2017.05.16

MSG MS014

TESTER FOR DIAGNOSTICS OF STATOR WINDINGS AND DIODE BRIDGES

USER MANUAL

QUALITY WARRANTY INNOVATION SERVICE TRAINING UNIQUENESS

CONTENTS

1. DESCRIPTION

Tester MSG MS014 is used for diagnostics of stator windings and diode bridges. The device has small dimensions and a light weight, it was developed according to the requirements of actual service stations. The feature of the tester is diagnostics of stator windings and diode bridges with no additional testing and measuring devices.

Diagnostics of stator windings is carried out through automatic identification of phase connection, detecting winding integrity and measuring the difference in phase distortion. The device detects the following stator winding failures:

- inter-turn fault;
- inter-winding fault;
- winding breakdown to alternator body;
- open-phase fault.

Diagnostics of diode bridges involves establishing of circuit connection of diodes and measuring their operability. Diagnostic mode data appear on LCD display in real time. Stator or diode bridge testing lasts less than a minute.

2. TECHNICAL CHARACTERISTICS

Supply voltage, V	100-250
Supply frequency, Hz	50/60
Supply type	Single-phase
Maximum consuming power, W	40
Dimensions, mm	219*214*80
Weight, kg	3
Stator windings testing	
Voltage, V	12/24
Types	‘Star’, ‘delta’
Detected failures	- Inter-turn fault - Inter-phase fault - Phases to alternator body - Open-phase fault
Error of measurement, %	1-3
Testing of short circuit to the body, kOhm	12
Diode bridges testing	
Voltage, V	12/24
Current, A	30 (Pulse current)
Detected failures	- Breakdown - Open circuit

3. CONTROL UNITS

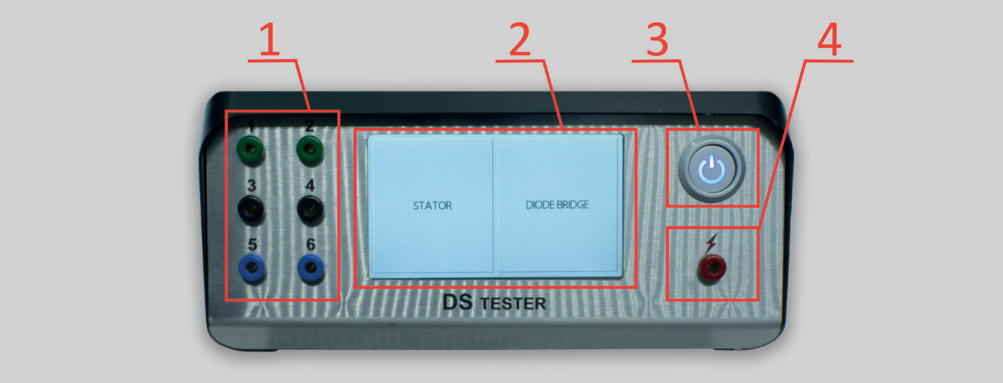

Fig. 1. MS014 Tester – Front panel

The tester is performed in black metallic frame with inclined front panel, made of stainless steel. The front panel **(Fig.1.)** consists of:

1 - connection ports to connect tested stator windings or diode bridges and stator windings through 1-6 connecting cables (included in the tester set);

2 - colored LCD **display**;

3 - tester **on/off switch**;

4 - connection port to detect insulation resistance level of stator windings.

Fig. 2. MS014 Tester – Back panel

The back panel **(Fig. 2)** consists of:

1 - mains cable connection slot;

2 - fuse (2A).

4. TESTING OF STATOR WINDINGS

4.1 General Information

Stator is a fixed element of electric unit, interacting with its moving part, the rotor. It consists of magnetically conductive core with coil windings fixed circle-wise.

Rotating inside of the stator, the rotor generates alternating current in it. The frequency of generated alternating current equals the rotor frequency, multiplied by the number of poles (usually 6).

Description of alternator stator winding **(Fig. 3)**:

1 - winding terminals, phases: A, B, C;

2 - stator winding;

3 - magnetically conductive core.

