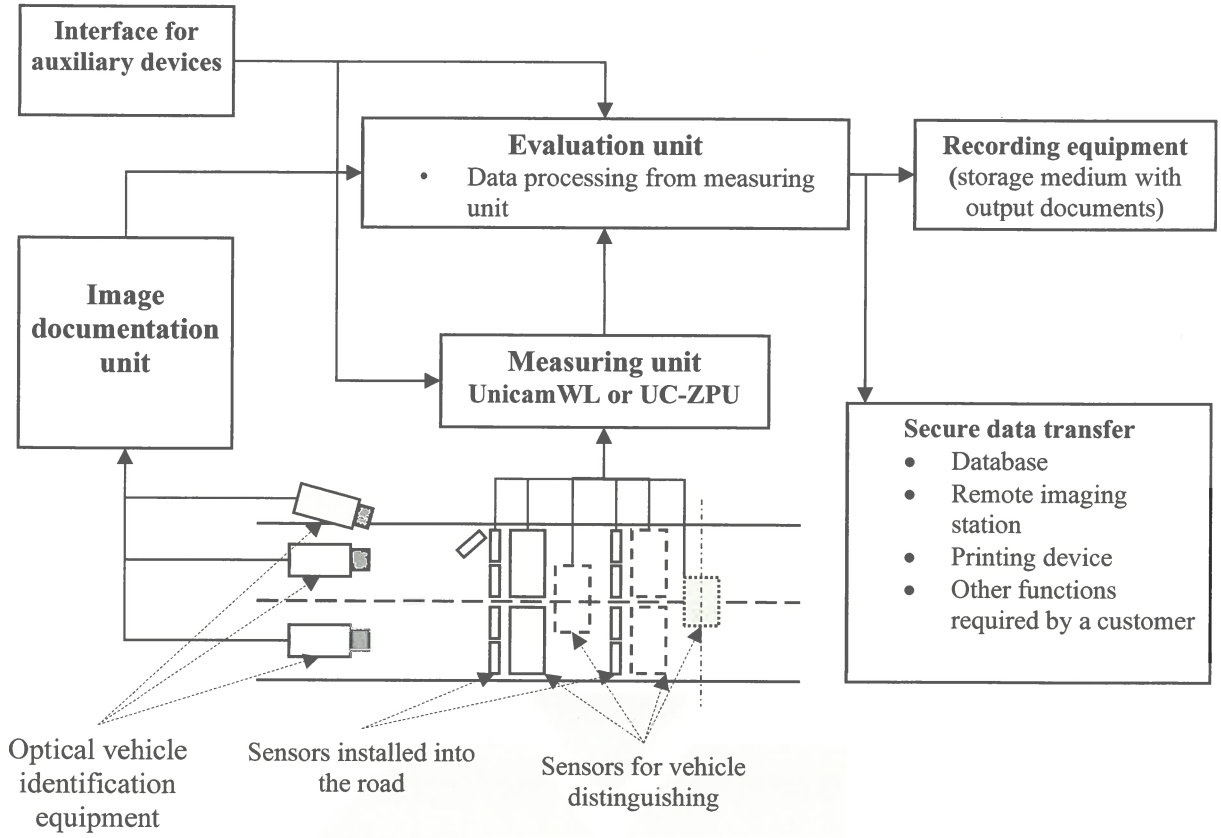


Figure 1 Schematic composition of the automatic measuring system

2.1. Sensors/Load cells

Piezoelectric load cells from manufacturer Kistler of type series LINEAS are used within the measuring system (they can be called as sensors or thresholds in the design documentation):

Model	Type	Manufacturer
LINEAS	9195…	KISTLER Instrumente AG, Eulachstrasse 22, Postfach, CH−8408 Winterthur

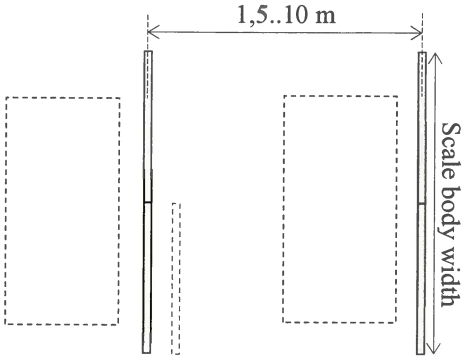
The measuring system consists of four to eight load cells placed one behind the other and forming the body of the weighing system. The system allows the use of various configurations of load cells with separate settings, the possibility of independent calibration and evaluation algorithms. This feature of the measuring system allows, among other things, to define and independently calibrate and verify the weighing system body located at the lane interface.

The measuring system can either use only a certain configuration within the whole or it can be designed and installed directly as a certain configuration.

