DESIGN BUREAU FIZELEKTRONPRIBOR, LTD.

Russian Classification of Production 42 1550

Moisture Analyzers (Moisture Meters)
FIZEPR-SW100
(VIGT.415210.100-17.x design versions)

Technical description and operation manual
VIGT.415210.100-17 RE

(supplement to Part 1 of the Operation Manual VIGT.415210.100 RE)
Rev. 2.3.

Samara, 2024

CONTENTS

1. Introduction

1.1. This technical description and operation manual are designed for familiarization with the device, principle of operation, rules of installation, preparation, inspection, adjustment and maintenance in operation of moisture analyzers (moisture meters) FIZEPR-SW100, versions VIGT.415210.100-17.x, where index "x" in the moisture meter designation is the modification number.

Along with the full designation "Moisture Meter FFIZEPR-SW100 VIGT.415210.100-17.x", it is allowable to use an abbreviated designation: "Moisture Meter FIZEPR-SW100.17.x".

1.2. Moisture meters FIZEPR-SW100.17.x are designed to measure moisture content – water fraction (in percentage terms) in bulk and paste-like materials, as well as in liquid materials.

Main applications of these moisture meters:

- Control of concrete mixture inside concrete mixers
- Control of fine bulk materials on the conveyor belt and in the screw conveyor
- Control of materials in boilers at high temperatures and high pressures
- Measurement of materials in sampling systems including at extreme pressures.

1.3. Moisture meters FIZEPR-SW100 are equipped with two channels to transmit measurement results:

- RS-485 digital interface, MODBUS RTU protocol
- 4-20mA current loop analog interface.

1.4. Moisture meters FIZEPR-SW100 are manufactured in both general purpose industrial version and explosion-proof version. Moisture meters in explosion-proof version have explosion-proof certification, Certificate of Conformity No. TR CU 012/2011 No. TC RU C-RU.АД07.В.03758/21, Series RU No. 0264976.

1.5. Moisture analyzers FIZEPR-SW100 correspond to Class III of electrical shock protection in accordance with GOST 12.2.007.0-75 and are designed to operate at a safe ultra-low voltage of 24V. Moisture analyzers have neither external nor internal electrical circuits operating at a higher voltage.

1.6. Moisture meters FIZEPR-SW100 meet the requirements of TR CU 020/2011 "Electromagnetic Compatibility of Technical Means", Declaration of Conformity TR CU 020/2011 Reg. No. EAEU N RU Д-RU.PA03.B.47448/23 dated 25.04.2023.

1.7. The manufacturer retains the right to make modifications in the design and circuit of the moisture meter that do not affect its specifications, without adjusting the operating and maintenance documentation.

2. Moisture meter versions and operating principle

2.1. Moisture meters FIZEPR-SW100.17.x have a structure consisting of two components: a sensor and an electronic unit connected by a cable. Cable connection with the sensor is non-separable and filled with compound. Cable connection with the electronic unit is detachable.

Electronic units of all versions are identical, interchangeable. Sensors are manufactured in various versions. They differ by their design and therefore their application.

The list of versions is provided in Table 1.

Table 1

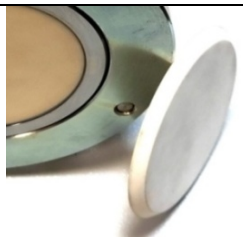
Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

Moisture meter designation	Purpose	Sensor design version
FIZEPR-SW100.**17.1** (VIGT.415210.100 -17.1)	Measurement of water content in concrete mixture inside the concrete mixer	 The sensor is made in the cylindrical enclosure 80 mm in diameter. Sensor head is made of hardened stainless steel. Sensor is supplied with a fixing set.
FIZEPR-SW100.**17.2** (VIGT.415210.100 -17.2)	Measurement of water content in concrete mixture inside twin-shaft concrete mixers, measurement of bulk and paste-like material moisture in cylindrical sampling systems. Sensor head surface is concave for sensor mounting on radiussed walls.	  The sensor is made in the cylindrical enclosure 80 mm in diameter. Sensor head surface is made concave as a round cylinder surface with the cylinder radius selected to meet customer requirements for sensor installation on the cylindrical wall of the twin-shaft concrete mixer or inside the sampling system pipe. Sensor head is made of hardened stainless steel. Sensor is supplied with a fixing set.
FIZEPR-SW100.**17.21** (VIGT.415210.100 -17.21)	Measurement of bulk, paste-like materials in sampling systems 50 mm in diameter (diameter is specified when ordering).	 Sensor is made as a piston with a diameter of 50 mm. Allowable force on the piston is 5000 N.

<table>
<tr><td rowspan="2">FIZEPR-SW100.17.8
moisture meter sensor

(VIGT.415210.100
-17.8)</td><td>Measurement of water content in concrete mixture inside concrete mixing machines, measurement of material moisture on conveyor belts.

Sensor head surface is made concave to fit the cylindrical surface of the twin-shaft concrete mixer.</td><td> 
The sensor is made in the cylindrical enclosure 108 mm in diameter. Sensor head is replaceable, it is made of hardened stainless steel. The sensor enclosure is made of stainless steel AISI 321. Sensor is supplied with a fixing set.</td></tr>
<tr><td>Replaceable sensor head
VIGT.415210.100
-17.81</td><td> 
Replaceable sensor head is made of hardened stainless steel.</td></tr>
<tr><td rowspan="3">FIZEPR-SW100.17.12
sensor

(VIGT.415210.100
-17.12)</td><td>Control of water content in concrete mixture inside concrete mixers, moisture control of bulk materials (powders and other bulk materials) on conveyor belts (sand, coal, carnallite).</td><td> 
The sensor is made in the cylindrical enclosure 108 mm in diameter. Sensor head is covered with a disk (plate) made of abrasion resistance alumina ceramics. Sensor design feature: customers can replace the ceramics disk on their own. Sensor is supplied with a fixing set.</td></tr>
<tr><td>Replaceable ceramics disk
VIGT.415210.100
-17.121</td><td> 
Replaceable alumina ceramics disk.
To replace the disk, unscrew the sensor cover using the FIZEPR-SW100.17.122 accessory wrench.</td></tr>
<tr><td colspan="2"></td></tr>
</table>

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

	Accessory wrench VIGT.415210.100 -17.122	 Sensor cover unscrew device for FIZEPR-SW100.17.121 ceramics disk replacement.
FIZEPR-SW100.**17.15** (VIGT.415210.100 -17.15)	Measurement of materials in boilers at temperatures of up to 145°C and pressures of up to 6 bar.	 The sensor is made in the cylindrical enclosure 75 mm in diameter. Sensor head is covered with a disk (plate) made of abrasion resistance alumina ceramics.  The sensor is supplied with a mating (clamping) flange for installation in the boiler and with a high-temperature gasket to be placed under the flange. A nozzle with a flange may be included in the scope of supply.

The list of electronic unit modifications is provided in Table 2.

Table 2

Electronic unit reference code (decimal number)	Electronic unit design version
VIGT.415210.101	General purpose industrial electronic unit
VIGT.415210.101-**02**	Electronic unit in a certified explosion-proof enclosure.

Photos of sensors and electronic units are shown in the appendix.

2.2. Sensors of moisture meters in the FIZEPR-SW100.17.x version feature a sensor (sensing element) located on the sensor end and having a flat structure without protruding parts. The absence of protruding elements in the sensor design allows the use of such sensors in mixers, conveyors and other applications where the presence of a protruding element is not desirable or acceptable.

It should be noted that the use of a flat sensor also causes a significant drawback inherent to all sensors of this type without exception including those produced by Western companies: Franz Ludwig GmbH, IMKO GmbH, Hydronix Ltd, SWR engineering Messtechnik GmbH, Bikotronic-Industrie-Elektronik GmbH, ACO Automation Components Johannes Mergl e.K., etc.

The probing electromagnetic field of the flat sensor decreases sharply as moving away from the sensor surface, so the material layer located on the sensor surface affects measurement results much more strongly than the same layer located at a distance of just 5 mm from the sensor. This feature leads to the fact that in order to measure materials sticking on the sensor, it is necessary to clean the sensor surface, as for instance this is ensured in concrete mixers where the gap between the moving blades and the sensor surface is set to several millimeters.

Note. If it is necessary to measure not a thin layer of the material, but a noticeable volume (including materials that stick on the sensor), use moisture meters of the FIZEPR-SW100.10 series. The sensor of these moisture meters is made as two mutually spaced electrodes, and the measured material fills the entire space between these electrodes. As a result, the sensor in FIZEPR-SW100.10.x version ensures material measurement in a volume of several liters to hundreds of liters.

2.3. According to their operating principle, FIZEPR-SW100 moisture meters are radiowave (microwave) permittivity meters (dielectric moisture meters). The method of permittivity measurement ε_r is based on measuring electromagnetic wave deceleration factor k_{dec} in the controlled material (factor k_{dec} is functionally related to permittivity ε_r of the controlled material). Measurements are made by probing the medium with radio waves, and the moisture meter determines factor k_{dec} by calculating the ratio of sensor resonant frequency in air to its resonant frequency in the controlled material. The moisture meter processor calculates the moisture content based on the measured k_{dec} factor value taking into account the controlled material temperature (thermoresistance is mounted inside the sensor to measure the controlled material temperature). The calculation is made based on calibration tables prepared for each type of the controlled material and stored in the moisture meter memory. The moisture measuring method used provides high accuracy and repeatability of measurement results. The moisture meter metrological characteristics do not depend on external conditions, and measurements are not affected by the temperature of semiconductor converters and the electronic unit itself.

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

It is important to note that to ensure high accuracy of moisture measurement specified in the data sheet, moisture meter calibration (preparation of calibration tables) must be performed on the material to be measured.

2.4. Moisture content – a parameter measured by the moisture meter – is a ratio between the weight of water contained in the material to the wet material weight and is defined by the following formula:

$$W = \frac{m_w - m_d}{m_w} \times 100\% , \qquad (1)$$

where W - material moisture content;

m_w - weight of the wet material sample;

m_d - weight of the same material sample after drying.

Note. It should be noted that a number of industries use a different moisture content definition: moisture content is defined as the ratio of the mass of water contained in the material to the mass of the dry material. In this case, moisture content is calculated according to the formula:

$$W = \frac{m_w - m_d}{m_d} \times 100\% . \qquad (2)$$

The moisture meter can be calibrated using any of the above formulas, but calibration according to the first formula is recorded in manufactured moisture meters as a default setting (unless there is a special requirement from the customer). In this manual, the first moisture content definition is used when describing technical parameters.

3. Metrological and technical characteristics

3.1. Main parameters and specifications

Moisture meters are manufactured in accordance with technical specifications VIGT.415210.100TU based on the set of design documentation VIGT.415210.100-17.

Table 3 lists main moisture meter specifications.

