



TSH-008

OPERATIONAL MANUAL ON DIAGNOSTICS OF ALTERNATORS, STARTERS AND VOLTAGE REGULATORS



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INTRODUCTION

The present manual contains the description of the methods of evaluation of technical condition of automotive alternators, starters and voltage regulators at the bench TSH-008 (hereinafter “the bench”).

⚠ WARNING! Stremtec BV Netherlands is not responsible for any harm caused by the improper usage of equipment.

Test bench TSH-008 checks:

1. The technical condition of automotive alternating current alternators with rated voltage 12 and 24V under the load up to 150 and 75 A accordingly, including alternators of system «start-stop» 12V.
2. Automotive starters with power of 11kW with rated voltage 12 and 24 V, without load (at idle).
3. The performance capacity of 12/24V voltage regulators - separately from alternators.

The diagnostics of automotive alternators and voltage regulators takes into account the following criteria:

- Stabilizing voltage;
- control lamp working performance capacity;
- FR (displaying of the frequency and FR duty ratio, voltage regulator response).
- The AC pulsation value.

For COM alternator types (voltage regulators):

- ID;
- Protocol;
- data exchange speed;
- LIN protocol type;
- regulator self-diagnostics errors.

The diagnostics of the automotive starters considers the voltage changes nature and the currents on the terminals 30, 45 and 50.

1. TEST BENCH DESCRIPTION

The bench consists of the following main elements (fig. 1):



Figure 1. Overall view of test bench

1 – Unit fixing chain.

2 – Alternator drive belts: V-belts and poly V-belts.

3 – Protective housing. When the protective housing is up, the diagnostics will be blocked.

4 – Power cables **B+**, **B-**.

5 – Front panel.

6 – Battery location section.

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There are the following diagnostic cable connection ports on the front panel:



Figure 2. Bench front panel

1 – Connection ports used for diagnostics of voltage regulators:

- **B+** – voltage regulator positive (terminal 30 and terminal 15);
- **B-** – voltage regulator negative (earth, terminal 31);
- **ST1, ST2** – ports for voltage regulator stator inputs (terminals) connection: P, S, STA, Stator;
- **FLD1, FLD2** – ports for the connection of voltage regulator brushes or relevant terminals: DF, F, FLD.

2 – Port for the connection of diagnostic cable to the starter terminal 50.

3 – Diagnostic cable connection port.

4 – Touch screen - to display diagnostic parameters of a diagnosed unit and to control the bench functions.

5 – Buttons to control the tightening and loosening of alternator drive belt and unit fixing chain.

Button **OFF/ON** - is responsible for the power on the bench. The bench is turned off by pressing the button «Turn off the bench» in the main menu of the service program.

Button **EMERGENCY STOP** - emergency stop of generator drive and chain/belt tightening.

Test bench TSH-008

On the right side of the bench are two USB ports for connecting the computer periphery (mouse, keyboard, Wi-Fi adapter) and one HDMI port for connecting the monitor.



Figure 3. Connectors on the side panel of the bench:
1 – HDMI; 2 – USB

The bench supply slip includes the diagnostic cable (fig. 4) that consists of the adapting wire kit (fig. 5) - for more convenient connection to alternator connection terminals or voltage regulator.

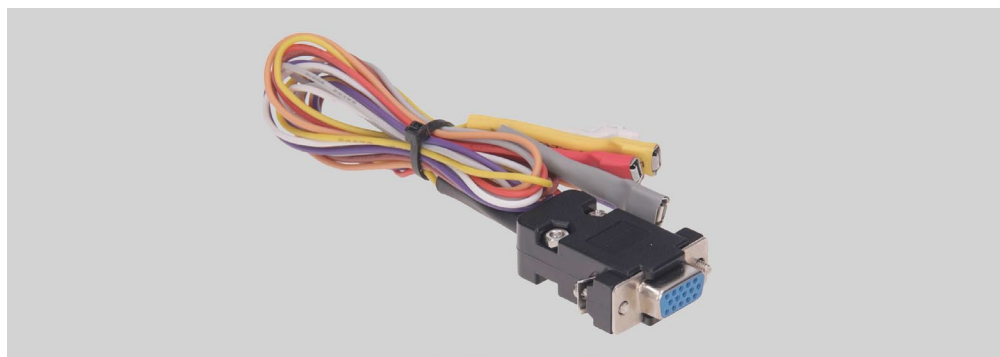


Figure 4. Diagnostic cable TSH-33001

The diagnostic cable MS-33001 has the following adapting wire color codes (see also Table 1):