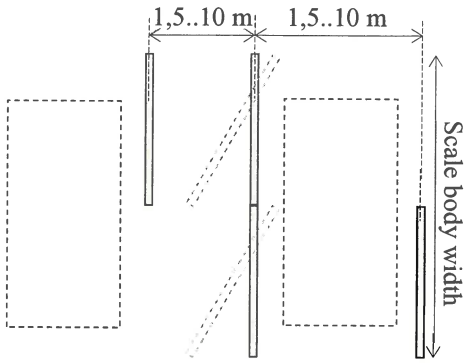
2.1.1 Measuring configuration of load cells/sensors

Different measuring configurations of load cells with 2, 3 or 4 groups of weighing sensors are possible, or the algorithm can use the input signals according to the configuration used. The group of weighing sensors usually consists of a right and a left sensor which either form a consecutive row or can be offset. Possible sensor configurations are shown in Fig.2. The relative positions of the load cells and the vehicle resolution sensors may differ.

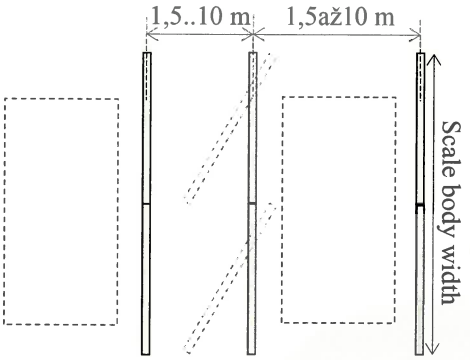
The measuring system is also able to work with one row of oblique crystal sensors used for both the weighing function and the vehicle position measurement. The possibility of installing one of the series of crystal sensors as oblique is schematically shown in Fig. 2 below. The oblique crystal sensors can be installed as a single continuous oblique row or as a pair of separate oblique sensors.



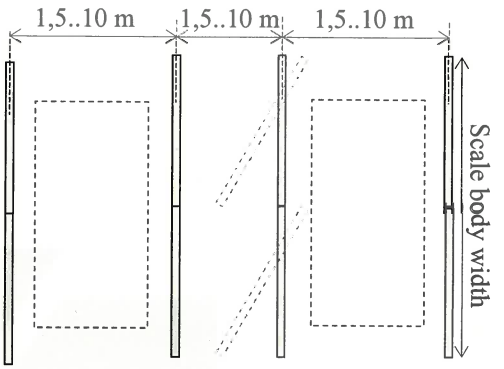
Two groups of load cells with an indication of a possible slight offset of the load cells



Three offset load cell groups



Three groups of load cells



Four groups of load cells

Figure 2 Possible sensor configurations

2.2 Vehicle identification device

The vehicle identification device processes the outputs from the load cells and the vehicle identification sensors, and may use some of the vehicle identification sensor types and configurations described in the sections below. The function of the vehicle identification device is not dependent on the direction of travel of the vehicle and the device is able to determine the direction of travel of the vehicle based on the time sequence of vehicle identification sensors and load cells. The device is used to identify the type of vehicle in terms of number and configuration of axles - categorization of vehicles according to a special regulation for transport.

If not all wheels of the vehicle have been weighed or the vehicle has not been distinguished, the device prevents the recording of weight and print or this fact is clearly marked on the record of measurement and / or print - the inscription "Metrologically not verified" is marked on the image document. A sample of such an image document is shown in Figure 5 below.

2.2.1 Vehicle identification sensors – induction loops

This type of vehicle identification sensor consists of two or one induction loop located in the area of the scale body. The induction loop represents the inductance in the LC oscillation circuit of the measuring unit. The loop consists of 2 to 4 turns of insulated wire located in a groove 30 to 100 mm below the road surface. The presence of the vehicle above the induction loop causes a change in the inductance of this coil and thus a change in the frequency of the oscillations, which is measured by the measuring unit. A schematic representation is shown in Figure 3 below.

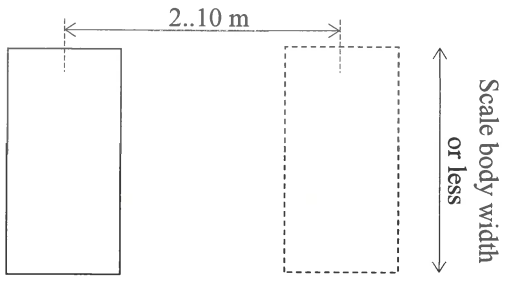


Figure 3 One or two induction loops forming a vehicle identification device

2.2.2 Vehicle identification sensors – external sensors

The vehicle identification device or measuring unit allows the connection of external vehicle identification sensors equipped with a logic output indicating the occupancy of the sensor. The external vehicle identification sensor is compatible with the vehicle identification device provided that it meets the following requirements:

- Reaction time ≤ 0,05 s
- Uncertainty of determining the presence of the vehicle in the longitudinal direction ≤ ±1 m

Examples of an external sensor that meet the above requirements could be an optical barrier or wall, a swept laser scanner located above the road, an independent induction loop system, and more.

