INDICATOR OF ELECTRICAL MACHINES WINDINGS DEFECTS IDVI-05

Operating manual

IDVI-05.00.000.OM

1 Purpose

1.1 The indicator is designed to control the windings of electrical machines and provides checks as follows:

1) three-phase windings for the presence of turn-to-turn short circuits, phase failure and correctness of phase connection;

2) deterioration of turn-to-turn insulation of three-phase random windings;

3) coils of windings laid in grooves, and pole coils for the presence of turn-to-turn short circuits;

4) short-circuited rotors for the presence of bar breaks;

5) condition of winding insulation relative to the machine casing and between the windings.

1.2 The main consumers of indicators are the enterprises operating or repairing electrical machines with voltage up to 1000 V.

2 Operating data

1) testing parameters:

– when checking three-phase windings for the presence of turn-to-turn short circuits, phase failure and correctness of phase connection, deterioration of turn-to-turn insulation of three-phase random windings and pole coils for the presence of turn-to-turn short circuits	coefficient of difference of impulses of test voltage of phases (coils) ($К_{d1}$);
– when checking short-circuited rotors for the presence of bar breaks	coefficient of the maximum difference of impulses of test phase voltages when the rotor is cranking ($К_{d2}$);
– when checking coils of windings laid in grooves for the presence of turn-to-turn short circuits	current in the tested coil;
– when checking condition of winding insulation relative to the machine casing and between the windings	insulation resistance (R_i);

2) range under testing $К_{d1}$ and $К_{d2}$, % 0-99;

3) range under testing R_i, MOhm 0-500;

4) K_{d1} value when one turn is closed in a phase (coil) or K_{d2} when one bar is broken, %, not less — 10;

5) impulse testing voltage amplitude:
   – when checking three-phase windings for the presence of turn-to-turn short circuits, phase failure and correctness of phase connection, V — 340;
   – when checking deterioration of turn-to-turn insulation of three-phase random windings, V — 1000;
   – when checking short-circuited rotors for the presence of bar breaks and pole coils for the presence of turn-to-turn short circuits, V — 160;
   – when checking coils of windings laid in grooves for the presence of turn-to-turn short circuits, V/turn — 1;

6) output DC voltage when measuring R_i, V — 1000±100;

7) indication — LED;

8) power supply — autonomous or from external power supply;

9) supply voltage, V — $4^{+0,2}_{-1,0}$;

10) consumed power, W, no more — 4;

11) overall dimensions, mm — 205x80x50;

12) weight*, kg, no more — 0.4;

13) operating position — free;

14) external power supply parameters:
   – rated DC output voltage, V — 4;
   – rated output current, A — 1;
   – rated AC input voltage, V — 220.

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* weight with battery specified, delivery set weight – 0.81 ± 0.05 kg.

3 Delivery set

1) IDVI–05, pcs. 1;
2) battery (Li-ion, 14500 type), pcs. 2;
3) power supply BPID-3, pcs. 1;
4) connecting cable with three clamps, pcs. 1;
5) connecting cable with two clamps, pcs. 1;
6) induction sensor, pcs. 1;
7) connecting wire, pcs. 2;
8) operating manual, copy 1;
9) case, pcs. 1.

4 Indicator structure and functioning

4.1 Indicator design (Fig. 4.1, 4.2)

Structurally the indicator is made in the form of a portable device, the plastic case of which consists of two parts, tightened with rubber edging.

There is a seven-segment three-digit display and LEDs, as well as inscriptions explaining the purpose of the indicator buttons on the front side of the casing.

There are sockets: «  » – to connect the connecting cables to indicator or induction sensor and «**1000 V**», «  » – to connect the connecting wires to indicator on the top wall of the casing.

There are two buttons: «  » – to turn on / off the indicator - and «**Enter**» - to control the indicator on the left side of the casing.

There is a socket «**4V, 1A**» – to connect to the external power supply BPID-3 (hereinafter referred to as «power supply») on the right wall of the casing.