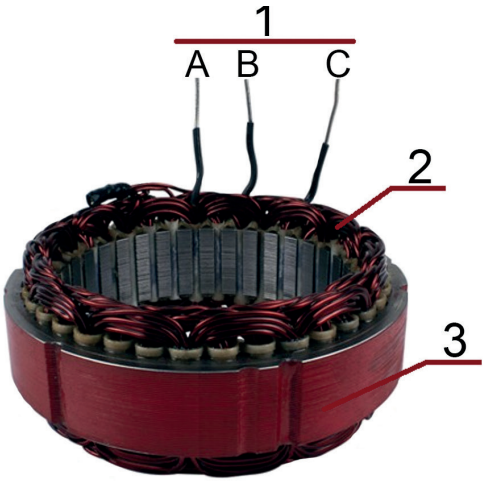

Fig. 3. Description of alternator stator winding

Three-phase stator winding consists of three separate windings, called phase windings or simply phases, wound in a certain order on the magnetic core. Current phases in the windings are displaced by one third of a period respectively one another, i.e. by 120 degrees **(Fig. 4)**.

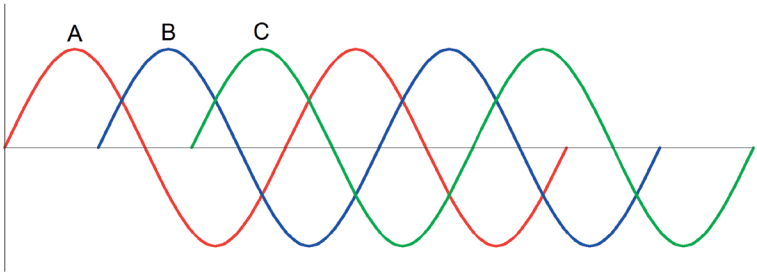

Fig. 4. Alternator stator winding phase displacement

Phase winding can be connected through 'delta' **(Fig. 5, to the left)** or 'star' diagram **(Fig. 5, to the right)**:

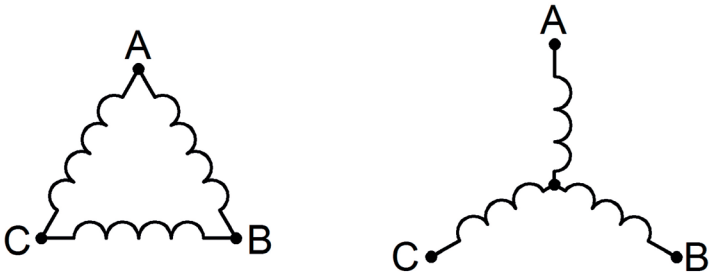

Fig. 5. Winding connection types

The windings are placed into steel frame slots, the magnetic core, to conduct magnetic flow from the exciting winding to the stator windings directly and to reduce area dissipation of magnetic flow. Magnetic field is created both in coils and stator magnetic core, thus, parasitic eddy currents appear, causing loss of power and stator heating.

Thus, the magnetic core is produced from the set of steel plates (laminated iron) to reduce the effect.

Several types of stator windings are presented below.