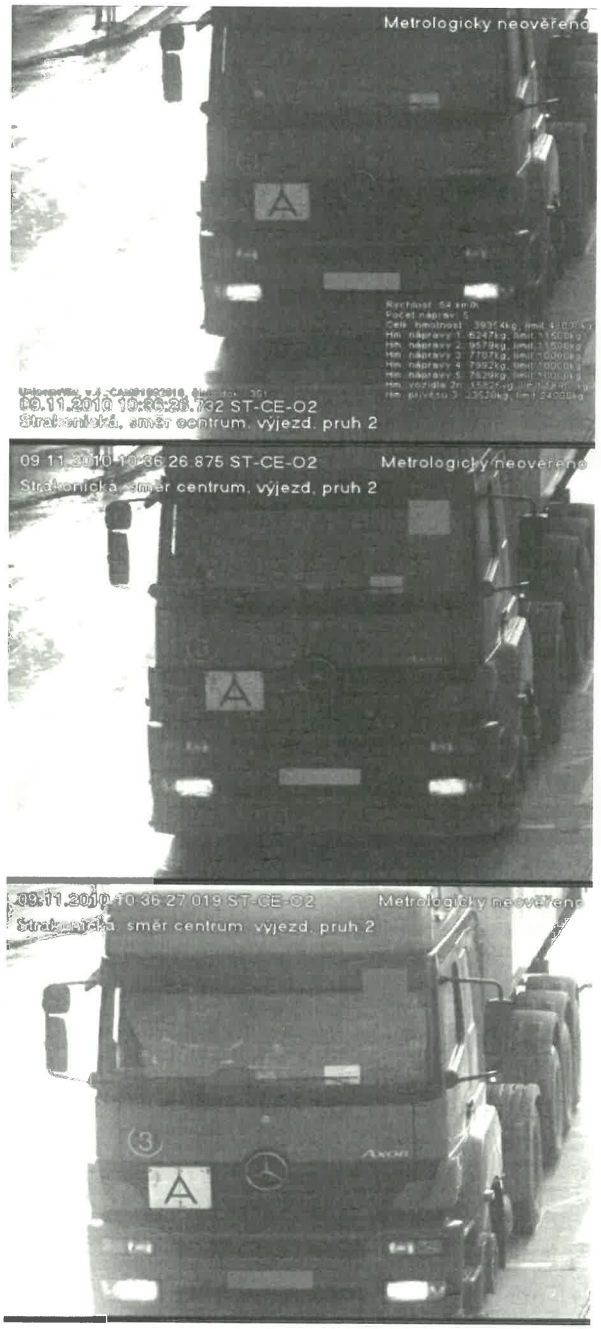


Figure 4 Example of a discarded (metrologically unverified) measurement (driving too far to the left)