On the back side of the case there are inscriptions explaining the purpose of the indicator sockets and containing basic information about it.

Inside the case there is a printed circuit board with elements of the indicator circuit and an accumulator battery (hereinafter referred to as «battery»).

General view of IDVI-05 indicator

Fig.4.1

Accessories to IDVI-05 indicator

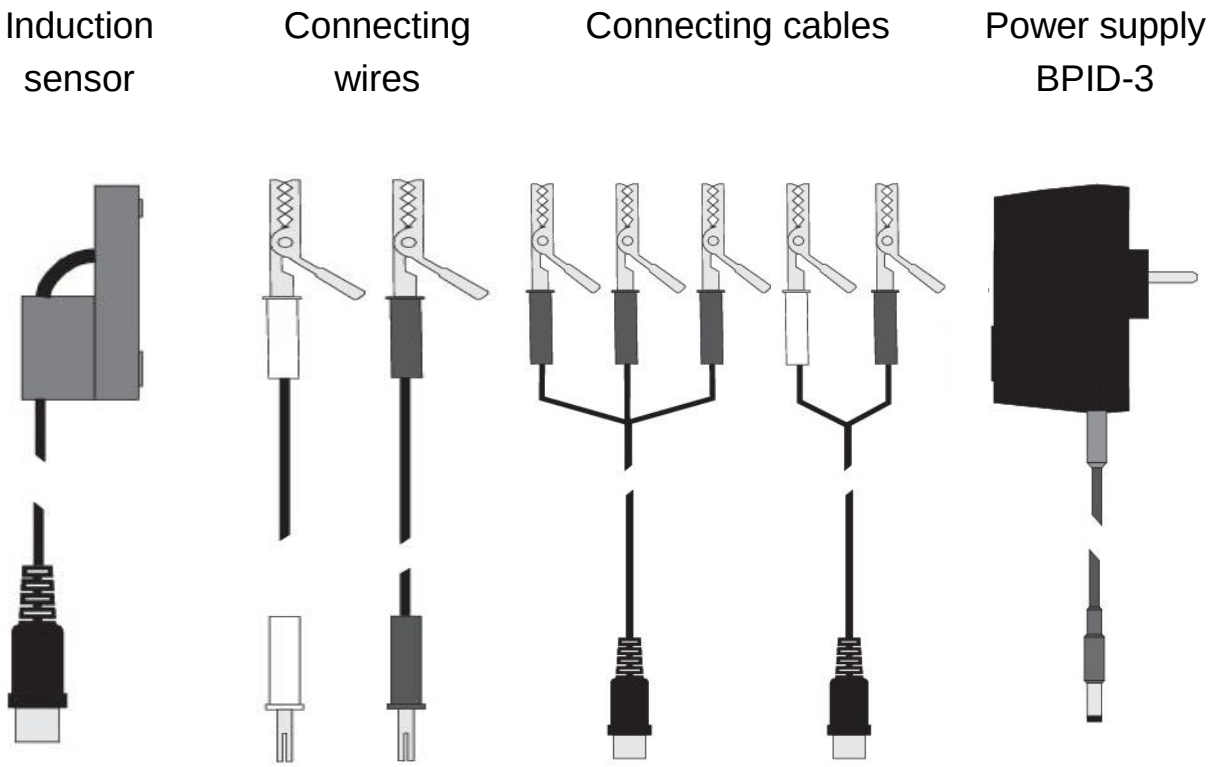

Fig.4.2

4.2 Principle of indicator operation

4.2.1 When checking three-phase windings for the presence of turn-to-turn short-circuits, phase failure and correctness of the phase connection, pole coils for the presence of turn-to-turn short-circuits and deterioration of the turn-to-turn insulation of three-phase random windings, the integral estimates of damped oscillatory test voltage pulses generated during discharge of the capacitor at clamps of phases (coils) are compared:

$$I_i = \int_0^{\infty} |u_i(t)|\,dt,$$

where *i* – index of the tested phase (coil).