Fig. 6. Stator, windings are connected through ‘delta’ diagram

Fig. 7. Stator, windings are connected through ‘star’ diagram

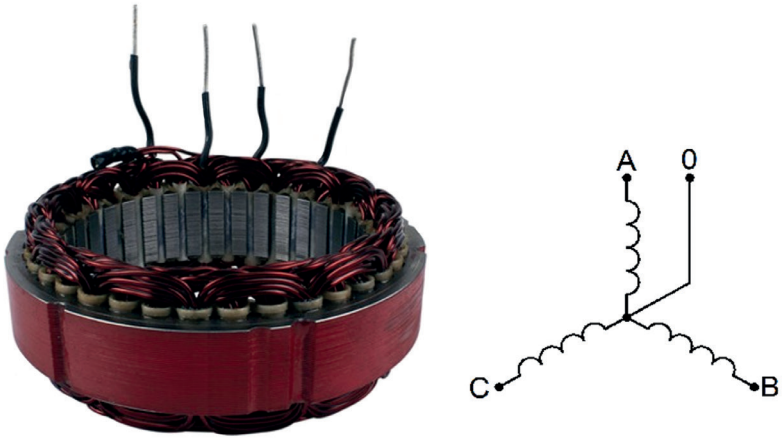

Fig. 8. Stator, windings are connected through 'star' diagram with center point

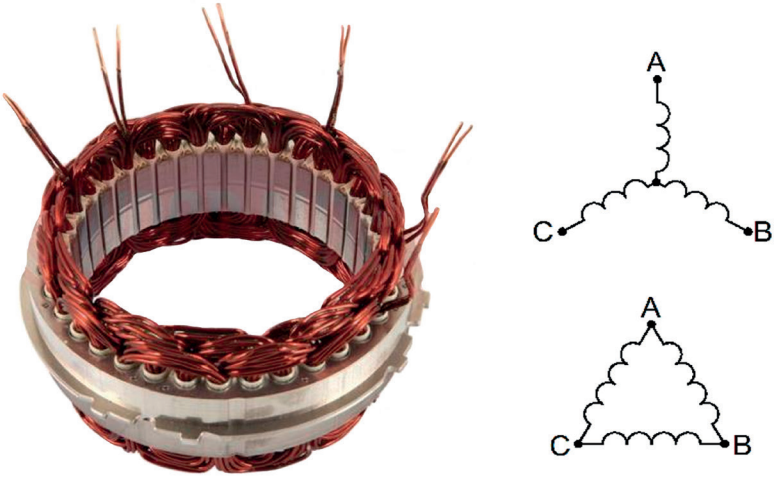

Fig. 9. Stator, windings are connected through 'star' or 'delta' diagram with jumpers in alternator diode bridge

4.2 Stator Windings Most Common Failures

- Inter-turn fault (single-phase short circuit):

a) alternator overload – alternator operation mode, when alternator current exceeds the limit, thus, stator windings overheat. Overheating causes damage of winding insulation, thus, inter-turn fault arises;

b) short circuit due to mechanical damage of the stator;

c) manufacturing defect of winding laying, or its unsatisfactory winding sometimes occurs;

d) Incorrect use and storage of an alternator may cause moisture ingress into the unit, it may lead to inter-turn fault as well.

- Inter-phase fault (short circuit between phases):

Inter-phase fault may be caused by the same reasons as inter-turn fault.

- Open fault of one or several windings:

Mechanical damage and/or long corrosion process, caused by moisture, may be the reasons for the winding wire breakage.

- Phase to magnetic core fault:

The reasons of phase to magnetic core fault are the same as in case of inter-turn fault.

4.3 Stator Windings Testing Mode Operation

Connect the tester to AC socket that corresponds to the characteristics of the device.

Switch on the tester with **on/off switch (3)** on the front panel (the button is lightened, MSG logo trademark appears on the display).

Then select stator windings testing mode on the touch display by pressing the button **STATOR (Fig. 10).**

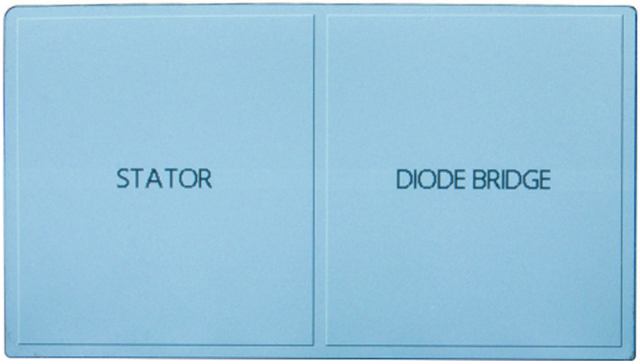

Fig. 10. MS014 Tester – Main Menu

Stator testing mode menu appears on the display **(Fig. 11)**.

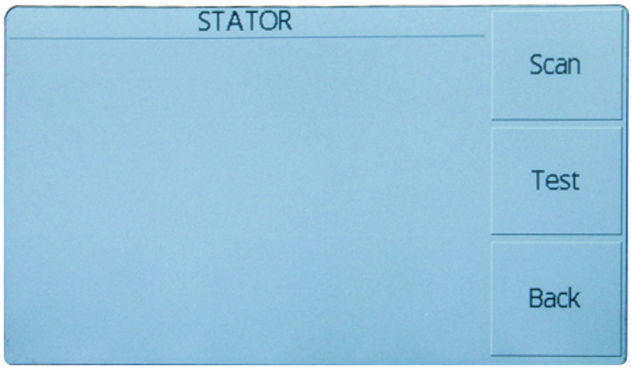

Fig. 11. Stator testing mode menu

Connect stator winding terminals to **1,2,3,4,5,6** connection ports. There is no need to observe polarity and order, the tester detects connected windings automatically.
In case when the stator has 3 outputs (connection diagram: 'star without center point' or 'delta'), connect any 3 cables (loose cables must be left disconnected and strictly isolated from each other and/or the stator), press **Scan**. Then the tester detects the number of connected windings which will be displayed on the screen as **Total Connections: (Fig. 12)** with the number of cables, connected to the windings.