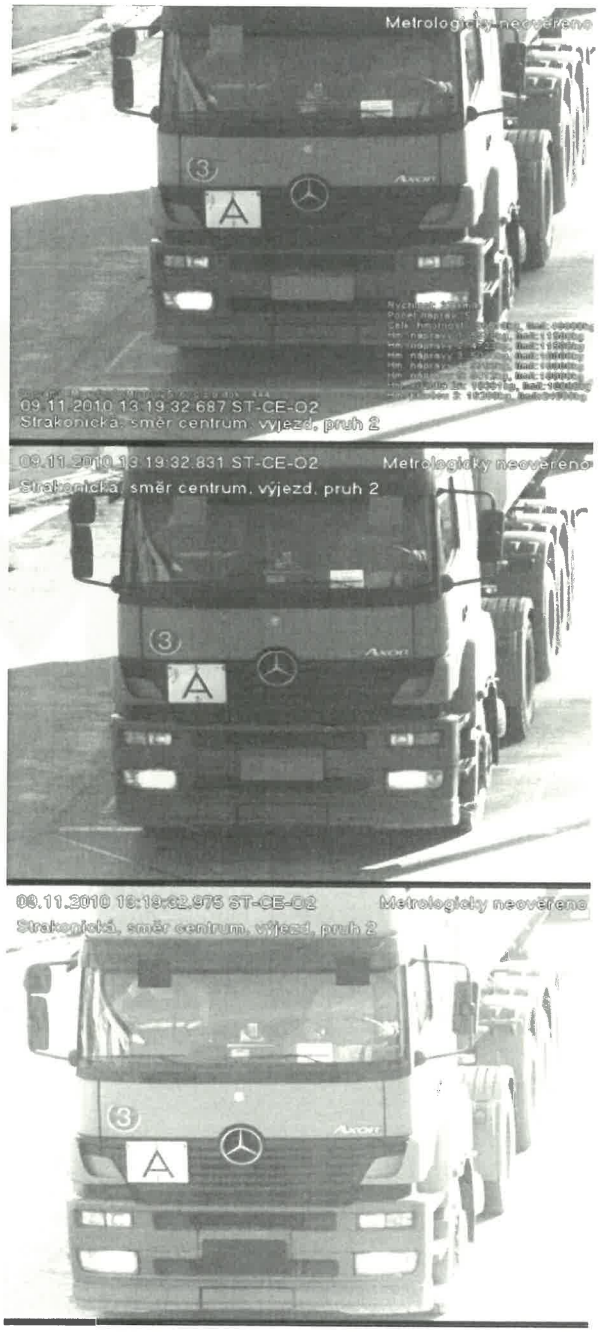


Figure 5 Example of discarded (metrologically unverified) measurement

2.3 Measurement of the speed of weighed vehicles and validation of the measurement process

2.3.1 Measurement of the speed of weighed vehicles

The speed of the weighed vehicle is measured on the basis of the sequence of time responses of the load cells. The vehicle speed is recorded as part of the vehicle weighing record in km/h. If the speed of the weighed vehicle is outside the range of working speeds or the vehicle is accelerated too much at the measuring point, no weighing record is made or this fact is marked on the vehicle weighing record and the word "Metrologically not verified" is marked on the image document. A sample of such an image document is shown in Figure 5 below. Indicated working speed error ≤ 2 km/h.

2.3.2 Validation of the measurement process

The measuring system validates the condition of the device and the course of the measurement process. If the measuring system detects a problem, the device prevents the recording of weight and print or this fact is clearly marked on the record of measurement and/or print - the inscription "Metrologically not verified" is marked on the image document. An example of such an image document is shown in Figure 4 above.

2.4 Measuring unit - unit for data collection, processing and digitization

The measuring unit is equipped with a number of measuring and communication interfaces. These are usually induction loop circuits, load sensor inputs, thermometer inputs, general I/O circuits, communication interfaces of various standards such as RS232, RS485, Ethernet and others.

During the measurement, the system detects the presence of the vehicle, measures the dynamic forces on the tires as a function of time and calculates the values of the total weight and the load on the axle or group of axles.

The principle of measuring the weight on the crystal sensors is the conversion of the load on the sensor into a charge Q. The area of the generated charge pulse is directly proportional to the measured weight at a given vehicle speed.

The data from the measuring unit is processed and evaluated by the installed SW. The channels of the measuring unit can be optionally configured and duplicated within the SW. Data from individual channels of the measuring unit can be processed independently within the SW.

Two different types of measuring units can be used in the measuring system.

Figure UnicamWL unit (left) and UC-ZPU unit (right)

2.4.1 UnicamWL unit

The UnicamWL measuring unit includes a charge amplifier with digitization. Up to 8 induction loops and up to 18 load cells can be connected to the unit to measure weight in up to 4 lanes.

2.4.2 Unit UC-ZPU

The UC-ZPU unit is a modular design and allows the use of different types of input and output boards and thus the connection of different combinations and types of sensors and devices. The number and type of inputs of this unit is variable.

Basic types of input and output boards:

- UB-DIO - IO signal board.
- UB-IND - induction loop input board.
- UB-PRS - charge input board.
- UB-LCS - strain gauge input board.

2.4.3 Evaluation unit

The evaluation unit consists of an industrial computer with the manufacturer's SW installed. The evaluation unit is connected to the measuring unit and to the image documentation unit via an Ethernet standard interface.

2.5 Optical vehicle identification equipment

The meter is equipped with an image documentation unit, which is used to generate an image document that records the weighing situation with secure identification of the weighed vehicle. The image documentation unit works in automatic mode, the setting of limit weight parameters for image document recording is enabled by the Wimer application. The situation when weighing the vehicle is captured by a digital camera. The outputs form individual digital images, which are stored in a data memory. Image document processing is performed using the UnicamVIOLATOR application. Viewing output documents, including digital signature verification, is possible, for example, using a specialized UnicamPEN application.