- Orange - **S** (Sense Pin) - the terminal that enables the measuring of the storage battery voltage by the voltage regulator as well as it compares the storage battery voltage with the alternator output voltage. This adapting cable is connected to terminal S;
- Red - **IG** (Ignition) - the terminal is used for the connection of the ignition circuit, the terminals: 15, A, IG;








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- White – **FR** – the terminal that transmits the data on the regulator load. This adapting wire is connected to the following terminals: FR, DFM, M;
- Gray – **D+** – the terminal for the connection of the circuit of voltage regulator control lamp. It's connected to the terminals: D+, L, IL, 61;
- Yellow – **GC** – is used for the connection of the channel of alternator voltage regulator control. This adapting wire is connected to the following terminals: COM, SIG, etc;
- Brown – **K30** – is connected to the starter terminal 30 that is connected to the storage battery terminal +;
- Violet – **K45** – is connected to the starter solenoid output connected to starter electric motor.



Figure 5. Adapting wire kit

Table 1 – Colour codes of cable TSH-33001

Connector	Terminal
	S
	IG
	FR
	D+
	GC
	K30 (starter)
	K45 (starter)

Use the cable TSH-33001 and wire kit (fig. 6) to test the voltage regulators separately from alternator.

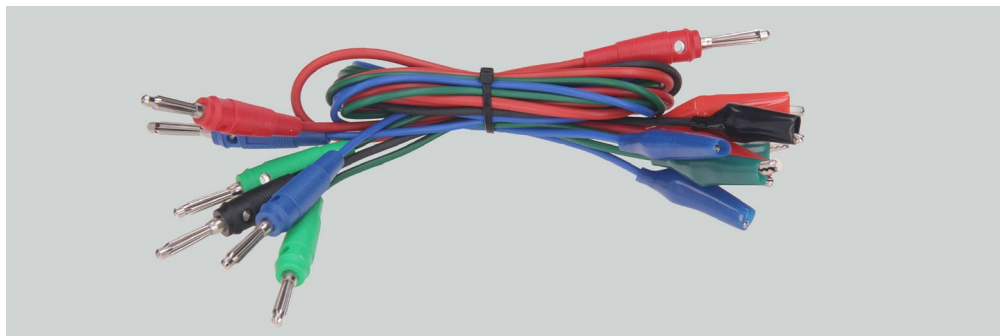


Figure 6. Wire kit for diagnostics of voltage regulators

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For the diagnostics of the starter, use the cable MS-33001 and the cable for the connection of the terminal 50 (fig. 7).



Figure 7. Cable for the connection of starter terminal 50

2. TEST BENCH MENU

The bench main menu (fig. 8) consists of:

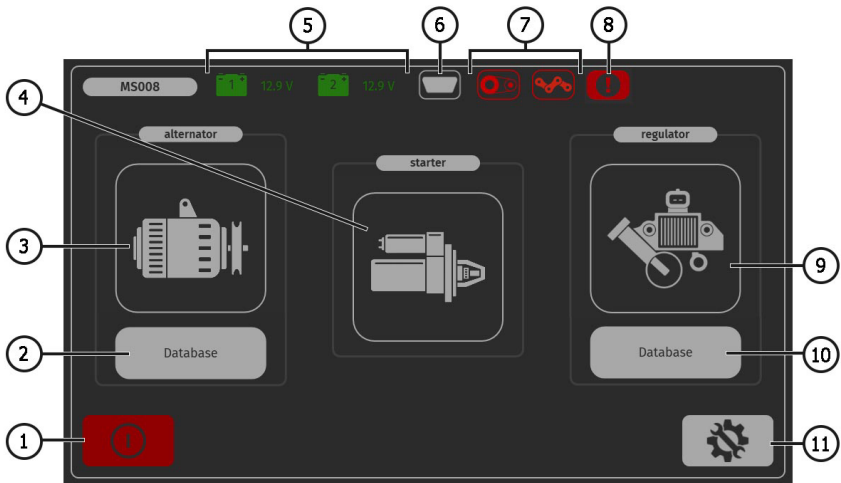


Figure 8. Bench main menu

- 1 – Bench **OFF** button.
- 2 – Button to enter alternator database.
- 3 – Alternator diagnostics activation button.
- 4 – Starter diagnostics activation button.

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5 – Information on the condition of the batteries connected to the bench.

6 – Indicator of the connected diagnostic cable.

7 – Indicator button for unit drive belt tightening and fixing chain tightening:

- red colour - belt/chain are not tightened;
- green colour - belt/chain are tightened.

Press to access the menu of belt and chain tightening control.

8 – Indicator button shows that the diagnostics cannot be performed. Press to open the window where you can read the reasons of blocking:

- protective housing is up;
- **EMERGENCY STOP** button is pressed.

9 – Voltage regulator diagnostics mode activation button.

10 – Button to transition the voltage regulator database.

11 – **SETTINGS** button – to enter bench settings menu.

In **SETTINGS** menu, you can change the program interface language only. The rest bench parameters can be set by the manufacturer specialists only.

⚠ WARNING! It's forbidden to modify any bench calibration data without professional help.

Once the mode of alternator diagnostics is activated, the menu for **choosing of the diagnosed alternator type** (fig. 9) that contains:

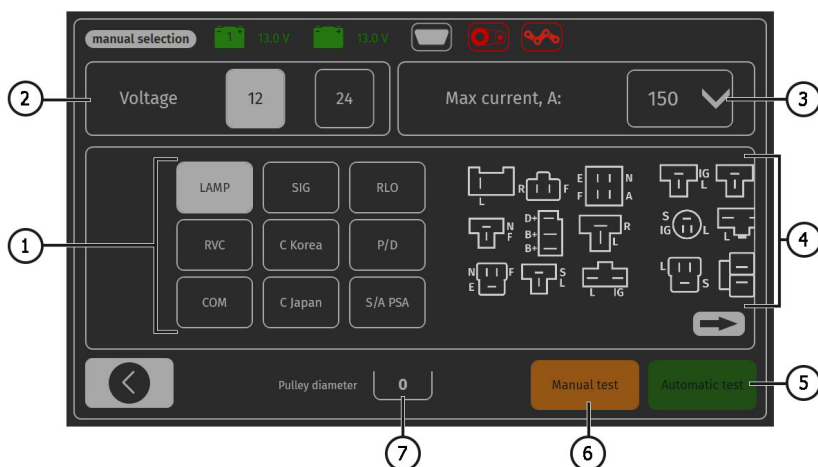


Figure 9. Menu for choosing of the diagnosed alternator type

1 – Diagnosed alternator type.

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2 – Rated voltage of the diagnosed alternator.

3 – Maximum current for the alternator diagnostics.

4 – Connector terminal references of the most popular alternator types for choosing the appropriate one for the diagnosed alternator.

5 – Button to switch to automatic diagnostic mode of selected alternator type.

6 – Button to switch to the manual diagnostic mode of the selected alternator type.

7 – Setting of the diameter value for alternator pulley. This parameter is set when the rotation rate during the alternator diagnostics has to be equal to the vehicle rotation rate.

Once the mode of voltage regulator diagnostics is activated, the menu for **choosing of the diagnosed voltage regulator** (fig. 10) that contains:



Figure 10. Menu for choosing of the diagnosed voltage regulator type

1 – Diagnosed voltage regulator type.

2 – Rated voltage of the diagnosed voltage regulator.

3 – Button to enter voltage regulator database.

4 – Connector terminal references of the most popular voltage regulator types for choosing the appropriate one for the diagnosed regulator.