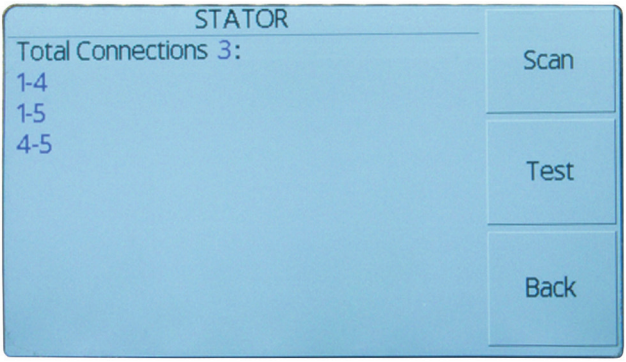

Fig. 12. Winding connection detection

In case when wire breakage is absent, 3 connections will be displayed on the screen. Otherwise, stator winding has open circuit.

Make sure that the 'crocodile' type connector contact to windings terminals is safe and of low ohmic resistance (on detecting connection of windings, pulse current exceeds 20A), otherwise, connection is not found.

In case when the stator has 6 outputs (connection diagram: 'star' or 'delta', commutating in alternator diode bridge), connect 6 cables and press **Scan**. The tester detects the number of connected windings which will be displayed on the screen as **Total Connections: (Fig. 13)** with the number of cables, connected to the windings.

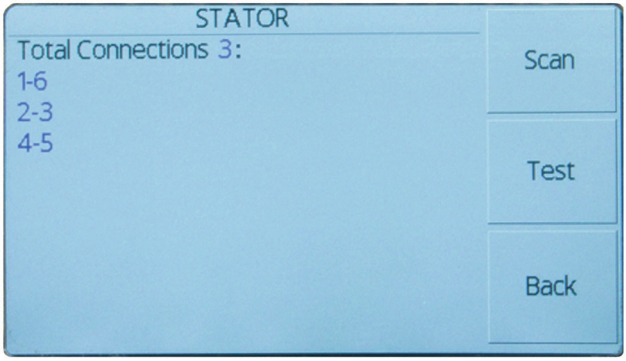

Fig. 13. Detection of phase connection in stator winding with separate phases

If phase windings are closed in regard to each other (which is one of the reasons of failure) in the process of detecting windings connection in **Scan** mode, the number of connections exceeds 6, the notification **Too many connections (Fig. 14)** appears on the display.

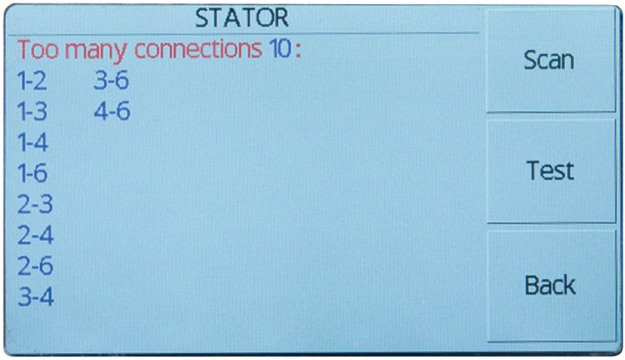

Fig. 14. Detection of phase connection with exceeded number of commutations

When 3 windings are found, press **Test** button.

The tester measures windings. The measured values **(Fig. 15)** are displayed on the screen, where:

- **Pins**: numbers of terminals to which the measured winding is connected;
- **Q, units**: winging inductance (displayed in nominal units);
- **Diff., units**: percentage difference between the measured values of winding inductance. The stator is considered to be faultless if the difference between the measured values does not exceed 10 percent (%);
- **Isol., kOhm**: insulation resistance. The value is indicated in kiloohm. The notification **norm** appears on the display when the winding is faultless. The notification **short** appears on the display in case of short circuit.

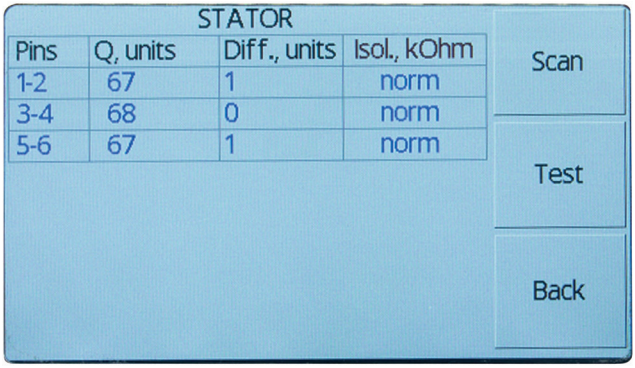

Fig. 15. Tested stator winding

CONCLUSION: Faultless stator winding. 1% difference between the phases which corresponds to the acceptable limits (10%). Satisfactory insulation winding.