In the presence of defects in the phase (coil), the corresponding integral es timate will be less than the integral estimate corresponding to the good phase (coil). The degree of this difference is set by the value of the difference coefficient of impulses of test voltages of phases (coils) K_{d1i}:

$$K_{d1i} = \frac{I_{max} - I_i}{I_{max}} * 100\%,$$

where I_{max} – the maximum of the values of the integral estimates I_i.

4.2.2 When checking short-circuited rotors for the presence of bar breaks, one revolution of rotor is made manually at speed of about 1 rpm and at intervals of 0.5 s integral estimates of decaying oscillatory pulses of the test voltage generated during the discharge of the capacitor at the terminals of one of the phases of the stator of the induction motor are determined at different positions of rotor relative to stator.

If there are breaks in the rotor bars, the corresponding integral estimates will differ. The degree of this difference is set by the value of the coefficient of the maximum difference between the impulses of the test voltages of the phase K_{d2}:

$$K_{d2} = \frac{I_{max} - I_{min}}{I_{max}} * 100\%,$$

where I_{max} and I_{min} – maximum and minimum integral estimates obtained for one revolution of rotor.

4.2.3 When checking the coil of winding, laid in the grooves, for the presence of turn-to-turn short-circuits, a pulse EMF with amplitude of 1V / turn is induced in it. In case of the presence of short-circuited turns in the coil, the pulse of magnetic induction of the field created by short-circuit current flowing through them is recorded.

4.2.4 When checking condition of the insulation of windings with respect to the machine casing and between the windings, a DC voltage is applied to the winding, the value of the insulation resistance is determined and the latter is compared with the threshold value (0.5 MOhm).

5 Safety measures

5.1 The indicator casing has the following signs:

«  » Attention! Read this manual before using the indicator.

«  » Attention! Dangerous voltage is generated at the clamps of connecting cables and wires.

5.2 The windings of the testing machine should be de-energized.

5.3 When using a connecting cable with three clamps, do not touch the clamps while the indicator is operating.

5.4 When using a connecting cable with two clamps, do not touch the clamps when the display shows flashing symbols «≡».

5.5 When using connecting cables the intermittent sound signal warns of formation of test voltage pulses at their clamps.

5.6 When checking the insulation condition of windings relative to the machine casing and between the windings turn off the protection devices (if any) and do not touch the clamps of the connecting wires. After its completion, the windings should be discharged to the grounded machine frame.

6 Prestarting procedure

6.1 Carry out visual examination of the indicator.

6.1.1 Check out completeness in accordance with a delivery set.

6.1.2 Ensure that there is no external damage to casing, connecting cables, induction sensor cable and connecting wires.

6.2 Check indicator power supply.

6.2.1 Turn on indicator by pressing the button «⏻». In this case, after indicating the battery charge level («**I I I I I I**» – maximum level, «**_ _ _ _ _ I**» – minimum) the reading «**500**» and green LED will light up.

If the reading «**LO**» appears and the green and red LEDs flash, then the battery needs to be charged. For this:

1) turn off indicator by pressing the button «⏻»;

2) connect the power supply to indicator (see Fig. 4.1, 4.2);

3) turn on the power supply into the AC 220 V, 50 Hz. In this case, the LEDs «~» and «**Charge»** will light up on the case of power supply unit. The end of the battery charge is indicated by switching off the «**Charge»** LED;

4) disconnect the power supply from the indicator and from the mains.

Note

1. The battery should be charged only with the power supply included into a delivery set.

2. The battery is also charged when the indicator is operating from the power supply.

6.2.2 Turn off the indicator by pressing the button «⏻».

7 Operation procedure

7.1 Three-phase winding checks for the presence of turn-to-turn short circuits, phase failure and for correctness of phase connection, and deterioration of the turn-to-turn insulation of three-phase random windings

7.1.1 Briefly short-circuit the three-phase winding to the machine casing!

7.1.2 Connect the connecting cable with three clamps to the indicator (see Fig. 4.1, 4.2).

7.1.3 Connect the connecting cable using clamps «**A**», «**B**» and «**C**» to the terminals of the three-phase winding of the machine. In this case, the phases should be connected according to the connection diagram for this machine (as star or delta).