5 – Button to get into the mode of the diagnostics of the chosen voltage regulator type.

3. APPROPRIATE USE

1. Use the bench for the specified purpose only.
2. Turning off the bench should be done through the interface of the service program by pressing the "**Turn off the bench**" button.
3. Press **EMERGENCY STOP** button only for the crisis shut down of bench drive, tightening, and to cut off the power clip supply.
4. In case of failures in the operation of the bench, stop further operation and contact the manufacturer or sales representative.

The manufacturer is not responsible for any damage or injury to human health resulting from non-compliance with the requirements of this manual.

3.1. Safety Guidelines

1. The bench has to be operated by the qualified persons who got the access to operate the definite bench types and who were instructed on the safe operating procedures and methods.
2. The bench has to be turned off if the supply is terminated, during the cleaning and tidying up, as well as in the emergency situations.
3. The work area must always be clean, with good light illumination, and spacious.
4. To ensure electrical and fire safety **PROHIBITED**:
 - connect the bench to the electrical network having faulty protection against current overloads or not having such protection;
 - use a socket without a grounding contact to connect the bench;
 - use extension cords to connect the bench to the electrical network. If the socket is far from the bench installation site, it is necessary to modify the electrical network and install the socket;
 - operation of the bench in defective condition.
 - Independently to repair and make changes to the design of the bench, because it can lead to serious damage to the bench and deprive the right to warranty repair.
5. It's forbidden to leave the units with running drive on the bench unattended.
6. While mounting and dismounting of a unit from the bench, to prevent arms from harming, be more cautious.

4. ALTERNATOR DIAGNOSTICS

The following general diagnostics stages are considered for all alternator types:

1. The mounting and the fixing of alternator on the bench.
2. The mounting of the belt onto the pulley and the tightening.

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3. Connection of the power wires to alternator. For convenient connection of power terminal B+, screw the adapter on the positive terminal of the alternator.
4. Connect the diagnostic cable to the alternator connector terminals.
5. Choose the relevant alternator diagnostics parameters.
6. Alternator diagnostics.
7. The dismantling of unit from the bench.

4.1. Connection of the wires of diagnostic cable to alternator connector terminals

To check the alternator performance, the wires of the diagnostic cable have to be properly connected to alternator connector terminals.

Referring to the alternator OEM, that is commonly indicated on the body or rear cover, find the information on the alternator connector terminal references in the bench database (fig. 11):

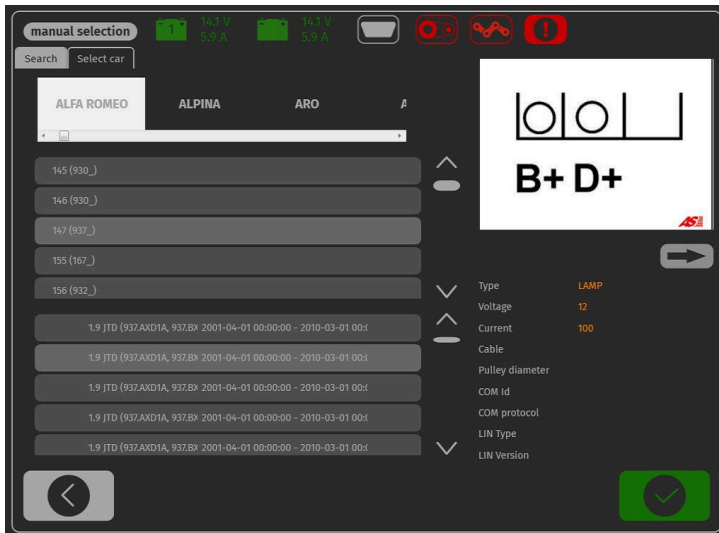


Figure 11. Database search menu and search results

1. Press **Database** in the bench main menu (fig. 8, ref. 2).

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2. In the opened window (fig. 11), in **Search** tab, enter the alternator serial number and press **Search** button, or in **Select car** tab, choose the car make and model of car where the diagnosed alternator was installed.
3. If the bench database has the required alternator, its type, main specifications, photos and connection terminal references (press arrow under alternator image to display the connection terminal references).
4. Use this information and the information from the Appendix 1 for the proper connection of the diagnostic cable wires to the alternator connector.