⚠ **WARNING! After the results of measuring are displayed on the screen, to determine the insulation state, it is necessary to touch stator magnetic core with the probe for several seconds in the place free from varnish.**

When the tester detects short circuit of winding to stator magnetic core, the repeating signal sounds, the notification **short (Fig. 16)** appears in **Isol.** column in front of the corresponding connection.

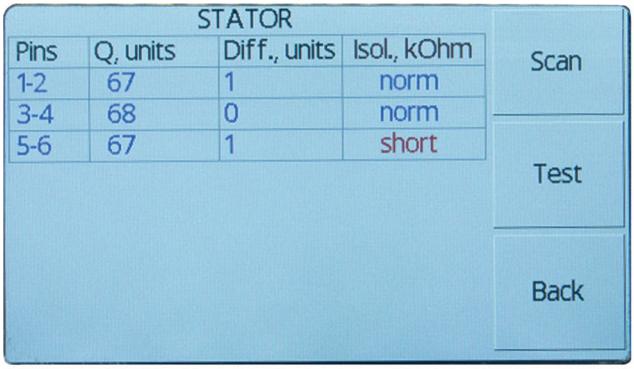

Fig. 16. Tested stator winding

CONCLUSION: Stator winding failure. 1% difference between the phases which corresponds to the acceptable limits (10%). Winding insulation is broken, **5-6** phase short circuited to the magnetic core body.

When the tester detects the decrease of winding insulation resistance to stator magnetic core (lower than 12 kOhm), resistance value in kiloohm is displayed in **Isol**. column in front of the corresponding connection.

On testing stator winding through 'star' diagram, connecting the center point to the tester outputs (4 tester cables must be connected), connection topology can be the same as in the **Fig. 17**.

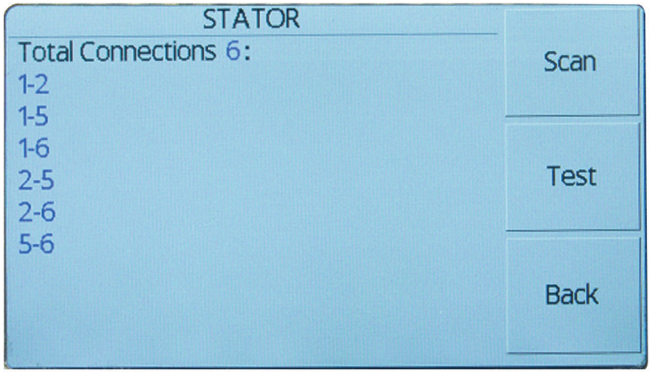

Fig. 17. Detection of phase commutation in stator winding 'star' with connected center point of phases

Such connection is not a fault, disconnect center point for convenience in estimation of measured values.

Further sequence of actions is the same as when testing the windings through 'star' diagram without center point. When measuring, the risk of losing contact with winding is possible. The notification **break (Fig. 18)** is displayed in the corresponding lines.

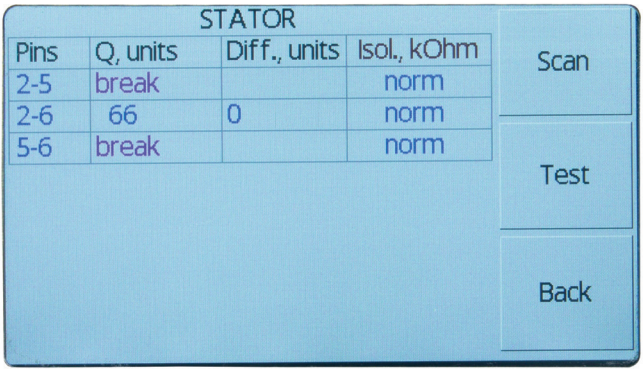

Fig. 18. Tested stator winding

CONCLUSION: The contact with **2-5** and **5-6** windings is lost.

The difference between measured values of windings, exceeding 10%, is the confirmation of stator failure **(Fig. 19)**.