Table 3

Item No.	Parameter	Value
3.1.1	Measurement range of moisture W - mass water fraction, % ***(see Note 1)***	0 to 100
3.1.1	Limits of permissible absolute error Δ of mass (volume) water fraction measurement according to MP242-1715-2014, % ***(see Note 2)***	Δ=0.035+0.05*W
3.1.3	Controlled material temperature range where moisture meter calibration is made, °C ***(see Notes 3 and 4)***	+ 5 … + 80
3.1.4	Working temperature range of sensor operation, °C:	-20 … +120

3.1.4.1	Permissible controlled material temperature range, °C: - Version 17.15	0 … +120 0 … +145
3.1.5	Working temperature range of Version **A** electronic unit operation, °C	-20 … +80
3.1.6	Working temperature range of Version B electronic unit operation (with extended temperature range), °C	-40 … +80
3.1.7	Working temperature range of Version **A** explosion-proof electronic unit operation, °C	-20 … +60
3.1.8	Working temperature range of Version **B** explosion-proof electronic unit operation (version with extended temperature range), °C	-40 … +60
3.1.9	Temperature measurement range, °C	-50 … +150
3.1.10	Limits of permissible absolute error of temperature measurement (in +5 … +80°C temperature range), °C	±1
3.1.11	Measurement period, sec ***(see Note 5)***	0.1 … 1
3.1.12	Output interface - digital - current, mA	 RS-485 Modbus RTU 4-20
3.1.13	Supply voltage, V nominal allowable ***(see Note 6)***	 24 18...32
3.1.14	Current consumption, mA, maximum	200
3.1.15	Dimensions of electronic unit in general purpose industrial version, mm	255 x 170 x 60
3.1.16	Dimensions of electronic unit in certified explosion-proof enclosure, mm	285 x 230 x 120
3.1.17	Weight of electronic unit in general purpose industrial version, kg	2
3.1.18	Weight of electronic unit in certified explosion-proof enclosure, kg	7
3.1.19	Dust and moisture ingress protection rating of electronic unit in general purpose industrial version according to GOST14254-2015	IP54
3.1.20	Sensor overall dimensions (without cable gland and cable), mm - Version 17.8, 17.12 - Version 17.1, 17.2 - Version 17.21 - Version 17.15	 Ø108 x 120 Ø80 x 120 Ø50 x 120 Ø75 x 180 (Ø126 x 180)

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

3.1.21	Sensor weight (without attachment fittings), kg, max - Version 17.8, 17.12 - Version 17.1 - Version 17.21 - Version 17.15	 4 3 2 5
3.1.22	Dust and moisture ingress protection rating of electronic unit in certified explosion-proof enclosure according to GOST14254-2015	IP66
3.1.23	Dust and moisture ingress protection rating of sensor according to GOST14254-2015	IP67
3.1.24	Length of communication cable between sensor and electronic unit, m ***(see Note 7)***	1,5 … 4
3.1.25	Maximum length of communication cable (RS485 digital signal, 4-20mA analog signal) from electronic unit to indication or control device (controller, computer), minimum, m	1000
3.1.26	Average time between failures, h	25 000
3.1.27	Average life, years	10

Notes

1. For concrete mixtures, the fraction of water does not exceed 14%, therefore, for moisture meters installed in a concrete mixer, the maximum moisture value is set in the calibration characteristic equal to 20% (the ratio of the mass of water to the total mass of the concrete mixture).
2. Absolute error values and factors affecting the error value are specified in Section 3.2 of this manual.
3. The user can freely update analyzer calibration with data for extension of moisture measuring temperature range for materials measured using supplied software by the method described in the operation manual.
4. When measuring materials containing ice, the moisture meter detects only unfrozen water. Measurement accuracy for materials containing ice is not regulated.
5. Nominal measurement time is 0.5...1sec, but for fast processes the measurement time can be reduced, e.g. for material control in mixers the measurement period can be reduced to a value less than 0.1s.
6. Supply voltage can be set to 12V at the customer's request.
7. Required communication cable length between the sensor and the electronic unit is agreed when ordering. Maximum cable length for the moisture meter in explosion-proof version is 4 m.

3.2. Measurement error

Refer to Table 4 for absolute error Δ values calculated by mathematic expressions (formulas) provided in Section 3.1.2.

Table 4

Moisture content value **W**	Limits of permissible absolute error **Δ**
5%	0.3%
10%	0.5%
20%	1%
40%	2%
50%	2.5%
70%	3.5
100%	5%

This absolute error value is determined based on Verification Method 242-1715-2014 in accordance with Section 6.4 of this Verification Method. It is important to note that moisture meter verification according to this Verification Method is performed using the following liquids: reference sample of mass (volume) water fraction GSO 9829 - 2011, GSO 8999-9007 - 2008, GSO 9261-9262 – 2008 or check mixtures for transformer oil and water. However, when measuring liquid materials, a very important factor is excluded that affects the results of bulk material measurements, in particular, the effect on the bulk density measurements of bulk materials. The bulk density of bulk materials depends on measurement conditions.

3.3. Main specifications and explosion-proof marking of moisture analyzers in explosion-proof version are shown in Table 5.

Table 5

Parameter	Value
Explosion-proof marking: - Electronic unit - Sensor	 Ex 1Ex d [iaGa] IIB T5 Gb Ex Ex tb [ia Da] IIIC T100ºC Db Ex PB Ex d [ia Ma] I Mb Ex 0Ex ia IIB T5 Ga Ex Ex ia IIIC T100ºC Da Ex PO Ex ia I Ma
Parameters of intrinsically safe circuits of the electronic unit	
Maximum output voltage U_o, V	10.5
Maximum output current I_o, A	1.11
Maximum external capacity C_o, μF	14
Maximum external inductance L_o, mH	0.02

Explosion protection of moisture meters is ensured by their design that meets the general requirements according to GOST 31610.0-2014 (IEC 60079-0:2011), explosion protection type "explosion-proof enclosures "d" according to GOST IEC 60079-1-2011, explosion protection type "intrinsically safe circuit "i" according to GOST 31610.11-2014 (IEC 60079-11:2011), dust ignition explosion protection type "t" according to GOST R IEC 60079-31-2010.

Applications of sensors for explosion-proof moisture meters are explosive zones of Class 0, Class 1 and Class 2 according to GOST IEC 60079-10-1-2011, IIA, IIB explosive mixture categories according to GOST R IEC 60079-20-1-2011, explosive zones of Class 20, Class 21 and Class 22 according to GOST IEC 60079-10-2-2011 containing explosive dust of Subgroups IIIA, IIIB and IIIC, as well as underground workings of coal mines and pits including those hazardous in terms of gas

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

(methane) and/or coal dust, and their surface structures according to electrical equipment explosion-proof markings, GOST IEC 60079-14-2011 and other regulatory documents governing the use of electrical equipment in potentially explosive environments.

Applications of electronic units for explosion-proof moisture meters are explosive zones of Class 1 and Class 2 according to GOST IEC 60079-10-1-2011, IIA, IIB explosive mixture categories according to GOST R IEC 60079-20-1-2011, explosive zones of Class 21 and Class 22 according to GOST IEC 60079-10-2-2011 containing explosive dust of Subgroups IIIA, IIIB and IIIC, as well as underground workings of coal mines and pits including those hazardous in terms of gas (methane) and/or coal dust, and their surface structures according to electrical equipment explosion-proof markings, GOST IEC 60079-14-2011 and other regulatory documents governing the use of electrical equipment in potentially explosive environments.

3.4. The moisture meter is designed for continuous operation.

4. Scope of supply

4.1. Moisture meter scope of supply:

1. Sensor VIGT.415210.100 – 17.x
2. Electronic unit VIGT.415210.101 (VIGT.415210.101-02)
3. Fixing set
4. Technical description and operation manual VIGT.415210.100, Parts 1 and 2
5. Data sheet VIGT.415210.100-17 PS
6. Disc or USB flash drive with SW100 and SWPro software.

4.2. The items listed in Table 6 may be additionally included in the scope of supply at the customer's request.

Table 6

Item description	Type, brand
USB – RS485 interface converter	AS4 converter by Owen, ATsDR.426469.032» by RPE "Bolid" or other companies
Measuring and regulating device with digital indication (input signal – 4-20mA current)	OWEN TRM201 converter by Owen, OWEN TRM1 by Owen, etc.
Operator panel with digital indication (MODBUS RTU RS485 digital input signal)	OWEN SMI1 converter by Owen
24V (or 12V) power supply	OWEN BP30B-D3-24 by Owen
Explosion-proof thermal cover for electronic unit. It is used when operating at temperatures below -40°C. Supplied with: - Thermal cover (wear and chemically resistant, water-oil repellent fabric) - 25 NTR2-VT, 50Hz, 220V, 2ExellT6 self-regulating heating tape with power cable in the 3 m metal hose - Terminal box.	EkoTerm Ex-02 by EkoTerm

5. Moisture meter design description, operation description

5.1. The moisture meter consists of an electronic unit and a sensor connected by a cable. **Cable connection with the sensor is non-separable and filled with compound.** Sensor cable is connected to a terminal block located under the electronic unit cover.

5.1.1. Sensors in VIGT.415210.100-17.8 version (Appendix 1) have a cylindrical enclosure made of stainless steel AISI 321 or 316L. The enclosure is 108 mm in diameter. The sensor end part (sensing head) in contact with the controlled material is removable. The outer ring and central disk of the sensor head are made of stainless steel ASTM 440B subjected to heat treatment (hardening), but for salt measurements these elements are made of 316L steel, which is more resistant to chemically active substances.

5.1.2. Sensors in VIGT.415210.100-17.12 version (Appendix 2) have a cylindrical enclosure made of stainless steel AISI 321 or 316L. The enclosure is 108 mm in diameter. The flat part of the sensor (sensing head) in contact with the controlled material is formed by a disk made of alumina ceramics. This ceramics features high abrasion resistance and hardness, but at the same it is brittle. The ceramic disk is secured on the sensing head with a retaining ring. The ring is made of stainless steel ASTM 440B subjected to heat treatment (hardening). The ceramic disk is replaceable and can be replaced in case of damage. A backup ceramic disk and disk replacement device are not included in the scope of supply of this moisture meter and can be supplied on request.

Enclosures of sensors 17.8 and 17.12 are secured on the base using a fixing set VIGT.415210.751 (Appendix 9). Attachment design allows for a fairly simple sensor installation and dismantling while in service.

These sensors are designed for installation in the hole of a hopper, mixer, but can also be installed on a skid when measuring bulk materials on a conveyor belt.

5.1.3. Sensors in VIGT.415210.100-17.1 version (Appendix 3) have a cylindrical enclosure made of stainless steel AISI 321 or 316L. Enclosure is 80 mm in diameter. Sensor 17.1 enclosure is secured on the base using a fixing set VIGT.415210.752 similar to the VIGT.415210.751 set in terms of design.

5.1.4. The sensor VIGT.415210.100-17.2 is made in the cylindrical enclosure 80 mm in diameter. The sensor is intended for use in single-shaft and twin-shaft horizontal concrete mixers and sampling systems. Sensor head surface is concave for sensor mounting on radiussed walls. The sensor head is made of hardened stainless steel ASTM 440B. The sensor is supplied with a fixing set.

5.1.5. The sensor VIGT.415210.100-17.21 (Appendix 5) is designed for sampling systems. The sensor is made as a piston with a diameter of 50 mm. Allowable force on the piston is 5000 N. The sensor enclosure has a thread for securing to a hydraulic drive rod.

5.1.6. The sensor VIGT.415210.100-17.15 (Appendix 6) is used in boilers. The sensor is made in a cylindrical enclosure with a diameter of 75 mm. The enclosure has a "skirt" 126mm in diameter. The sensor is introduced into a boiler through a flanged nozzle and is clamped with a mating flange, flange version is 80-6-01-1-V according to GOST 33259. The depth of sensor insertion into the boiler can be adjusted by the thickness of spacer rings installed between the sensor "skirt" and the nozzle flange. To seal the connection of the nozzle flange with the sensor "skirt" and with spacer rings, it is

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

recommended to use high-temperature gaskets SNP GOST R 52376-2005 for DN80, PN6 flanges. Permissible boiler pressure is 6 kgf/cm^2.