The following data is displayed in the data display field on the individual images - image documents:

- measured weight value with measuring unit
- maximum permissible weight value according to a special regulation for transport with a measuring unit
- measured axle load value with measuring unit
- maximum permissible axle load value according to a special regulation for transport with a measuring unit
- measured load value per axle group with measuring unit
- maximum permissible axle load value according to a special regulation for transport with a measuring unit
- measured speed of the weighed vehicle with measuring unit
- number of axles of the weighed vehicle
- time (with seconds resolution) and date (day, month, year)
- type designation of the meter
- serial number of the meter
- serial number of the image document
- designation of the measuring point
- additional image description

The image information and the measured value information are indivisibly combined into one data file and are integrated into the pixel structure of the digital image. The authenticity of the entire digital image data file is unambiguously detectable by coding (identification number of the image document). The data file is secured against violation with a digital mark (signature). A sample image document with a description is shown in Figure 7 below.

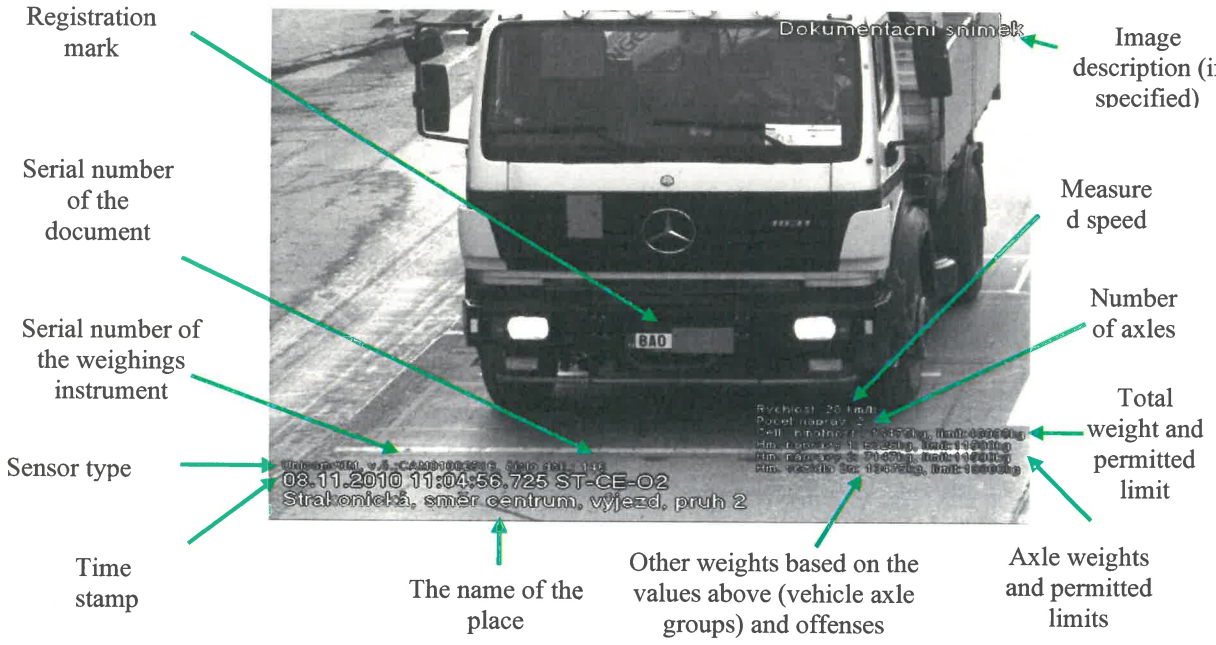


Figure 7 Example and description of the image document

2.6 Software equipment

The software used is divided into two parts. The legally relevant part is protected against accidental or intentional changes. The second part can be freely modified. The software is identified as follows: Wimer 2.xxx.034. The first number (2) indicates the version with a separate legal part, the first three digits (xxx) identify the version that may be subject to change and the second three digits (034) identify the version that is protected against changes.

Any change in the SW version will result in a change in the version number. The changes are reflected in the corresponding parts of the SW identification. The change of the legal part is thus reflected in the second three digits, while the change of the other parts in the first three digits.

The system performs a checksum using the MD5 hash at startup. The checksum is performed separately on the binary file of the separate legal part and separately on the binary file of the other parts of the application. Identification of both parts of the application and both checksums are available from the application menu.

Separate legal part of SW

Version	Binary file	Checksum (MD5)
034	WIMCore.dll	78c48a9a97aad595ad5e82a7d58124a5

The software consists of the following parts

- Wimer - scale software, vehicle resolution, speed and weight measurement.
- UnicamVIOLATOR - software that takes care of the creation and security of output (offense) documents.

Offense documents can be viewed, for example, with specialized UnicamPEN software.
The software is designed for Windows XP SP1 or higher. The functionality of the balance software may be conditioned by connection to other software equipment of the manufacturer.
A legally significant part of the software is in a form that ensures that a change to the software is not possible or is automatically recorded, including its nature and demonstrably detectable (e.g. by an audit trail).