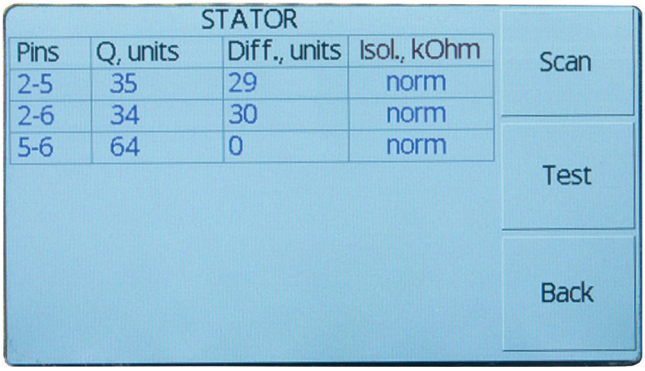

Fig. 19. Tested stator winding

CONCLUSION: Stator winding failure. The difference between phases exceeds 10%.

5. TESTING OF DIODE BRIDGES

5.1 General Information

Diode rectifier block on three parallel half-bridges (on six semiconductor diodes) converts three-phase alternating current of the stator into direct current (rather in unidirectional pulsating current) at the output of alternator unit.

A common diagram of rectifier on three parallel half-bridges is presented in the **Fig. 20.**

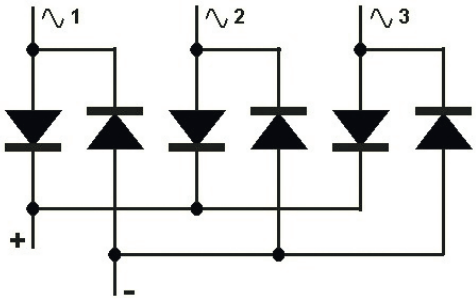

Fig. 20. Rectifier diagram

On increasing electrical consumers in modern cars, alternators are optimized for high current, up to 200-220A. As known, the voltage on P-N junction of diode in open state is about 0.7-1.0 V, which causes a big amount of heat generation. Heat sinks are used for cooling a diode bridge.

Alternator unit is exposed to contamination, overheat and overcooling as much as any other car unit, thus, alternator diodes are water-proof and protected from other reacting substances **(Fig. 21)**.

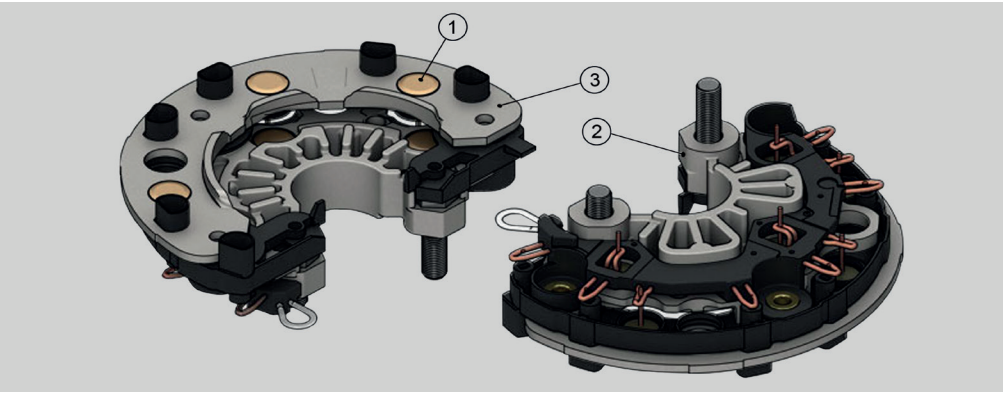

Fig. 21. Alternator diode bridge external view (BOSCH F00M133218)

Assembled alternator diode bridge is presented in the **Fig. 21** (F00M 33218 diode bridge, manufactured by BOSCH), where:

1 – alternator diodes

2 – positive heat sink

3 – negative heat sink

Diode bridges can be divided into 2 types by construction:

I) diodes are pressed (sometimes soldered) into rectifier heat sink plates;

II) diodes are soldered on heat sinks with ribbed surface.

To avoid a short circuit of aluminium heat sinks, plates are fully or partially covered with a layer of insulating material.

Stator winding terminals are welded/soldered or fixed with screw connection to specialized mounting faces of alternator diode bridge.

5.2 Diode Bridges Most Common Failures

The most common failures are:

• Short circuit of one or several diodes;

• Open circuit of one or several diodes, caused by mechanical damage, or prolonged exposure to corrosion;

• Short circuit of positive and negative heat sinks, caused by foreign metal objects, formations or contamination of current-conducting bridges.