5.2. Electronic units are manufactured in general purpose industrial version and an explosion-proof version. Wiring diagrams of all electronic units are identical in all issues except for explosion protection.

5.2.1. The enclosure of the electronic unit in general purpose industrial version is shown in the photos in Appendices 2 and 7. Two LEDs are mounted on the side wall of this enclosure to monitor moisture meter operation.

The "POWER" LED is connected to the +24V input power supply circuit and illuminates when power is supplied.

The "CONTROL" LED is bi-color. Green light indicates RS-485 network communication. Red light illuminates when the moisture meter responds to requests from an external device (computer, controller, etc.).

The electronic unit is fixed near the sensor at a distance determined by the connection cable length specified in the order. If cable is 1.5m long, the electronic unit is installed at a distance of no more than 1.0m from the sensor.

Depending on the operating temperature range, the electronic unit is supplied in two versions:

- For operation in a temperature range from -20°C;
- With an increased temperature range for operation at temperatures from -40°C.

There is one FECA1IB sealed cable gland installed on the electronic unit enclosure to route cables from the sensor. Cables between the sensor and the electronic unit are protected by a RZ-SLP-NG-12 metal hose in a PVC jacket. For sensors used on a conveyor, the sensor cable is protected by a thick-walled rubber tube - 10x17.5-1.47 V MBS rubber pressure hose according to GOST 10362-2017 with thread reinforcement.

Cable entries into the sensors are also made through the specified cable glands installed on the sensor enclosure. To connect communication and power cables, two PG-9 type sealed cable glands or VK-M16-8-MP12 cable glands are installed on the electronic unit enclosure designed for sealed entry of a 4-8 mm unarmored round cable laid in a metal hose with a nominal bore of 12 mm.

5.2.2. The explosion-proof electronic unit VIGT.415210.101-02 (shown in Appendices 1, 8 and 10) is made in an explosion-proof enclosure and has explosion-proof marking 1Exd[iaGa]IIBT5Gb.

Three LEDs are installed inside the block housing to control the connection with the moisture meter and the operating mode.

The "POWER" LED is connected to the +24V input power supply circuit and illuminates when power is supplied.

The "RX/TX" LED is bi-color. Green light indicates RS-485 network communication. Red light illuminates when the moisture meter responds to requests from an external device (computer, controller, etc.).

The "STATE" LED illuminates during measurements. If it does not illuminate, the measurement process is completed (e.g. in the "fast spectrum transmission without moisture measurement" mode).

Two or three explosion-proof sealed cable glands FECA1IB (depending on version) are installed on the electronic unit enclosure. They are used for connecting cables from the sensor, as well as connecting power and communication cables. Cables between the sensor and the electronic unit are protected by a RZ-SLP-NG-12 metal hose in a PVC jacket. The metal hose with the cable on the side of the electronic unit is filled with compound over at least 100 mm long section. Cable entries

into the sensors are also made through the specified cable glands installed on the sensor enclosure and filled with compound.

For operation at temperatures below -40°C, the electronic unit must be placed in a thermal cover. A possible version of an explosion-proof thermal cover is shown in Table 4, and its photos are shown in Appendix 10.

5.3. Moisture meter operation description

Moisture meter operation is based on measuring electromagnetic wave deceleration factor (k_{dec}) in the controlled material. As the water content in the material increases, the material permittivity rises and so the wave propagation velocity decreases. The fraction of water - material moisture content W - is calculated according to the deceleration factor value.

Deceleration factor k_{dec} is the ratio of sensor resonant frequency in air to its resonant frequency in the controlled material. Measurements are made by probing the medium with radio waves at frequencies of the 40...750MHz range (this range can be extended, and measurements can be made in the range from hundreds kHz to 1.5HHz). k_{dec} is determined by the characteristic (resonant) frequencies in the sensor signal spectrum. At these frequencies, the sensor signal spectrum has minimum values (spectrum example is shown in Fig. 1 in Part 2 of the Operation Manual).

Electromagnetic wave deceleration factor in the material k_{dec} is calculated according to the formula:

$$k_{dec} = f_0 / f_M \ ,$$

where f_0 – resonant frequency of the sensor in air);

f_M – sensor resonant frequency when it is filled with the controlled material (when the sensor is immersed into the material).

The measurement consists in periodical measurements of resonant frequency f_M and k_{dec} deceleration factor value calculation. k_{dec} value conversion to W moisture content is performed using calibration tables providing correspondence between k_{dec} deceleration factor, moisture and temperature.

Thus, the moisture meter principle of operation is to periodically search for sensor resonant (characteristic) frequency f_M, measure temperature and calculate moisture content based on these parameters.

A tunable generator forming a harmonic probing signal and a sensor signal processing device are located in the moisture meter electronic unit. The sensor includes a primary transducer (i.e. a probe) and an electronic detector that converts a high-frequency signal at the sensor output into low-frequency voltage.

As illustrated above, the moisture meter generator is periodically automatically tuned in the frequency range, and the moisture meter finds resonant (characteristic) frequencies f_M in the spectrum obtained as a result of scanning. The moisture meter calculates electromagnetic wave deceleration factor in the material from the lowest found frequency f_M, as well as frequency f_0. Then, according to the calibration tables compiled for a set of temperatures and stored in the electronic unit memory for the selected material, the moisture meter microcontroller calculates the material moisture content W. Calibration tables for different materials (sand, gravel, sunflower oil, cement production sludge, etc.) are entered into the electronic unit memory from the computer. The total number of such tables stored in the moisture meter memory is almost unlimited.

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

It should be noted that water permittivity is about 80, and permittivity of most materials is between 2 and 4. Significant difference between permittivity of water and other materials is exactly what allows to measure water content in the mixture due to a noticeable increase of total mixture permittivity if moisture is present in the material.

Please note: ice permittivity is about 3, so these moisture meters (as well as all known industrial moisture meters of other types) record only unfrozen water when measuring materials containing ice.

The measured moisture value obtained in the moisture meter processor is transmitted from the electronic unit output via RS-485 digital interface and, simultaneously, via 4-20mA current signal to the external indicator or industrial controller that controls the process.

6. Labeling

6.1. The electronic unit enclosure is labeled with the following markings:

Instrument type - on the front panel (on the cover)

Moisture meter serial number - on the enclosure side wall or also on the cover.

6.2. A seal may be installed inside the electronic unit to prevent unauthorized tampering with the factory assembly.

7. Transport and consumer packaging

7.1. Transport and consumer packaging is designed to store and transport the moisture meter, and to ensure its safety during transportation for the entire storage period.

7.2. The moisture meter, parts and components included in the scope of supply complete with operational documentation must be packed in a transport packaging.

7.3. Operational documentation must be wrapped in a polyethylene film.

7.4. The scope of supply shall include a packing list in the transport container indicating the name and quantity of the products delivered in it.

8. General operation instructions

8.1. The moisture meter consists of an electronic unit and a sensor connected by a cable. **Cable connection with the sensor is non-separable and filled with compound.** Sensor cable is connected to a terminal block located under the electronic unit cover. If it is necessary to disconnect the sensor and the electronic unit, open the electronic unit cover, disconnect the cable from the terminal block, disconnect the connector, then loosen the cable entry clamp. After that the cable must be carefully removed from the electronic unit cable entry.

8.2. The moisture meter must be powered from a general-purpose stabilized DC voltage source with the output voltage of 24V (maximum permissible supply voltage values are 18...32V). Own power consumption of the moisture meter electronic unit does not exceed 3.6W.

8.3. Information is transmitted simultaneously and independently via two lines:

- Digital communication line, RS-485 Modbus RTU interface
- 4-20 mA current loop.

8.4. The moisture meter is ready for operation in 1-2 minutes after the supply voltage is applied.

8.5. Unpacking rules.

8.5.1. Upon receipt of the container with a moisture meter, visually inspect it together with the person responsible for transportation. It is necessary to make sure that the container is completely safe. In case of any container damage, a relevant report shall be drawn up and signed by persons responsible for acceptance and transportation, sealed and sent to the carrier.

8.5.2. During the cold season, containers must be unpacked only after holding them in a warm room for 2 hours at a temperature not lower than 18-20°C.

8.5.3. After unpacking, the contents of packages shall be checked against the inventory in the packing lists.

8.5.4. Check the completeness in the “Scope of supply” section of the data sheet. Description, designation, serial number and quantity of products listed in the data sheet shall correspond to the records in packing lists.

8.6. Inspection rules.

8.6.1. Perform visual inspection in order to check safety and integrity of the moisture meter enclosure. The product must be free from any scratches, cracks, dents, traces of corrosion and other defects that can be detected during external inspection.

8.6.2. All defects and non-conformities detected during unpacking and external inspection and completeness verification are reported in a damage claim signed by persons responsible for moisture meter acceptance, approved by the head of the customer plant and sent to the manufacturer.

9. Safety precautions

9.1. A 24VDC voltage source used to power the moisture meter must be a power source that converts a higher voltage to a safe extra-low voltage by an isolation transformer or a converter with separate windings. For example, OWEN BP30B-D3-24 24V power supplies meet the above requirements.

The moisture meter corresponds to Electric Shock Protection Class III in accordance with GOST 12.2.007.0-75 when using a source for powering the moisture meter that meets the above requirement.

9.2. Do not operate the moisture meter if the electronic unit cover is removed.

9.3. Do not operate the moisture meter with poorly attached connectors or poor contact in terminal connectors.

9.4. Do not operate the moisture meter in explosive production conditions without grounding the moisture meter electronic unit.

9.5. The moisture meter electronic unit and sensor must be installed on grounded metal structures.

9.6. Only persons who have studied this technical description, and have been instructed in safety precautions when working with electrical installations and electronic equipment, shall be allowed to install (dismantle), operate, maintain and repair the moisture meter.

9.7. All types of maintenance, repair and installation associated with the replacement of fuses, disconnection and switching of wires, etc., as well as moisture meter dismantling must be performed only when it is disconnected from the power source.

10. Installation procedure

10.1. Safety regulations set out in Section 9 of this manual and in regulatory technical documents applicable at the customer plant shall be strictly observed during the moisture meter installation.

10.2. The moisture meter supplied for on-site installation has passed acceptance testing.

10.3. First choose mounting locations for a sensor and an electronic unit. Take into account permissible operating conditions when choosing mounting locations. Prepare mounting locations for moisture meter components in accordance with overall and mounting dimensions.

10.4. The moisture meter on-site installation is carried out in the following order:

- Mount the sensor in a prepared location according to the recommendations of Sections 12 and 13 of this Operation Manual

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

- Fix the electronic unit in a prepared location
- Remove the electronic unit cover and make electrical installation.

When choosing a location for electronic unit installation, take into account the connecting cable length. The electronic unit must be freely accessible. The appearance of electronic units with the top cover removed is shown in the photos in Appendices 7 and 8.

10.5. The wiring diagram for moisture meter connection to external circuits is shown in Appendix 11.

Results can be displayed on a controller or a computer via RS-485 Modbus RTU interface. Also, any indicator with a 4-20 mA current input can be used to display measurement results. For example, the OWEN TRM-201 measuring and regulating device can be connected to the 4-20 mA current output as shown in Appendix 11. Calibration features of the OWEN TRM-201 measuring and regulating device are given in Appendix 12.

If it is necessary to set the current output parameters, obtain diagnostic information about the moisture meter operation, record its characteristics, adjust the moisture meter or change the communication parameters, connect a computer (laptop) to the electronic unit using the RS485-USB interface adapter converter. Parameter adjustment instructions are provided in Part 2 of this manual.

Voltage source is a power supply with an output voltage of 24V, e.g. OWEN BP 30B-D3-24.