7.1.4 Turn on the indicator. In this case, after indication of the battery charge level, the reading «**AbC**» and the green LED will light up.

If instead of one of the symbols «**A**», «**b**» or «**C»**, the symbol «**–**» appears and the red LED lights up, this indicates the break of the corresponding phase and there is no need to follow the further recommendations of clauses 7.1.5 - 7.1.14.

Note

Possible conditions and defects of the winding and options for their indication are given in Table.7.1.

7.1.5 Press the «**Enter**» button. In this case the symbol «**A**» and the value K_{d1} (roughly) will appear at amplitude of the test voltage pulses Um = 340 V for the phases to which the clamps «**b»** and «**C»** of the connecting cable are connected.

Note

When checking the stator winding of the assembled machine, the value of K_{d1} is also affected by unevenness of the air gap and rotor defects. To exclude these factors, before each measurement of K_{d1} (exactly), slowly turning the rotor (at speed of approximately 1 rpm) find its position at which the minimum value of K_{d1} (roughly) is observed.

7.1.6 Press «**Enter**». In this case, next to the symbol «**A**», the symbols «**--**» will blink, indicating the presence of test voltage pulses with amplitude of Um = 340 V on the phases of the winding, and after 5 seconds the value of K_{d1} will change (exactly) at Um = 340 V and a green or red LED will light up.

If the red LED lights up, the indicator automatically switches to testing the phases to which the clamps «**A**» and **«C**» of the connecting cable are connected with pulse voltage with amplitude of Um = 340 V, and execution of recommendations of clauses 7.1.7, 7.1.8 is excluded.

Note

K_{d1} values at Um = 340 V are followed by a dot on the display to distinguish them from the corresponding values at Um = 1000 V.

7.1.7 Press «**Enter**». In this case, next to the symbol «**A**», the symbols «**--**» will blink, indicating the presence of test voltage pulses with amplitude of Um = 1000 V on the phases of the winding, and after 5 seconds they will be replaced by the value of K_{d1} (exactly) at Um = 1000 V and a green or yellow LED will light up.

Table 7.1 Possible conditions and defects of the winding and options for their indication

Indicator readings	Condition or type of winding defect
1	2
AbC green LED	No phase loss
-bC **A-C** **Ab-** red LED	No phase loss
At Um=340 V: **A00** – **A09** **b00** – **b09** **C00** – **C09** green LED	No turn-to-turn short circuits. The phases are connected correctly.
At Um=340 V: **A00** – **A09** **b00** – **b09** **C00** – **C09** green LED _____ At Um=1000 V: **A10** – **A99** **b10** – **b99** **C10** – **C99** yellow LED	No turn-to-turn short circuits. The phases are connected correctly. Turn-to-turn insulation deteriorated
At Um=340 V: **A10** – **A99** **b10** – **b99** **C10** – **C99** red LED	Turn-to-turn short circuits. Incorrect phase connection
r00 – **r09**	No bar breaks
r10 – **r99**	Rotor bars are broken

Table 7.1 continued

1	2
green LED	No turn-to-turn short circuits
red LED	Turn-to-turn short circuits
A00 – **A09** . . . **L00** – **L09** green LED	No turn-to-turn short circuits
A10 – **A99** . . . **L10** – **L99** red LED	Turn-to-turn short circuits
0.50 – **500** green LED	Insulation of windings relative to the machine casing and between windings in normal condition
0.00 – **0.50** red LED	Insulation of windings relative to the machine casing and between windings in poor condition

7.1.8 Press «**Enter**». In this case, the symbol «**b**» and the value of K_{d1} (roughly) will appear at amplitude of the test voltage pulses of Um = 340 V for the phases to which the clamps «**A**» and «**C**» of the connecting cable are connected.