5.3 Diode Bridges Testing Mode Operation

The device tests unidirectional conduction of diode bridge elements, connected through measuring cables, to detect failures. The testing is conducted by set current pulse. Both sides current-conducting diode bridge element is indicated as **SHORT CIRCUIT** on the display, increased resistance (semiconductor degeneracy) or non-conducting element is indicated as **OPEN CIRCUIT** on the display. Besides, on finishing the measurement, the tester restores the diode bridge topology (**B+, B-** and connection terminals of stator windings), if it is possible. Sometimes a diode bridge has a big amount of short-circuited elements and elements under open circuit, which gives no possibility to identify its topology. In such cases it is recommended to use the additional information (amount of short-circuited elements and elements under open circuit) on the display.

Press **DIODE BRIDGE** to enter the testing mode of diode bridges **(Fig. 10)**.

Diode bridges testing menu is displayed on the screen **(Fig. 22)**.

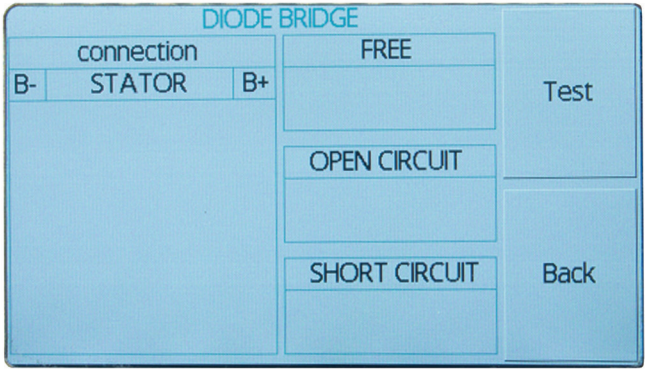

Fig. 22. Diode bridges testing menu

Description in the frames when testing diode bridges:

- **connection**: diode bridge topology display frame;
- **FREE**: disconnected measuring cables option frame;
- **OPEN CIRCUIT**: diode bridge elements under open circuit option frame;
- **SHORT CIRCUIT**: diode bridge short-circuited elements option frame;
- **Test**: button to start the measurement;
- **Back**: button to stop the measurement and return to the main menu.

Connect all the diode bridge leads to the tester through the required number of cables. There is no need to observe polarity and order, the tester detects connected windings automatically. Disconnected cables must be isolated from each other and diode bridge elements.

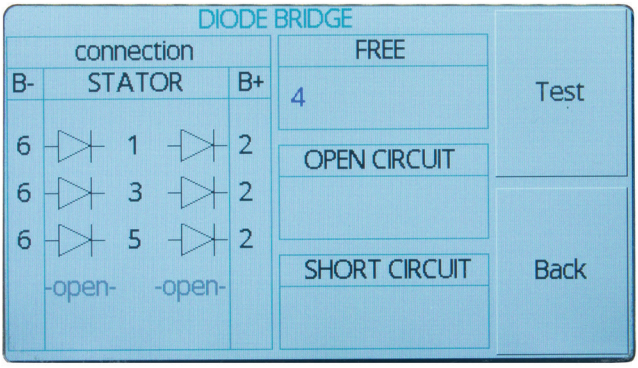

Fig. 23. Tested diode bridge

Then press **Test** button. The device tests the connected diode bridge and displays the results on the screen.
Faultless three-armed diode bridge testing is presented in the **Fig. 23**. Measuring cables 1,2,3,5,6 are connected, cable 4 is disconnected.

Faultless three-armed diode bridge testing is presented in the **Fig. 24**. The order of connected measuring cables was changed in comparison with the previous figure.

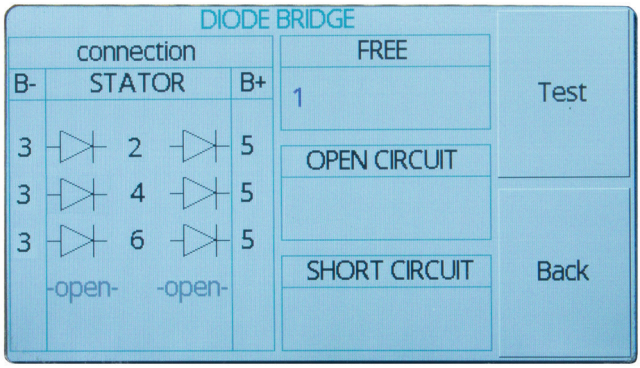

Fig. 24. Tested diode bridge

Testing of a diode bridge in failure (bus open circuit **B+**) is presented in the **Fig. 25**. The number of elements under open circuit is displayed in **OPEN CIRCUIT**.