10.6. Electrical connection of the moisture meter shall be carried out in the following order:

10.6.1. Connect the sensor cable to the electronic unit (IN1, IN2 terminals, IN3 connector).

10.6.2. Connect the temperature sensor cable to the "RTD" or "TEMPER" terminals.

10.6.3. Connect the communication cable to the "RS-485" terminals (if required).

10.6.4. Connect the cable to "I_OUT" 4-20mA current output terminals (if required).

10.6.5. Connect the power cable to the "24V" terminals.

Note. "I_OUT" current output is not galvanically isolated from the power circuit.

11. Recommendations for sensor use in concrete mixers

Choosing a location for sensor installation in a concrete mixer is one of the most critical issues since the material where the sensor is installed will determine all measurement results.

It is necessary that the sensor is located in the mixed material flow and that no material accumulates on its measuring surface.

11.1. In vertical shaft concrete mixers (SB-138 type), the sensor is installed on the floor at a distance of 2/3 from the concrete mixer center (see Fig. 1).

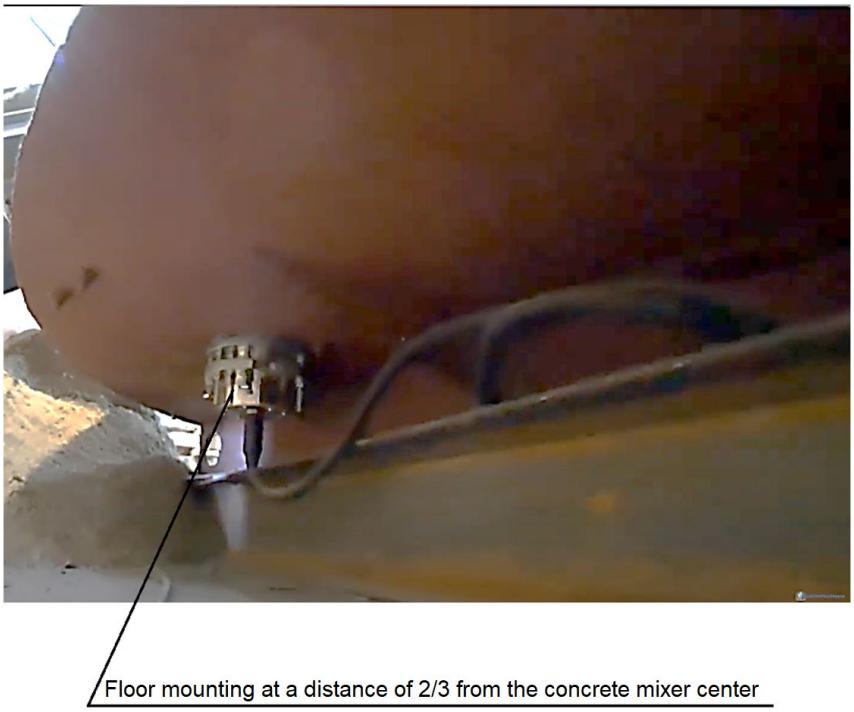


Figure 1.

In a planetary concrete mixer, the sensor must also be installed on the floor. An ideal place is the area where the material flow is the calmest, away from excessive turbulence caused by the mixing blade operation. Usually it is a place near the side wall of the concrete mixer. Therefore, as a rule, it is recommended to place the sensor so that its inner edge is about 10-15cm away from the side wall of the concrete mixer. A minimum distance must be not less than 5cm (see Fig. 2).

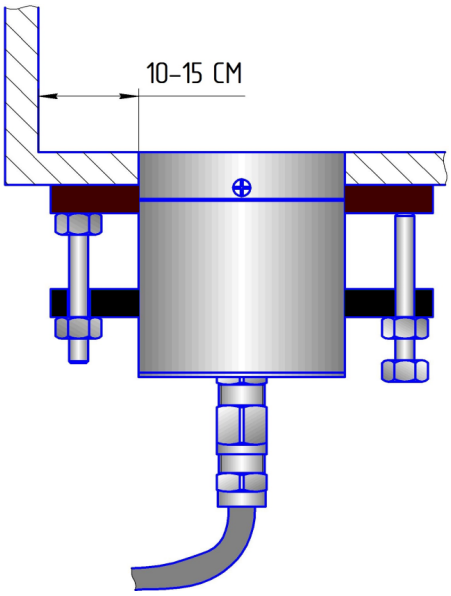


Figure 2.

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

Figure 3. Example of the hole in the concrete mixer floor.

11.2. It is also possible to install the sensor on the side wall, but for with small mixing volumes it is necessary to position the sensor so that it is always in the mixture. When installing the sensor on the side wall, the sensor must be located not closer than 50 mm to the bottom (Fig. 4).

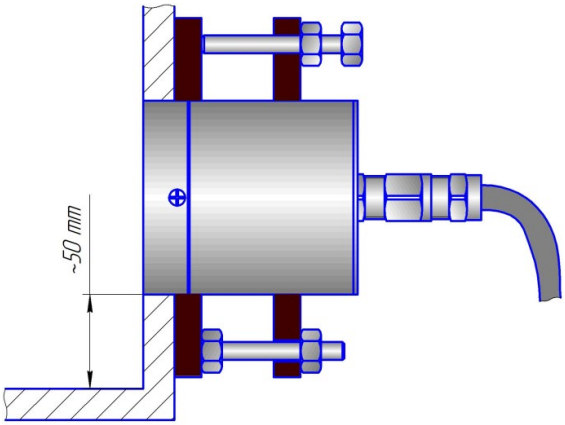


Figure 4.

11.3. In single-shaft horizontal concrete mixers the best way is to place the sensor at an angle of 30° above the base so that to prevent covering the sensor measuring surface with water stagnating in the concrete mixer base (see Fig. 5). It is necessary to place the sensor approximately in the middle of the concrete mixer length, and in the upward flow direction. If it is impossible, e.g. when this area is blocked with doors through which the concrete mixer is unloaded, in this case the sensor may be installed on the opposite side in the downward direction of blade movement. Similar recommendations apply to the twin-shaft mixer.

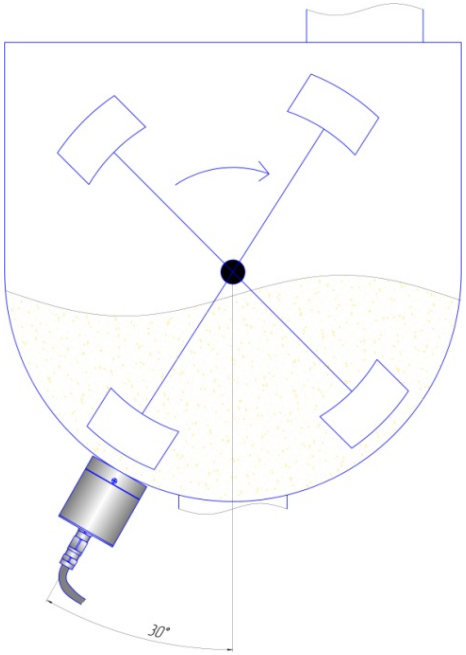


Figure 5.

11.4. When installed on flat surfaces, the measuring surface of the sensor should be flush with the concrete mixer floor (wall) as shown in Fig. 6.

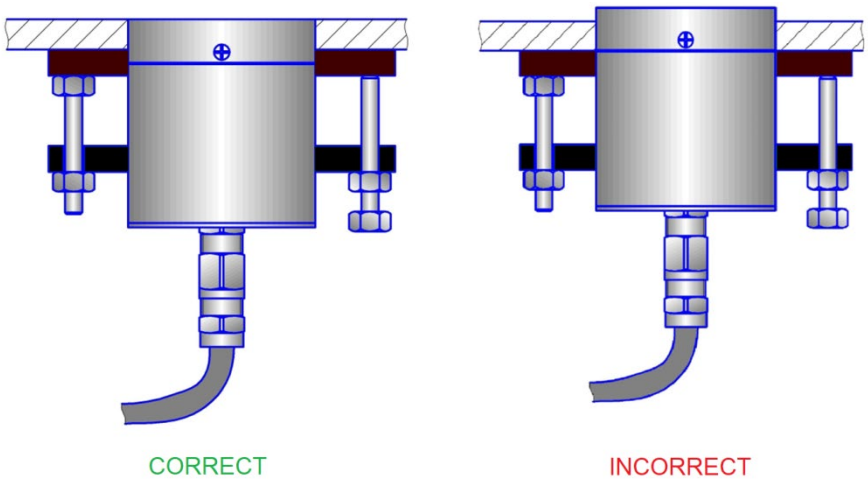


Figure 6.

If the sensor is mounted on a curved surface, then it must be installed so that the sensor surface is flush with the concrete mixer wall radius. Correct and incorrect options are shown in Figure 7.

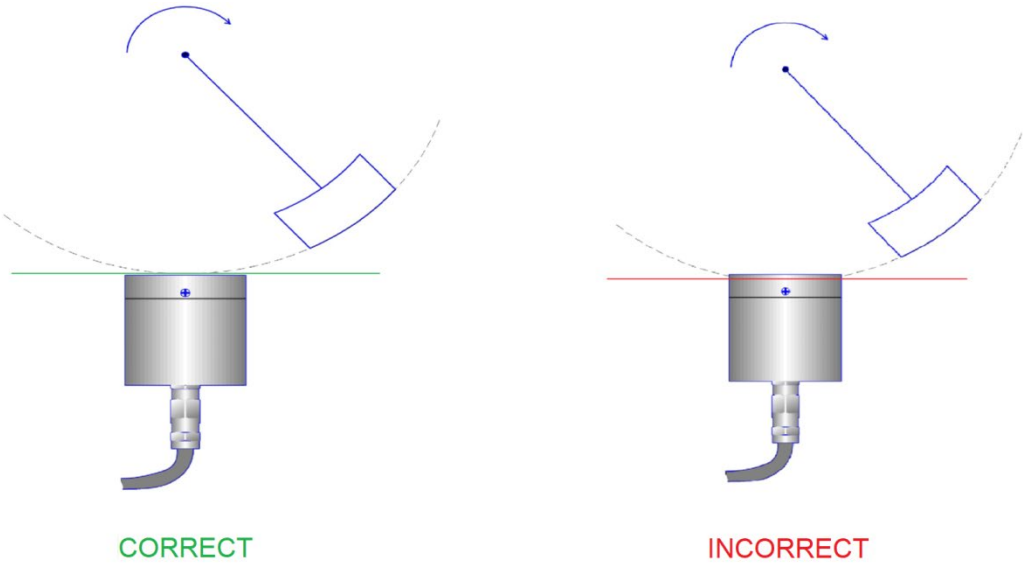


Figure 7.

11.5. Sensor installation and removal features

11.5.1. Make a Ø109…110 mm hole in the selected place (on the side wall or in the floor of the concrete mixer) for sensors of 17.8 and 17.12 versions. (For sensor in the 17.1 version, the hole diameter is Ø81…82). Using electric welding, secure the Steel 20 ring from the fixing set on the outside of the mixer (Appendix 9). It is recommended to center this ring with the sensor installed and secured in it.

NOTE: **During welding, the moisture meter sensor must be removed from attachment fittings in order to avoid burnout of electronic components due to induced noise!**

It is recommended to weld the ring in a disassembled state.