7.1.9 Press «**Enter»**. In this case, next to the symbol «**b**», the symbols «--» will blink, indicating the presence of test voltage pulses with amplitude of Um = 340 V on the phases of the winding, and after 5 seconds the value of K_{d1} will change (exactly) them at Um = 340 V and a green or red LED will light up.

If the red LED lights up, the indicator automatically switches to testing the phases to which the clamps «**A**» and «**b**» of the connecting cable are connected, with a pulse voltage with amplitude of Um = 340 V and execution of recommendations of clauses 7.1.10, 7.1.11 is excluded.

7.1.10 Press «**Enter**». In this case, next to the symbol «**b**», the symbols «--» will blink, indicating the presence of test voltage pulses on the phases of

the winding with amplitude of Um = 1000 V, and after 5 seconds the value of K_{d1} will change (exactly) them at Um = 1000 V and a green or yellow LED will light up.

7.1.11 Press «**Enter**». In this case, the symbol «**C**» and the value of K_{d1} (roughly) will appear at amplitude of test voltage pulses of Um = 340 V for the phases to which the clamps «**A**» and «**b**» of the connecting cable are connected.

7.1.12 Press «**Enter**». In this case, next to the symbol «**C**» the symbol «--» will blink, indicating the presence of test voltage pulses on the phases of the winding with amplitude of Um=340 V, and after 5 seconds the value of K_{d1} will change (exactly) them at Um=340 V and a green or red LED will light up.

If the red LED lights up, the indicator automatically stops measurement K_{d1} (exactly) for the phases to which the clamps «**A**» and «**b**» of the connecting cable are connected, and execution of recommendations of cl. 7.1.13 is excluded.

7.1.13 Press «**Enter**». In this case, next to the symbol «**C**» the symbols «--» will blink, indicating the presence of test voltage pulses on the phases of the winding with amplitude of Um=1000 V, and after 5 seconds the value of K_{d1} will change (exactly) them at Um=1000 V and a green or yellow LED will light up.

7.1.14 Based on the values of the measured K_{p1} and glowing of LEDs, establish the presence or absence of turn-to-turn short-circuits in the winding, failed phase connection and evaluate deterioration of turn-to-turn insulation (see Table 7.1).

Note

The last measured values of K_{d1} for all pairs of winding phases can be repbaruced for the required number of times by pressing the button «**Enter**».

7.1.15 Turn off the indicator.

7.1.16 Disconnect connecting cable from the indicator.

7.2 Checking of short circuited rotors for the presence of bar breaks

7.2.1 Connect the connecting cable with two clamps to the indicator (see Fig. 4.1, 4.2).

7.2.2 Connect the connecting cable using clamps to the terminals of one of the phases of the three-phase stator winding.

Note

If it is not possible to connect the connecting cable to the terminals of one phase of the motor, you can connect it to the beginning of two phases. In this case, the indicator sensitivity will be reduced twice and all its readings should be multiplied by 2.

7.2.3 Turn on the indicator. In this case «**r-r**» reading will appear after indication of the battery charge level.

7.2.4 Press the button «**Enter**». In this case the symbol «**r**» and blinking symbols «**--**» will be displayed.

7.2.5 Slowly (at speed of approximately 1 rpm) rotate the rotor by one revolution.

7.2.6 Press «**Enter**». In this case the symbol «**r**», the value of the coefficient K_{p2} and green or red LEDs will light up.

7.2.7 According to the indicator readings, establish the fact of presence or absence of bar breaks in the short-circuited rotor (see Table 7.1).

7.2.8 Turn off the indicator.

7.2.9 Disconnect the connecting cable from the indicator.

7.3 Checking the coils of windings laid in grooves for the presence of turn-to-turn short circuits.

7.3.1 Connect induction sensor to the indicator
(see Fig. 4.1, 4.2).

7.3.2 Turn on the indicator. In this case, after the battery charge level is indicated, the reading «**- - -**» and green LED will light up.