The means of securing software under metrological control of meters are as follows:

a) Access is allowed only to the authorized person using codes (keyword) that are changeable.
b) All interventions of the operator or the superior control system are automatically stored in the memory of the meter, stating the date and time of the intervention, identification of the authorized person performing the intervention and the type of intervention.
c) When the memory capacity for storing intervention records is exhausted, any stored records cannot be deleted automatically.
d) The relevant intervention records may be retrieved in full, in full.
e) Deletion of intervention records is not permitted to any person other than the authorized person.
f) Downloading software under metrological control is only possible via the appropriate protected interface connected to the balance.
g) The software version identification is attached to the software, which changes in the event of any change in the software version
h) Functions that are performed or initiated via the software interface must meet the requirements and conditions of the regulation number 0111-OOP-C010-15.

2.6.1 Software identification

The balance software is unambiguously identifiable by the version listed in the header of the GUI window. Any change in the software version will result in a change in the version number. An example of the software header with the version shown is shown in Fig.8 below.

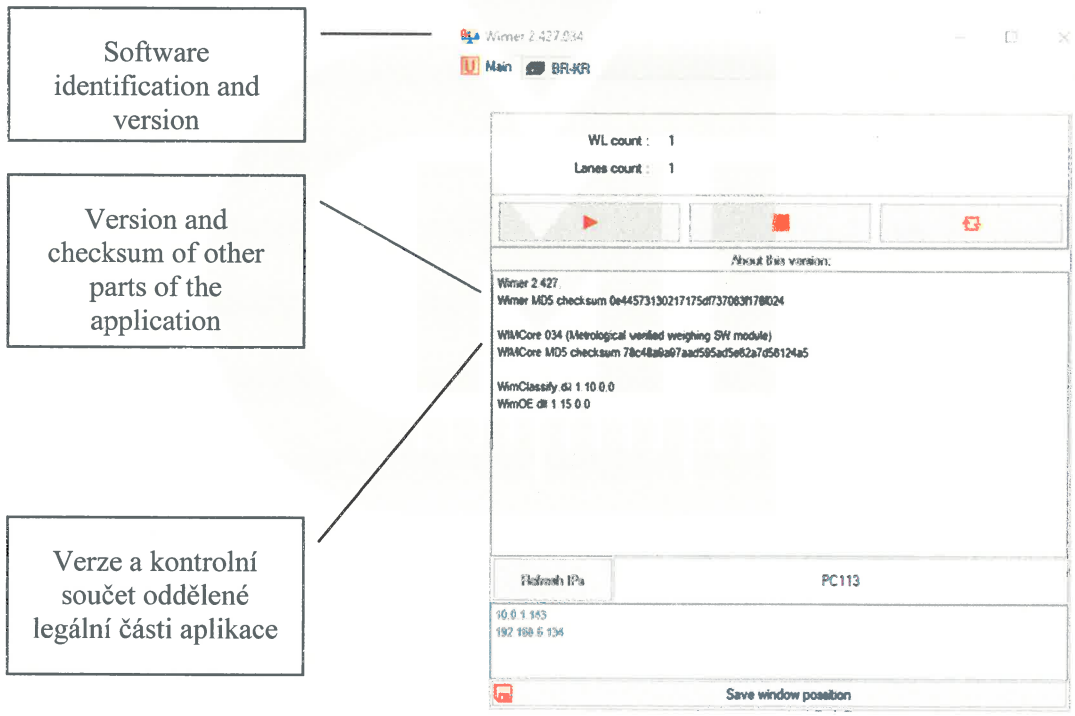


Figure 8 SW identification and checksums available from the application menu

Software identification

- version Wimer 2.xxx.034

The system performs a checksum using the MD5 hash at startup. The checksum is performed separately on the binary file of the separate legal part and separately on the binary file of the other parts of the application. Identification of both parts of the application and both checksums are available from the application menu. Any change in the checksums of the legally separated part or the checksums of the other parts of the application is stored in the intervention records in the instrument's memory.

2.6.2 Verification of the correctness of the SW version

Checksum and application version information is available from the program menu. If a SW change occurs, this condition is detected and the description of the change is given as an entry in the meter

memory together with the MD5 hash value. The checksum is performed separately on the binary file of the separate legal part and separately on the binary file of the other parts of the application. Deleting change records is not allowed to anyone other than the authorized person.

2.7 Recording device

The recording equipment shall record and store the relevant measurement data specified in Article 2.5. The data is stored in the balance's memory for the following operations (indication, printing, data transfer, totals, etc.) on the hard disk. The stored data is protected against intentional and unintentional changes during the transfer and / or storage process and contains all relevant information needed to reconstruct previous measurements. The data stored on removable storage media for storing measurement data are secured with a code key, and their identification, integrity and authenticity are ensured. The stored data can also be the subject of subsequent operations (indication, printing, transmission, totals, etc.).