11.5.2. Once welding is completed, install and secure the sensor:

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

- Screw three M10 studs into the ring until tight and secure them using three M10 locknuts

- Secure a clamping ring on the sensor using two M8 bolts and locate the clamping ring so that it can be further adjusted

- Install the clamping ring assembly with the sensor on threaded studs so that the sensor working surface is flush with the concrete mixer wall, secure with M10 nuts, washers and snap rings

- Install three M10 bolts along with three remaining locknuts and fix the unit so that the sensor working surface is in the correct position: it must not protrude into the concrete mixer beyond its walls.

Check compliance with this requirement using a steel ruler applied to the mixer surface. Then it is recommended to rotate concrete mixer blades by hand and make sure that scrapers clean the working surface and do not interfere with the sensor.

11.5.3. Fully tighten the whole assembly including locknuts.

11.5.4. Once the sensor is installed and adjusted, fill the gap around the sensor with silicon sealant.

11.5.5. Additional installation recommendations:

- Sensor position must be such that it is visible through the inspection hatch in the concrete mixer lid when the concrete mixer is empty and it must be accessible for maintenance and adjustment of its installation level.

- When installed on the concrete mixer bottom, the sensor must be at the highest point of the concrete mixer floor, otherwise it will overestimate moisture content values.

- The sensor must be beyond the points of water entry, cement, sand and especially crushed stone loading.

- If the sensor is installed on the curved surface, e.g. on the side wall, than it is necessary to install it so that the sensor does not protrude inside and does not interfere with blades.

- Avoid areas with high material inhomogeneity. Optimal measurement is achieved in places where the material evenly moves near the sensor.

11.5.6. Periodically check the sensor working surface for wear. In addition, control the armor wear and adjust the sensor installation depth as it wears so that the sensor surface does not protrude over the armor. This requires additional blade adjustment to ensure efficient mixing and clean sensor working surface. If the sensor surface will protrude inside the concrete mixer too much, there is a risk of its damage by blades and crushed stone falling between the blades and the sensor. A recommended gap between the blades and the sensor surface is 2...3mm. For better sensor surface cleaning, it is recommended to use blades with polyurethane pads.

12. Recommendations for sensor use on a conveyor belt

12.1. The controlled material (charge) must fit tightly to the sensor surface; no air gap between the sensor surface and the controlled material is acceptable.

12.2. The thickness of the material layer under the sensor must be at least 4...5 cm. If the material layer thickness is less than the specified value, it is recommended to install additional guide (raking) plates in front of the sensor to ensure the required material layer thickness near the sensor. If the material layer is thicker than 5 cm, then the layer thickness has no any effect on measurement results.

12.3. The skid is fixed with the ability to move up and down depending on the thickness of the layer on the conveyor belt. The sensor cable must be secured so that its bending radius is not less than

25 cm. Cable securing must eliminate any mechanical effect on the cable at the point of its connection with the sensor cable gland.

12.4. A stopper must be provided to limit the skid downward movement so that the gap between the skid and the belt cannot become less than 30 mm, i.e. it is necessary to exclude an excessive skid approach to the belt when there is no material on the belt. It is necessary to take into account that the conveyor belt ends are often connected with bolts, and bolt heads may overhang the belt by 20mm (to be confirmed).

12.5. It is recommended to install the sensor mounting skid at a slight angle to the conveyor belt to ensure a tight contact between the sensor and the controlled material. An optimal angle of the skid surface inclination to the belt surface is 5 ... 15°. To meet this requirement, the skid is sometimes fixed on links not only on the front section of the skid, but also using additional links fixed on the skid end. When it is fixed this way, front and rear links must form a parallelogram.

12.6. The force of sensor pressing to the material surface must not change during the operation since the bulk density of bulk materials affects measurements. Skid pressure on the controlled material must be stable, and this is achieved using a load or springs.

12.7. The best option is to install sensors on the conveyor with sensing elements covered with a ceramic plate (sensor of the 17.12 or 17.8 version with a ceramic disk stuck on the sensor surface). Material sticking on the ceramic surface is minimal, Ceramic surface of the sensor must slightly project from the skid opening, i.e. it must be approximately 0.5...1.0mm lower than the skid surface.

12.8. In order to exclude skid bouncing, i.e. skid breakaway from the material and air gap formation between the sensor and the material, it is desirable to preliminarily level the controlled material surface in front of the skid. A roller (drum) 200mm and more in diameter can be used for this. The drum must be secured so that it does not touch the belt (and especially bolts connecting the conveyor belt ends) when there is no material.

13. Pre-starting and operation procedure, measurement procedure

13.1. The moisture meter must be serviced by an operator who is familiar with the operation of electronic equipment, has studied this technical specification and operation manual and have been instructed in safety precautions when working with electrical equipment.

13.2. Preparation for work is carried out in the following order:

13.2.1. Make sure that electrical connections correspond to the wiring diagram. Check reliability of wire connection to terminal clamps.

13.2.2. Energize the moisture meter.

13.2.3. Make sure that the "POWER" LED on the electronic unit side panel is illuminated.

13.2.4. Make sure that the "CONTROL" LED on the electronic unit side panel is flashing (when RS485 line is connected).

Note. LEDs of electronic units made in explosion-proof enclosure are located on a top panel – connection board.

13.2.5. Once all the above actions are performed, the moisture meter is ready for operation.

13.2.6. If any moisture meter failure is detected, turn off power, identify and correct the occurred failure as described in Sections 12 and 13 of this manual.

13.3. Measurement procedure

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

Before taking measurements, make sure that the moisture meter sensor is completely filled with the controlled material. Read measurement results from the indicator device (OWEN TRM-201 measuring and regulating device or a computer screen).

13.4. Measurement reliability evaluation

Evaluation of measurement reliability (accuracy) is performed by comparing moisture meter readings with laboratory test results.

These data are entered into the "Measurement Reliability Evaluation Report" (see Appendix 16) with the date of sampling and the temperature of the material.

When taking samples for laboratory measurements from the controlled material volume with the moisture meter, the moisture meter readings are recorded in the report, and once the laboratory analysis is completed, the results are recorded in a corresponding line. Then the difference between obtained values is calculated taking into account the sign.

The frequency of sampling is determined by the company.

In case of systematic unacceptable differences between moisture meter and laboratory data perform the analysis of possible causes.

Possible reasons for such differences are listed below:

- Moisture meter calibration does not correspond to the controlled material, in particular, the moisture meter was not calibrated on a "dry material"
- The moisture meter sensor is heavily contaminated with sediments
- An unrepresentative sample is taken for laboratory analysis
- The controlled material structure is unstable in terms of moisture content.

The following solutions are recommended to eliminate the above causes for discrepancies:

1. Moisture meter calibration does not correspond to the controlled material

Compare the laboratory measurement results accumulated for a long period of time and respective moisture meter measurement results. It should be noted that these data must include measurements in a sufficiently wide moisture measurement range.

In order to assess operating quality and calibration accuracy of the moisture meter, you may use the manufacturer's warranty services by sending a configuration file to info@fizepr.ru

This file must be saved immediately after calibration using the software included in the scope of supply (see Section 2.2, Part 2 of the Operation Manual).

2. The moisture meter sensor is heavily contaminated with sediments

Clean the sensor from sediments. Adjust the sensor and/or blade position in the concrete mixer.

3. The plant laboratory uses a different method of moisture calculation

There are two main moisture measurement methods as specified in the industry standards:

1) Moisture content is calculated as a ratio between water mass and wet material weight.
2) Moisture content is calculated as a ratio between water mass and dry material weight.

FIZEPR-SW100 moisture meters usually use the first method (see Section 2.4 of this Manual). If measurement by the second method is required, calibration tables must be modified for the selected method and moisture volume units by recalculating table values. Such recalculation can be done unassisted or using the manufacturer's services (warranty service) after moisture meter delivery or at the ordering stage.

4. An unrepresentative sample is taken for laboratory analysis

When sampling the material for laboratory analysis, the following mandatory condition shall be fulfilled: moisture content in a sample must be equal to the average moisture content in the material volume measured with the moisture meter.

For example, in a standard dispenser, the moisture content of sand prepared for a concrete mixer may differ by 2% or more at different points in volume (about 0.5 cubic meters). Therefore, there are certain features of sampling for laboratory analysis. A representative sample must contain material from different parts of the entire volume, which can be achieved, for example, by repeated gradual discharging material in small doses from a hopper (dispenser). Otherwise, the calculated accuracy of the laboratory analysis will not be achieved and its result cannot be considered reliable.

We can recommend another method for obtaining samples: at least 8...10 samples must be taken from different parts of the volume controlled by the moisture meter. Use the laboratory method for each sample to determine the moisture. Determine the resulting moisture by mathematical averaging. The advantage of this method is that it also allows estimating the accuracy of laboratory analysis by the magnitude of the variation in the sample measurement results.

5. Controlled material has an unstable composition changing over time

The results of measuring the moisture content of bulk materials are affected by the material grain particle-size distribution, appearance of fine dust as an impurity, salt content, as well as bulk density changing over time. All these physical factors may affect material dielectric parameters and standard calibration used by the manufacturer may not be suitable. In this case, it is necessary to create a new calibration based on a comparison of measurement results obtained by the moisture meter with laboratory analysis results. Based on the comparative statistics of moisture meter readings and their corresponding laboratory results, the user can create a new calibration on its own or contact the moisture meter manufacturer.

14. Description of communication protocol

14.1. Digital communication with the moisture meter is carried out via MODBUS RTU protocol via RS-485 Modbus RTU interface with the following parameters:

- Connection speed - 4800, 9600, 14400, 19200, 38400; 57600 or 115200 baud
- Parity - none
- Number of stop bits - 1 or 2.

Default communication parameters (factory settings):

- Connection speed – 19200 baud
- Number of stop bits - 2
- Address – 127
- Timeout between requests 100 ms.

14.2. Features of MODBUS RTU protocol implementation:

- Register reading by 03 (03h) command
- Support of echoing back testing 08 (08h) command
- When attempting to read address range that exceeds limits specified in the table, the moisture meter gives no response
- Register record by 16 (10h) command
- Register record is possible only in those registers for which record is allowed. In addition, recording must additionally be allowed by writing the password to 0020 (0014h) register. When trying

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

to record in registers that are read-only or if there is no password, the moisture meter gives no response.

14.3. MODBUS RTU registers are shown in Table 7.

Table 7

Register address (DEC)	Register address (HEX)	Description	R/W
0000	0000	Measured moisture content expressed in hundredths of a percent. True moisture content must be calculated according to the formula: W = reg[0000] / 100 with an accuracy of 2 decimal places.	R
0001	0001	Temperature in degrees Kelvin. Temperature in degrees Celsius must be calculated according to the formula: t = reg[0001] – 273.	R
0002	0002	Not used	R
0003	0003	Moisture meter firmware version number	R
0007	0007	***For firmware version 33 and earlier.*** Deceleration factor k measured by the moisture meter and multiplied by 5000. Deceleration factor is calculated according to the formula: k = reg[0007] / 5000 with an accuracy of 4 decimal places.	R
0020	0014	Record protection register	R/W
0163	00A3	Total number of moisture meter calibrations	R
0164	00A4	Number of current calibration	R/W
0224	00E0	Temperature in degrees Celsius. ***(Register value is relevant only for positive temperatures)***	R
0229-0230	00E5-00E6	***For firmware version 34 and later.*** Refined refractive index (x100000). Deceleration factor is calculated according to the formula: k = (reg[0230]+reg[0229]*65536) / 100000 with an accuracy of 5 decimal places.	R
0231	00E7	***For firmware version 34 and later.*** Temperature in tenths Kelvin. Temperature in degrees Celsius must be calculated according to the formula: t = reg[0231] / 10 – 273 accurate to a tenth.	R

15. Maintenance check

The list of basic maintenance checks is given in Table 8.