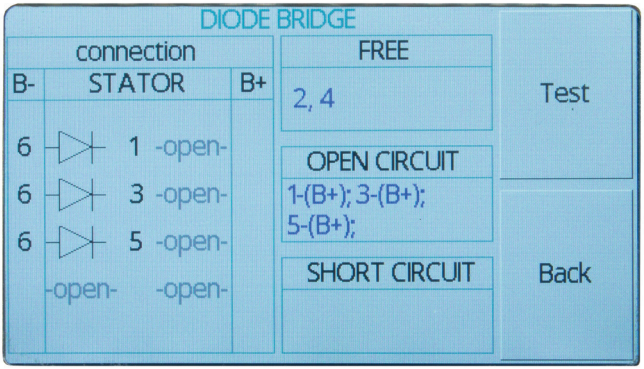

Fig. 25. Diode bridge in failure – open circuit

Testing of a diode bridge in failure (bus open circuit **B-**) is presented in the **Fig. 26**.

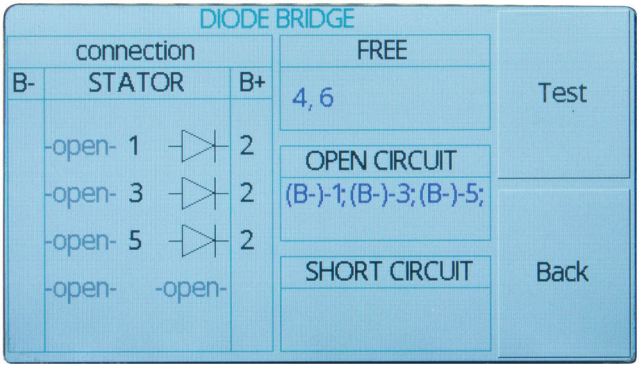

Fig. 26. Diode bridge in failure – open circuit

Testing of a diode bridge in failure (one element bus open circuit) is presented in the **Fig. 27**. Measuring cables, connected to the element under open circuit, are displayed in **OPEN CIRCUIT**.

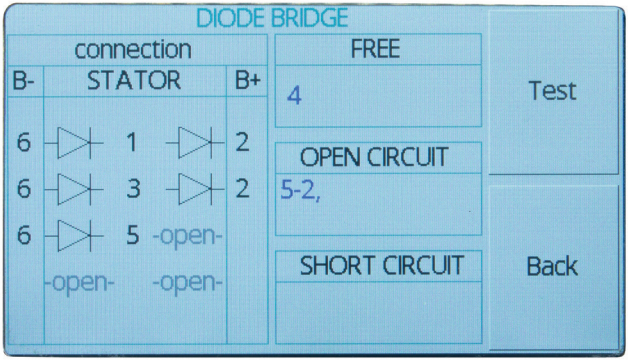

Fig. 27. Diode bridge in failure – open circuit

Testing of a diode bridge in failure (short circuit) is presented in the **Fig. 28**. Measuring cables, connected to short-circuited element, are displayed in **OPEN CIRCUIT**.

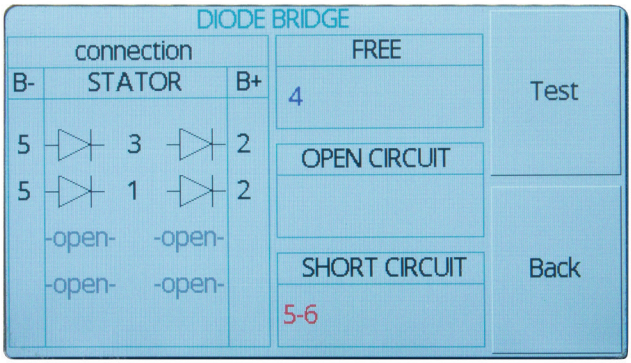

Fig. 28. Diode bridge in failure – short circuit

⚠ **WARNING! If a diode bridge has more than 6 leads (such diode bridge has purposely electrically connected leads, serving for commutation of stator windings into set diagram), closed leads must be detected, only one of them must be used for connection of measuring cables (only one lead out of a pair of closed leads).**

6. TEST CERTIFICATE

Tester MSG MS014 for diode bridges and stator windings meets technical requirements of Directive 2014/30/EU - Electromagnetic Compatibility (EMC) EN Directive 2014/35/EU - Low voltage (LVD) Directive 2006/42/EC - Machinery (MD) and is qualified for exploitation.


MSG
equipment