7.3.3 Positioning the induction sensor along the axis of the groove and pressing it tightly against the surface of the core stack, alternately «pass» through all the grooves. In case of detection of a coil with short-circuited turns, the intermittent sound signal will appear, a flashing reading «**⊏⊐**» will be displayed and red LED will light up.

7.3.4 Turn off the indicator.

7.3.5 Disconnect the induction sensor from the indicator.

7.4 Checking pole coils for the presence of turn-to-turn short circuits

7.4.1 Connect the connecting cable with two clamps to the indicator (see Fig. 4.1, 4.2).

7.4.2 Connect the connecting cable using clamps to the terminals of the first tested coil («**A**»).

7.4.3 Turn on the indicator. In this case «**r-r**» reading will appear after indication of the battery charge level.

7.4.4 Press «**Enter**» for a long time (more than 2 s). In this case, reading «**nP2**» will light up, which displays the number of poles of the machine set in the memory of the indicator, equal to two. If you need to change it, you should press «**Enter»** for the required number of times.

7.4.5 Press «**Enter**» button for a long time. In this case the value of the first tested coil («**A**») will be displayed.

7.4.6 Press «**Enter**». In this case, blinking symbols «≡» will appear, indicating the presence of test voltage pulses at the terminals of coil **A**. After removing the test voltage, «**b**» reading is displayed**.**

7.4.7 Connect the connecting cable with clamps to the terminals of the next tested coil.

7.4.8 Press «**Enter**» and wait for the next reading («**C**», «**d**», «**E**», «**F**», «**H**», «**L**» or «**End**»).

7.4.9 If the indicator shows «**End**», then follow the recommendations of cl. 7.4.10, and if «**C»**, «**d**», «**E**», «**F**», «**H**», «**L**» follow cl. 7.4.7, 7.4.8.

7.4.10 By pressing «**Enter**» in turn, follow the values of the coefficients K_{d1} according to the indicator readings for all the tested coils.

7.4.11 According to the indicator readings, establish the fact of presence or absence of turn-to-turn short-circuits in the coils (see Table 7.1).

7.4.12 Turn off the indicator.

7.4.13 Disconnect the connecting cable from the indicator.

7.5 Checking the condition of insulation of the windings relative to the casing and between the windings

7.5.1 Connect the connecting wires to the indicator (see Fig. 4.1, 4.2).

7.5.2 Connect «**1000 V**» clamp to one of the windings, and «⏚» clamp to the casing of the machine.

7.5.3 Turn on the indicator. In this case, after indication of the battery charge level, the R_i value and green or red LED will light up.

7.5.4 According to the indicator readings evaluate the conditions of insulation of the winding relative to the machine casing and between the windings (see Table 7.1).

7.5.5 Turn off the indicator.

7.5.6 Disconnect the connecting wires from the indicator.

8 Indicator operability control

8.1 Connect the connecting cable with three clamps to the indicator and close its clamps «**A**», «**b**» and «**C**» together.

8.2 Turn on the indicator. In this case after indication of the battery charge level, «**AbC**» reading and green LED will light up.

8.3 Press the «**Enter**» button twice. In this case 5 s after «**A--**» reading appears, «**A00.**» reading and green LED will light up.

8.4 Press «**Enter**». In this case 5 s after «**A--**» reading appears, «**A00**» reading and green LED will light up.

8.5 Press «**Enter**» twice. In this case 5 s after «**b--**» reading appears, «**b00.**» reading and green LED will light up.

8.6 Press «**Enter**». In this case 5 s after «**b--**» reading appears, «**b00**» reading and green LED will light up.

8.7 Press «**Enter**» twice. In this case 5 s after «**C--**» reading appears, «**C00.**» reading and green LED will light up.