Table 8

Checking procedure	Technical specifications
1. Grounding check with an ohmmeter	Transitional resistance value standard for wires and grounding contacts determined by the in-plant regulatory documents and Electrical Installation Code.
2. Visual inspection	See Section 15 "Maintenance".

16. Troubleshooting

16.1. It is allowed to eliminate detected failures directly on site only when the moisture meter is disconnected from the power supply.

16.2. When replacing failed components, strictly follow instructions specified in Section 15 "Maintenance" of this manual.

16.3. Replacing the failed components and checking the moisture meter after the elimination of detected failures must be carried out by a service technician.

16.4. A list of the most possible failures is provided in Table 9.

Table 9

Description of malfunction, external manifestations and additional signs	Probable cause	Method of elimination
1. Power LED is off when the moisture meter is energized. Additional signs: - Supply voltage at the electronic unit input is 24V - Power supply circuit current is absent or less than 20mA.	Broken power wire. Reversed power wires. Burnt-out FU1 fuse.	Persons responsible for electrical installation and operation of communication lines shall correct the failure in accordance with regulations in force. Disconnect moisture from the grid. Open the cover of the electronic unit and replace the FU1 fuse.
2. Power LED is off when the moisture meter is energized. Additional signs: - Supply voltage at the electronic unit input is absent or low	Short circuit in the moisture meter power supply circuit	Persons responsible for electrical installation and operation of communication lines, as well as for moisture meter operation, shall correct the failure in accordance with regulations in force.
3. No connection with the moisture meter.	Breakdown or reversal of the communication cable, incorrect network settings of the moisture meter	Persons responsible for electrical installation and operation of communication lines, as well as for moisture meter operation, shall correct the failure in accordance with regulations in force. If cable is OK, but there is still no connection, check network settings of the moisture meter. Press and hold "Reset" button for at least 5 seconds to reset moisture meter network settings (restore default network settings). The button is located on the bottom board of the electronic unit under the cut in the top board. For details refer to Section 3.1, Part 2 of this manual.

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

17. Maintenance

17.1. General instructions.

17.1.1. Maintenance is carried out to ensure normal operation and preserve the operational and technical characteristics of the moisture meter throughout its service life.

17.1.2. Maintenance is the systematic monitoring of the moisture meter technical condition, regular technical inspection and elimination of any failures.

17.1.3. After troubleshooting, check the moisture meter technical state for normal operation.

17.2. Types and frequency of maintenance.

17.1.2. Depending on frequency and scope of work the following maintenance types are specified as listed in Table 10.

Table 10

Maintenance types	Frequency	Person responsible for maintenance
1. Scheduled maintenance: - weekly maintenance - preventative maintenance	 Once a week Every six months	Operator handling the moisture meter Specialist handling the moisture meter
2. Unscheduled maintenance	When a moisture meter failure is detected	Specialist handling the moisture meter

17.2.2. Dates of preventive maintenance can be changed and brought in line with the production plans and terms adopted at the plant operating moisture meters. At the same time, preventative maintenance frequency shall be at least once a year.

17.2.3. Weekly maintenance includes a visual inspection to ensure:

- Reliability of connection, as well as the absence of breaks or damage of the connecting cable insulation.
- No dents and visible mechanical damage to the moisture meter enclosure.
- Mechanical fastening reliability of the sensor and the electronic unit.

17.2.4. During preventive maintenance, the following works shall be carried out:

- Removal of dust and dirt from external surfaces of the electronic unit and the moisture meter sensor.
- Visual inspection
- Checking the status of communication cables and connecting wires.
- Measurement of current consumption and supply voltage.

17.2.5. Unscheduled maintenance is carried out in case of failure and includes moisture meter repair.

17.3. If the sensor head of the VIGT.415210.100-17.8 sensor is worn out, replace it following the instructions given in Appendix 13. If the sensor head of the VIGT.415210.100-17.12 sensor is damaged or worn out, replace it following the instructions given in Appendix 14.

18. Storage and transportation

Moisture meter storage and transportation conditions are in accordance with GOST 15150-69 for Groups 3 and 5, respectively.

18.1. The moisture meter components in the manufacturer's package can be stored under conditions of heated hard-wall rooms with the air free from acid vapors, alkalis and other hazardous substances that cause corrosion.

18.2. Moisture meter shelf life in the manufacturer's package is 1 year.

18.3. The moisture meter packed in a shipping container can be transported by any means of transport in closed vehicles at any distance.

18.4. Transportation must be carried out with all precautionary measures. Boxes with packaging must not be thrown or turned over.

19. Recycling

19.1. The moisture meter contains no precious metals or other substances subject to mandatory recycling.

19.2. The moisture meter is not dangerous to human life and health, as well as the environment. After the end of the service (operation) life, it can be disposed according to the technology adopted by the company operating the moisture meter.

20. Warranty

Moisture meter warranty period is 24 months from the date of delivery to the customer.

Warranty obligations for moisture meters apply provided that their commissioning procedure, conditions and rules of operation, transportation and storage specified in this Operation Manual are met.

Warranty obligations shall not cover any mechanical damages of moisture meters including the sensor abrasive wear or cable damage.

Failure to comply with the moisture meter operation, transportation and storage conditions specified in this Operation Manual makes the manufacturer warranty null and void.

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

21. Appendices

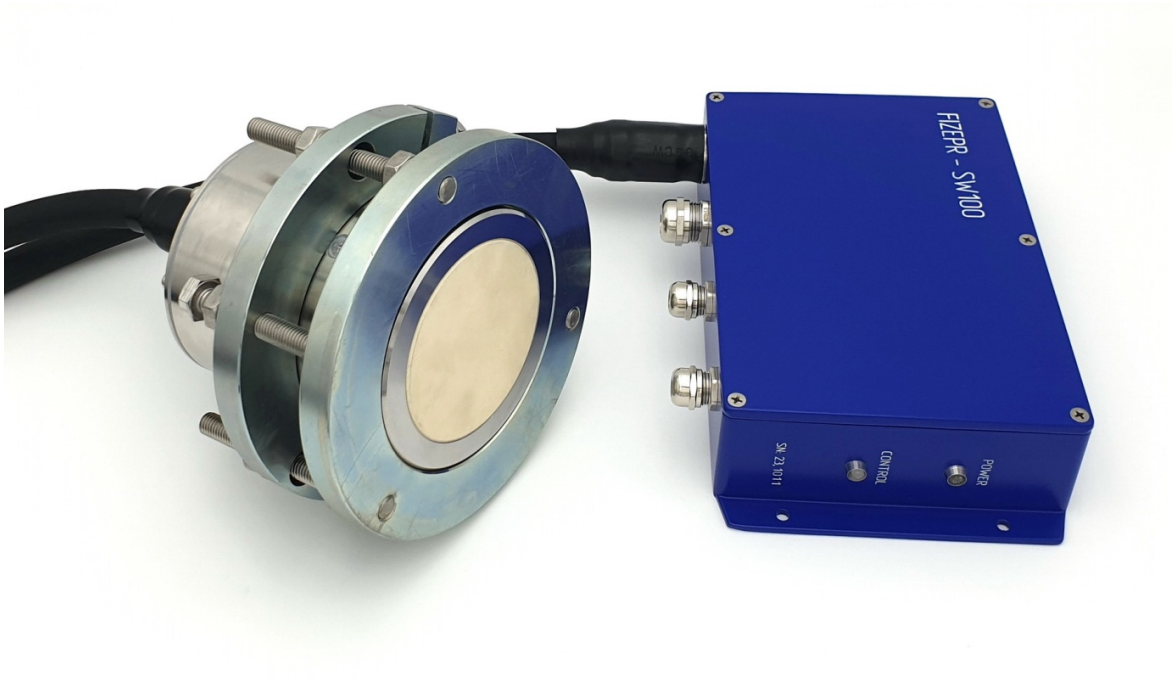
List of appendices

1. Moisture meter FIZEPR-SW100.17.8
2. Moisture meter FIZEPR-SW100.17.12
3. Sensor VIGT.415210.100-17.12 with a fixing set
4. Sensor VIGT.415210.100-17.2 with a fixing set and in a sampling system
5. Sensor VIGT.415210.100-17.21
6. Sensor VIGT.415210.100-17.15 with a fixing set and a mounting nozzle
7. General purpose industrial electronic unit VIGT.415210.101
8. Explosion-proof electronic unit VIGT.415210.101-02
9. Fixing set VIGT.415210.751
10. Thermal cover EkoTerm Ex-02.
11. Wiring diagram for moisture meter FIZEPR-SW100 connection to external circuits
12. Setting relay actuation parameters of OWEN-TRM 201 measuring and regulating device
13. Replacement instruction for sensor head VIGT.415210.100-17.81
14. Replacement instruction for sensor head VIGT.415210.100-17.121
15. Conveyor application examples of moisture meters FIZEPR-SW100.17.12
16. Measurement Reliability Evaluation Report

Moisture meter FIZEPR-SW100.17.8

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

Moisture meter FIZEPR-SW100.17.12



Sensor VIGT.415210.100-17.1
with a fixing set

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

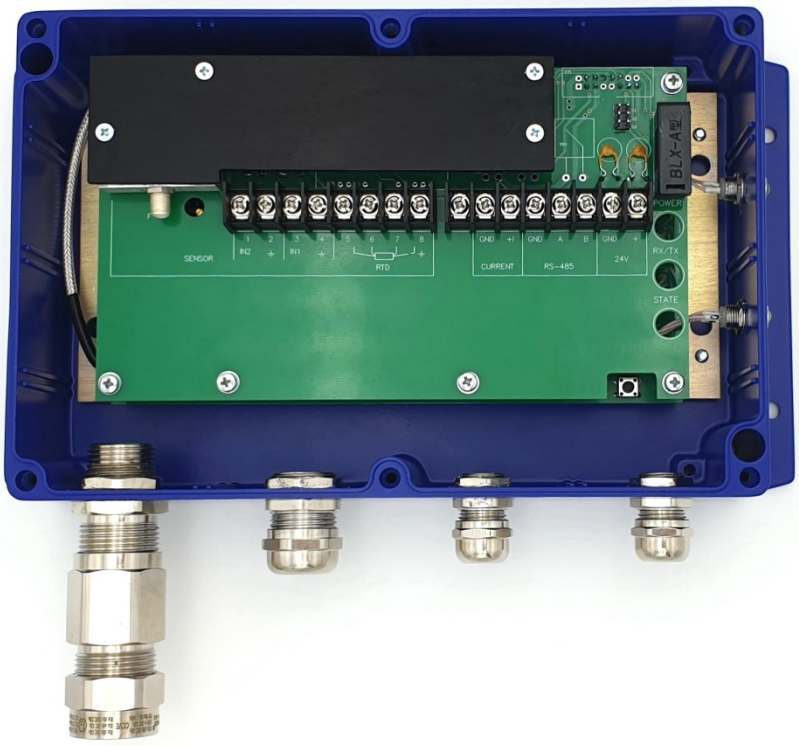
Sensor VIGT.415210.100-17.2
with a fixing set and in a sampling system