2.8 Auxiliary devices

External devices may be connected to the meter provided that they comply with point 3.9 OOP No. 0111-OOP-C010-15.

Auxiliary devices can consist of, for example:

2.8.1 Printing device

The instrument can be equipped with a printing device. The printed documents are of an informative nature and as such are only indicative, as they cannot contain security features ensuring authenticity.

2.8.2 Image unit

The meter can be equipped with a local or remote display unit, which allows viewing and processing of the recorded measurement records.

3 Design of the instrument

The construction of the meter must correspond to the documentation of the manufacturer CAMEA, spol. s r.o .: "UnicamWIM_20210101".

4 Main metrological and technical characteristics

4.1 Weighing range

	Min (kg)	Max (kg)
Axle load	500*)	≥ 20000
Vehicle weight	2000**)	Not limited

*) in the event that during the verification of the system according to the Act on Metrology No. 505/1990 Coll. as amended, this value is not tested by a suitable vehicle, the value Min = 1000 kg applies.

**) in the event that during the verification of the system according to the Act on Metrology No. 505/1990 Coll. as amended, this value is not tested by a suitable vehicle, the value Min = 3500 kg applies.

4.2 Scale interval

Axle load	≤ 20 kg
Vehicle weight	≤ 50 kg

4.3 Maximum permissible errors

Maximum permissible error for the weight of the vehicle determined by weighing in motion	≤ ±5%

Maximum permissible error for the axle load and the axle group of the vehicle determined by weighing in motion	≤ ±11%

4.4 Range of operating speeds

4.4.1 Measurement range

3 km/h to 255 km/h

4.4.1.1 Maximum passing speed

255 km/h

4.4.2 Metrologically controlled range

5 km/h *) to 140 km/h **)

*) in the event that during the verification of the system according to the Act on Metrology No. 505/1990 Coll. as amended, this value is not tested by a suitable vehicle, the value of 20 km / h applies.

**) in the event that during the verification of the system according to the Act on Metrology No. 505/1990 Coll. as amended, this value is not tested by a suitable vehicle, the value of 100 km / h applies.

4.5 Traffic intensity range

4000 vehicles/hour
96000 vehicles/day

4.6 Range of operating temperatures

-40°C to +70°C
If the temperature of the measuring system is outside the working range, the measurement is blocked.

4.7 Mechanical endurance

The construction of the meter meets the requirements of PPE No. 0111-OOP-C010-15 point 3.10.1. The mechanical environment class M3 in the sense of Government Decree No. 464/2005 Coll. Applies to load cells.

4.8 Power supply

DC 10 - 35 V.

5 Securing of the instrument

Parts that must not be unauthorizedly disassembled or adjusted by the user must be secured in an appropriate manner. Securing will take place in the places according to the article below:

The measuring unit and the evaluation unit are usually located in a common switchboard.

The main label of the meter is located on the cover of the measuring unit or alternatively near the unit inside the distribution box. The master label is destroyed when attempted to be removed or must be secured with a verification mark. The main verification mark is located near the main label.

Near the main label there is also a label with the values of calibration constants obtained during the last setting of the scales.

5.1 UnicamWL unit securing

With the help of securing marks (verification labels) it is possible to secure the dividing plane of the unit housing or alternatively the screw heads of the unit cover. In the switchboard, it is also possible to secure (connect) the unit to the switchboard structure with a lead seal on the cable.