8.8 Press «**Enter**». In this case 5 s after «**C--**» reading appears, «**C00**» reading and green LED will light up.

8.9 Turn off the indicator.

8.10 Disconnect the connecting cable from the indicator.

8.11 Connect the connecting cable with two clamps to the indicator and close its clamps together.

8.12 Turn on the indicator. In this case «**r-r**» reading will appear after indication of the battery charge level.

8.13 Press «**Enter**». In this case the symbol «**r**» and blinking symbols «**--**» will appear.

8.14 Press «**Enter**» again after 20 seconds. In this case, «**r00**» reading and green LED will light up.

8.15 Turn off the indicator and turn it on again. In this case, after indication of the battery charge level, «**r-r**» reading will be displayed.

8.16 Press «**Enter**» for a long time. In this case «**nP2**» reading will appear.

8.17 Press «**Enter**» for a long time. In this case «**A**» reading will appear.

8.18 Press «**Enter**». In this case, blinking symbols «  » will appear, indicating the presence of test voltage pulses on the terminals of coil **A**. After removing test voltage, «**b**» reading will light up.

8.19 Press «**Enter**». In this case, blinking symbols «  » will appear, and after their disappearance – «**End**» reading.

8.20 Press «**Enter**» twice. In this case after the first press «**A00**» reading will light up, and «**b00**» will appear after the second press.

8.21 Disconnect the connecting cable from the indicator.

8.22 Connect the induction sensor to the indicator.

8.23 Make a short-circuited turn from a piece of insulated wire and lay it on one side in the groove of the unwound stator or the unwound rotor of any machine.

8.24 Turn on the indicator. In this case, after indication of the battery charge level, «  » reading should be displayed.

8.25 Place the induction sensor along the axis of the groove with short-circuited turn, pressing it firmly against the surface of the core stack. In this case, the intermittent sound signal and a flashing reading «  » will appear and red LED will light up.

8.26 Open the short-circuited turn. In this case, the sound signal should stop, and «  » reading will change to «» reading.

8.27 Turn off the indicator.

8.28 Disconnect induction sensor from the indicator.

8.29 Connect the connecting wires to the indicator.

8.30 Turn on the indicator. In this case after indication of the battery charge level, «**500**» reading and green LED will light up.

8.31 Turn off the indicator.

8.32 Close the clamps of the connecting wires to each other.

8.33 Turn on the indicator. In this case after indication of the battery charge level «**0.00**» reading and red LED will light up.

8.34 Turn off the indicator.

8.35 Disconnect the connecting wires from the indicator.

8.36 The indicator is operative if all the requirements of Section 8 are met.

9 Typical malfunctions and methods of their elimination

Form of malfunction and its event	Probable reason	Remedy
1. When the clamps of the connecting cable with three clamps are short-circuited, the indicator gives «**-bC**», «**A-C**» or «**Ab-**» reading	Connecting cable breakdown	Find the breakdown point and restore contact
2. When the clamps of the connecting cable with two clamps are short-circuited, the indicator gives «**brE**» reading	Connecting cable breakdown	Find the breakdown point and restore contact
3. The indicator does not respond to the simulated short-circuited turn	Breakdown of induction sensor cable	Find the breakdown point and restore contact

10 Operating and storage conditions

10.1 Temperature range operation: -10°C to + 40°C (+14°F to +112°F).
10.2 Temperature range storage: -20°C to + 50°C (-4°F to +122°F).
10.3 Humidity: 0-80% relative humidity, non-condensing.

11 Acceptance certificate

The indicator IDVI-05 No. _____ corresponds to TU U14105464.005-97 and is classified as fit for operation.

Head of QC Department

Place of Seal _____ _____

Personal signature Full name

_____

Date

12 Warranty liabilities

12.1 The manufacturer guarantees the indicator performance if the owner observes the operating rules set out in the operating manual.

12.2 The warranty period is 24 months from the date of sale.

12.3 During the warranty period, the manufacturer undertakes to repair or replace the indicator free of charge. If the indicator fails, contact the manufacturer.

Date of sale _____