Sensor VIGT.415210.100-17.21

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

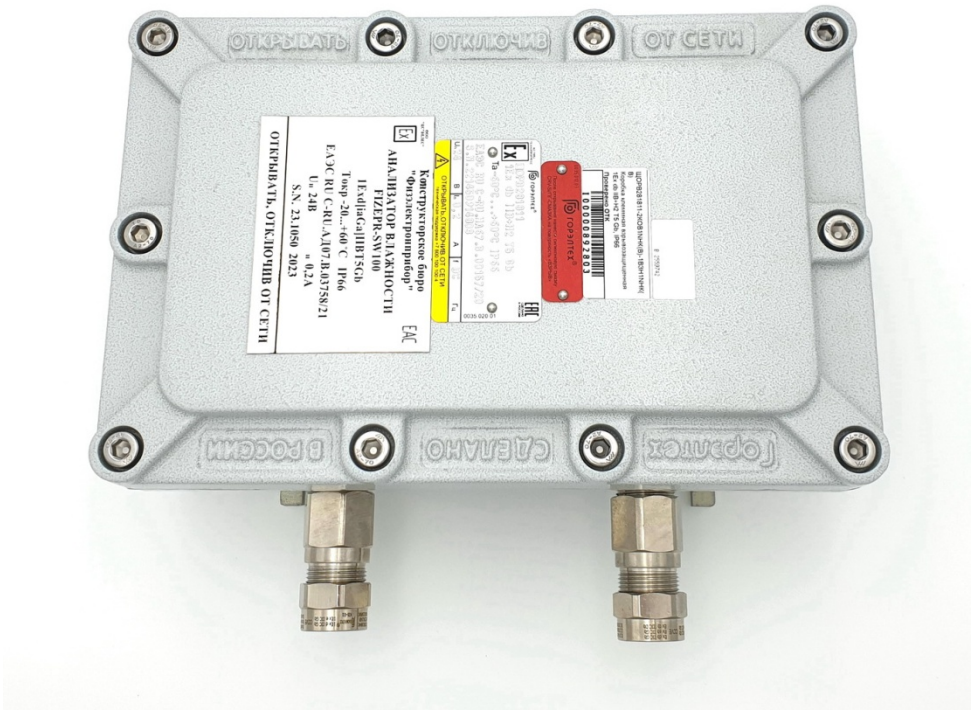
Sensor VIGT.415210.100-17.15 with a fixing set and a mounting nozzle

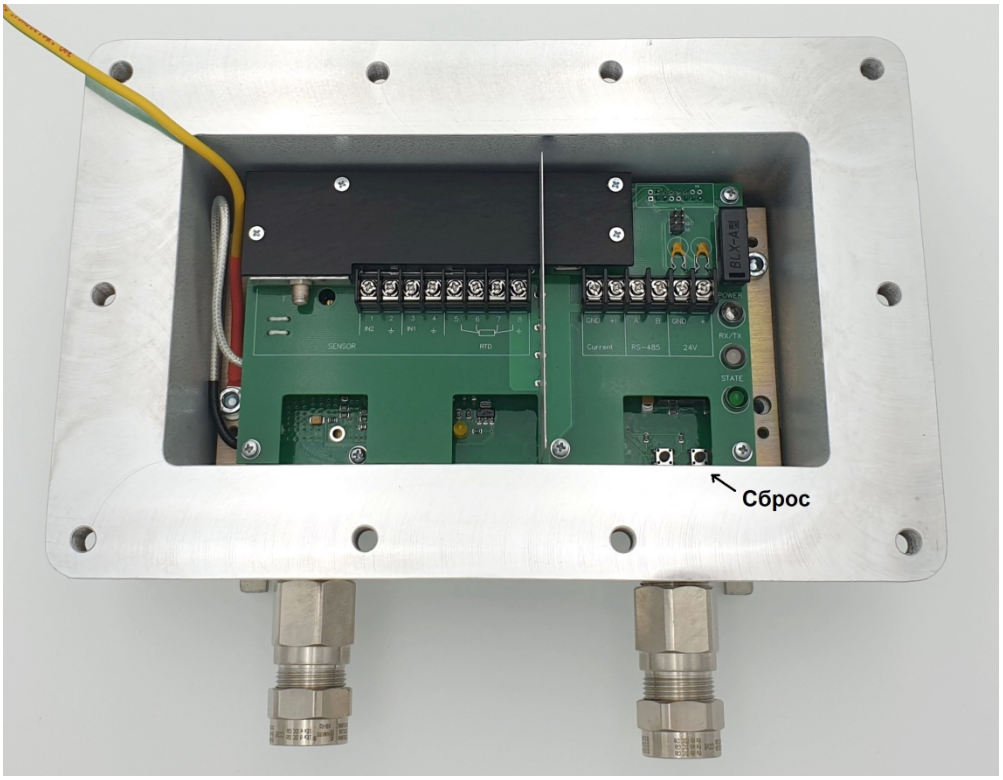
Electronic unit VIGT.415210.101
in general purpose industrial version



Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

Electronic unit VIGT.415210.101-02 in explosion proof version



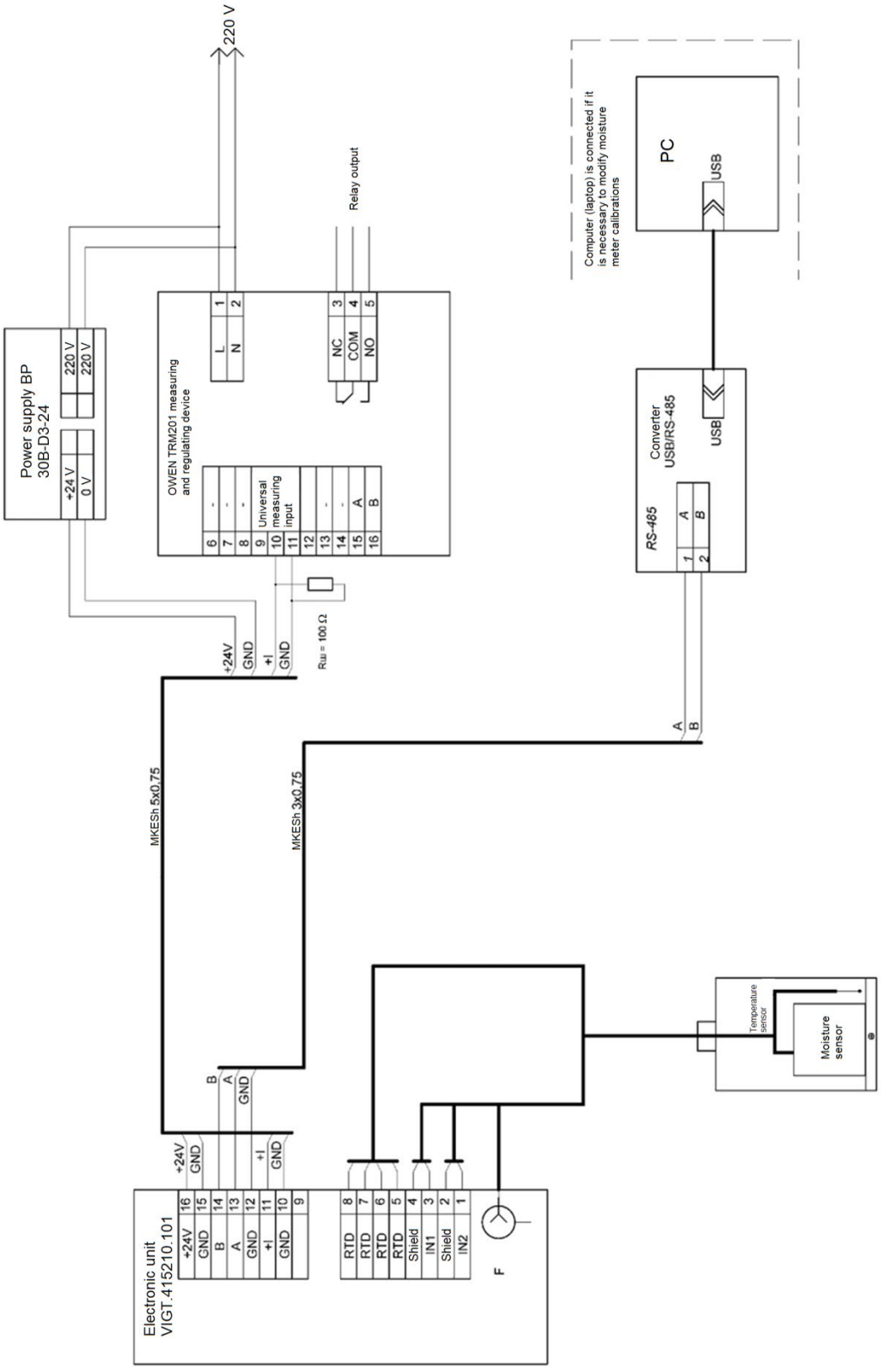


Fixing set VIGT.415210.751

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

Thermal cover EkoTerm Ex-02

Wiring diagram for moisture meter FIZEPR-SW100 connection to external circuits



Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

Setting relay actuation parameters of OWEN-TRM201 measuring and regulating device

The following example shows how to program the measuring and regulating device in order to control the water valve depending on the moisture content in diesel oil emulsion.

Let us consider the following case:
The water valve must be closed if moisture content in diesel oil emulsion rises to **15**% or higher.
If moisture content in emulsion drops to **10**% or lower, the water valve must be opened.
For this case the OWEN-TRM201 measuring and regulating device is set as follows:
threshold - 12.5%; hysteresis - 2.5%.

1. ***Selection of the actuation threshold*** (actuation threshold value is displayed on the lower green display).
   1.1. The required actuation threshold can be set with "up" and "down" arrow buttons. We set the threshold value of **12.5** (press and hold to speed up searching process).
   1.2. Briefly press "PROG." button.

2. Hysteresis setting

2.1. Enter the menu by pressing and holding "PROG." button for 3 - 6 sec.
The upper display will indicate the 'nEnU' caption (the first letter is 'n' with an overscore); the lower display will indicate the 'LuōP' caption (menu items are indicated on the green display).
2.2. Press "Up" button repeatedly to find 'LuōU' menu item.
2.3. Briefly press "PROG." button. ('SL.L' caption appears on the upper red display).
2.4. Press (repeatedly) "PROG." button to find a submenu item labeled 'HYS' on the upper red display.
2.5. Use "up" and "down" arrow buttons to set the required hysteresis value. Set **2.5**.
2.6. Briefly press "PROG." button.
2.7. To exit to the initial menu:
2.7.1. Press and hold "PROG." button until the following captions appear: 'nEnU' – on the upper red display (the first letter is 'n' with an overscore), 'LuōU' – on the lower display).
2.7.2. Use "down" arrow button to find 'LuōP' menu item.
2.7.3. Press "PROG." button (switch to indication mode: the red display shows the measured parameter value, the green display shows the actuation threshold).

3. Setting relay actuation method

Go through Sections 2.1 - 2.3.
3.1. Briefly press "PROG." button until the 'CnP' caption appears ('n' letter with an overscore) on the upper display.
3.2. Use arrow buttons to select the parameter value: 1. If 1 is selected, the relay is activated (relay contacts 3,4 are open, the valve is open) if the moisture value is below 10%, and disabled (valve closed) if the moisture value is above 15%.

Note. When the specified parameter value is set to 2, the relay is disabled if moisture drops below the threshold, and activated if moisture exceeds the threshold.

3.3. Briefly press "PROG." button.
3.4. Go through Section 2.7.

Please note that if zero voltage is applied to the valve, water supply is cut off. The valve is connected to normally open relay contacts (5, 6) in accordance with the diagram below.