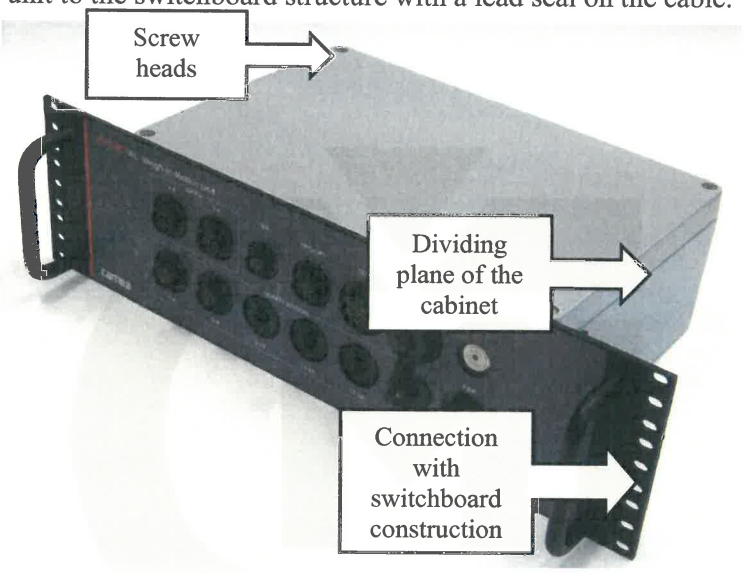


Figure 9 Securing the UnicamWL measuring unit

5.2 UC-ZPU unit securing

With the help of securing marks (verification labels) it is possible to secure the dividing plane between the unit housing and the inserted load cell input plates. The screws of the inserted load cell plates can also be secured with a lead seal on the cable, if necessary. In the switchboard, it is also possible to secure (connect) the unit to the switchboard structure with a lead seal on the cable.

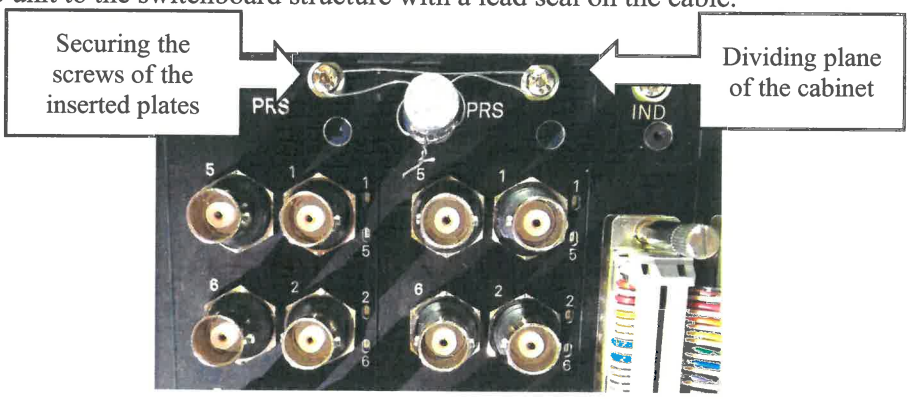


Figure 10 Securing the UC-ZPU measuring unit

5.3 Evaluation unit securing

With the help of securing marks (verification labels), the dividing plane of the cabinet can be secured. In the switchboard, the unit can be secured (connected) to the switchboard structure with a lead seal on the cable. In the case of the presence of a removable storage medium shaft, this shaft can be secured by means of securing marks (verification labels).

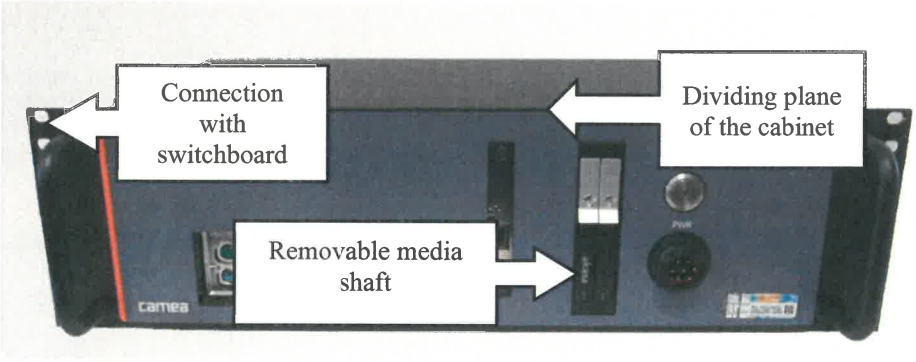


Figure 11 Securing of evaluation unit

6 Instrument descriptions and marking

The marking on the instrument must meet the requirements of Articles 4.1 and 4.2 of General Measure No. 0111-OOP-C010-15. The manufacturer/type plate of the instrument must bear at least the following information:

- manufacturer's identification mark;
- type-approval mark;
- type designation of the instrument;
- serial number;
- if the instrument is not suitable, or rather intended, for weighing vehicles with specific characteristics or carrying loads of certain specific characteristics, must be marked with a warning of restriction of suitability for weighing with a clear specification of the type and extent of such restriction (if relevant for the instrument);
- maximum passing speed in km per hour;
- weighing direction (if relevant for the instrument);
- power supply voltage, in V;
- power supply frequency, in Hz;
- operating temperature range (if different from -20 ° C to +40 ° C), in °C;
- software identification (if applicable);

and the following data on metrological parameters:

- upper weighing limit Max = ..., in kg or t;
- lower weighing limit Min = ..., in kg or t;
- scale interval d = ..., in kg or t;
- maximum operating speed v_{max} = ..., in km per hour;
- minimum operating speed v_{min} = ..., in km per hour;

7 Validity of verification

The period of validity of the verification is done by a decree of the Ministry of Industry and Trade.