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

Replacement instruction for sensor head VIGT.415210.100-17.81

For replacing the sensor head VIGT.415210.100-17.81 on the sensor VIGT.415210.100-17.8, the following tools and materials are required:

- Phillips head screwdriver (Ph2) – 1 pc
- Sealant (e.g. silicone, but any other sealant is acceptable) – 1 pc
- Acetone (or other solvent) – 1 pc
- Cloth – 1 pc

De-energize the electronic unit before the works. Follow the steps below to replace the sensor head:

1. Unscrew four screws securing the sensor head to the sensor enclosure (screw position is shown in Fig. 1):

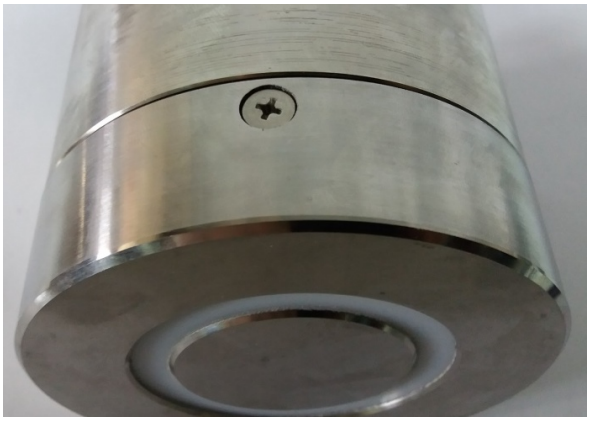


Figure 1.

2. Remove the sensor head carefully. Unscrew three screws securing the electronic board to the sensor head and install the board on the new sensor head (see Fig. 2). It is important not to pull back the board from the main sensor enclosure to avoid signal cable damage.

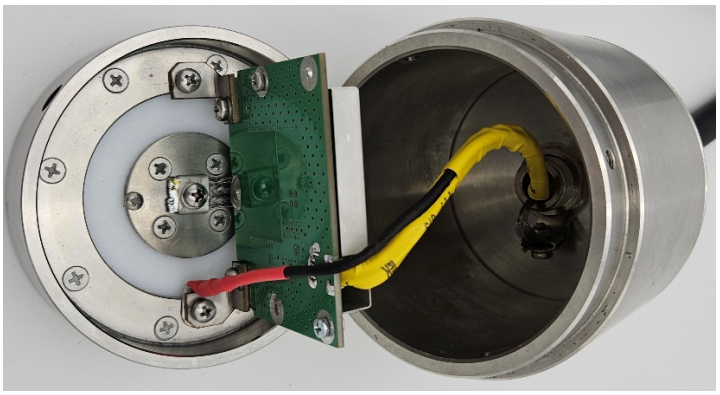


Figure 2.

3. Remove old sealant and use solvent to degrease the sensor surface. Apply new sealant to the M5 screw end and threaded portion. Hold in air in accordance with sealant application instructions. Assembly the sensor in reverse order. Use cloth to remove excess sealant.

4. Once all the procedures are completed, check sensor functionality and calibrate it "in air" in accordance with Section 5, Part 2 of the Operation Manual.

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

Replacement instruction for sensor head VIGT.415210.100-17.121

For replacing the sensor head VIGT.415210.100-17.121 on the sensor VIGT.415210.100-17.12, the following tools and materials are required:

1. Phillips head screwdriver (Ph2) – 1 pc
2. Sealant (e.g. silicone, but any other sealant is acceptable) – 1 pc
3. Solvent (acetone) – 1 pc
4. Cloth – 1 pc
5. Sensor cover (1) – 1 pc
6. Cover screwing wrench (3) – 1 pc
7. Alumina disk (4) – 1 pc
8. Caprolon gasket (5) – 1 pc

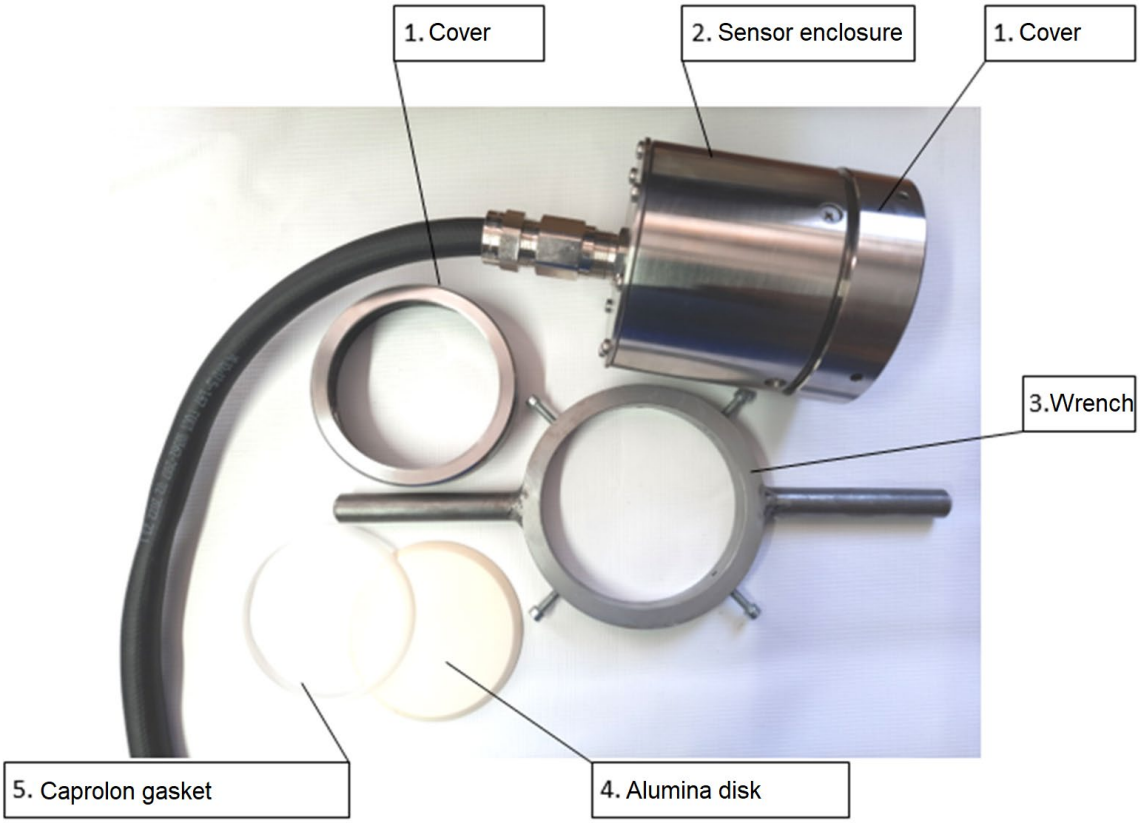


Figure 1

De-energize the electronic unit before the works. Follow the steps below to replace the sensor head:

1. Before any work, it is necessary to fix the sensor enclosure (2) and provide access to the cover (1) for unscrewing with an accessory wrench (3). For convenience, the sensor can be clamped in a vice with its cover (1) up. Fix the wrench (3) on the cover (1) by tightening 4 screws into dedicated holes in the cover (1).

2. Unscrew the cover (1), remove the damaged disk (4). Clean the sensor surface from sealant and any cement residues and degrease mating surfaces of the sensor with acetone, alcohol or any other degreasing agent.

3. Prepare a new gasket (5) and a ceramic disk (4). The order of assembly is shown in Figure 2. Degrease the surfaces of the gasket (5), cover (1) and ceramic disk (4).

4. Fix the cover (4) in the wrench using screws, see Figure 5.

5. Apply sealant on the sensor surface (see Fig. 3) and distribute evenly in a ~1mm layer. Similarly, apply sealant (see Fig. 5) the surfaces of the ceramic disk (4), gasket (5) and cover (1).
   Wait 10-15 minutes until sealant begin to polymerize. If sealant begins to thicken and lose its "stickiness" earlier, then start coupling the parts.

6. Put the ceramic disk (4) on the sensor surface trying to avoid any air bubbles appearing between the disk and the sensor surface. Press the disk to the sensor by hand and squeeze out excess sealant by circular motions (see Fig. 6).

7. By holding it with the wrench (3), put the cover (1) with the gasket (5) on the sensor with the pressed disk (see Fig. 7). Gradually screw the cover (1) until tight.
   Make sure that there is no air gap between the conical surfaces of the cover (1) and ceramic disk (4). The gasket (5) must be distributed evenly without any misalignment and fit tight to both surfaces.

8. Remove sealant residues using solvent (acetone).
   The sensor is ready to use 24 hours after the assembly is finished.

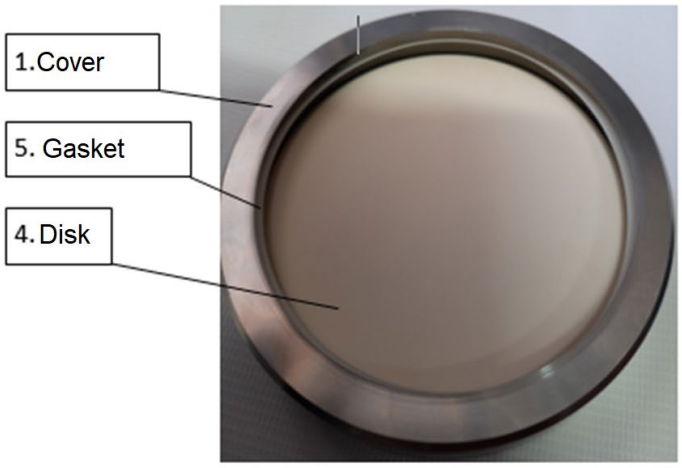


Figure 2

Figure 3

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

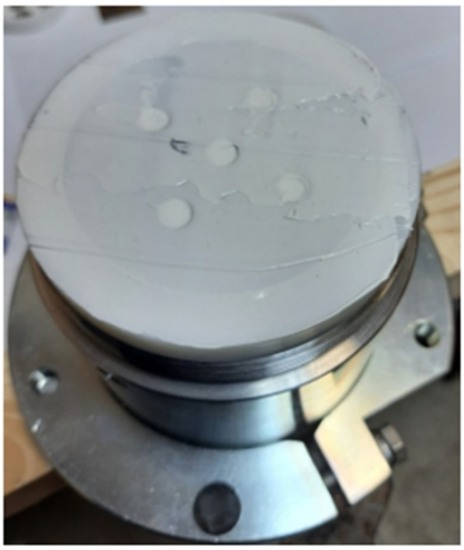


Figure 4

Figure 5

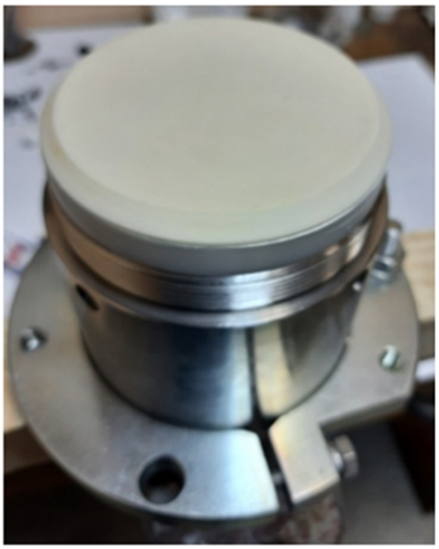


Figure 6

Figure 7

Conveyor application examples of moisture meters FIZEPR-SW100.17.12

Design Bureau Fizelektronpribor, Ltd.
Russia, Samara Tel. +7 (846) 925-63-53, +7 (846) 359-17-01, +7-927-778-79-34
E-mail: info@fizepr.ru Website: http://www.fizepr.ru

Measurement Reliability Evaluation Report

Sampling date and time	Material temperature, ˚C	Moisture measured with the moisture meter, %	Moisture measured in laboratory, %	Difference in readings, %	Remarks