If you can't find the alternator in the database, look for the reference of alternator connector terminals on the Internet. Then connect the diagnostic cable wires to the alternator connector terminals, referring to the table in the Appendix 1. Prior to diagnostics, choose the alternator type referring to the connector terminals.

Below you can see the example of the Bosch 0986049191 alternator connection (fig. 12).

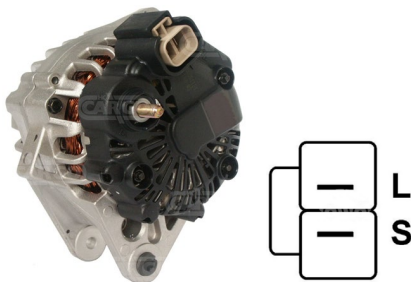


Figure 12. Bosch alternator 0986049191 and connector terminal references.

Referring to the terminals on the figure 12 identify the alternator type. Now, the terminal L refers to Lamp alternator type. Next, referring to Appendix 1, check what wires of diagnostic cable should be connected with the alternator connector (connection layout - Table 2).

Table 2 – Connection of Bosch alternator 0986049191 to the bench

Alternator connector terminal	Diagnostic cable wire	Diagnostic cable wire colour
L	Lamp	gray
S	S	orange

Diagnostics manual

Below you can see the example of the Toyota 2706020230 alternator connection (fig. 13).

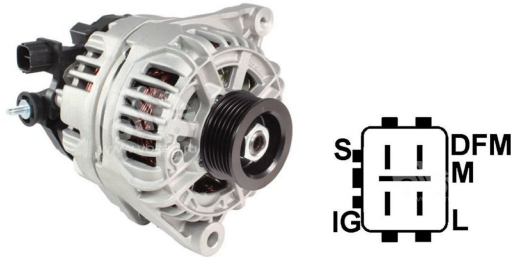


Figure 13. Toyota 2706020230 alternator and connector terminal references.

Referring to the terminals on the figure 13 identify the alternator type. Now, the terminal L refers to Lamp alternator type. Next, referring to Appendix 1, check what wires of diagnostic cable should be connected with the alternator connector (connection layout - Table 3).

Table 3 – Toyota 2706020230 alternator connection

Alternator connector terminal	Diagnostic cable wire	Diagnostic cable wire colour
S	S	orange
IG	IG	red
L	Lamp	gray
DFM (M)	FR	white

Below you can see the example of the Nissan 23100EN000 alternator connection (fig. 14).

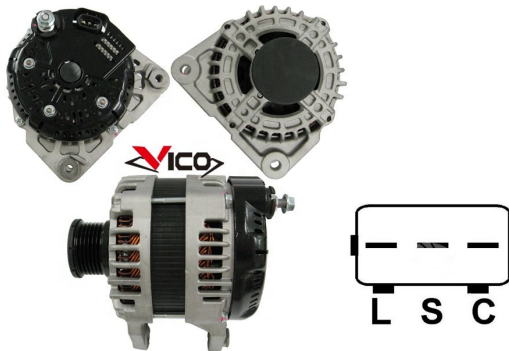


Figure 14. Nissan 23100EN000 alternator and connector terminal references.

Referring to the terminals on the figure 14 identify the alternator type. In this case, the terminal is C, and Japanese car make guides to alternator type - C JAPAN Next, referring to Appendix 1, check

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what wires of diagnostic cable should be connected with the alternator connector (connection layout - Table 4).

Table 4 – Nissan 23100EN000 alternator connection

Alternator connector terminal	Diagnostic cable wire	Diagnostic cable wire colour
L	Lamp	gray
S	S	orange
C	GC	yellow

4.2. Alternator diagnostics menu

When starting the diagnostics of Lamp, SIG, RLO, RVC, C KOREA, P-D, C JAPAN alternator types, the following information may be displayed (fig. 15):

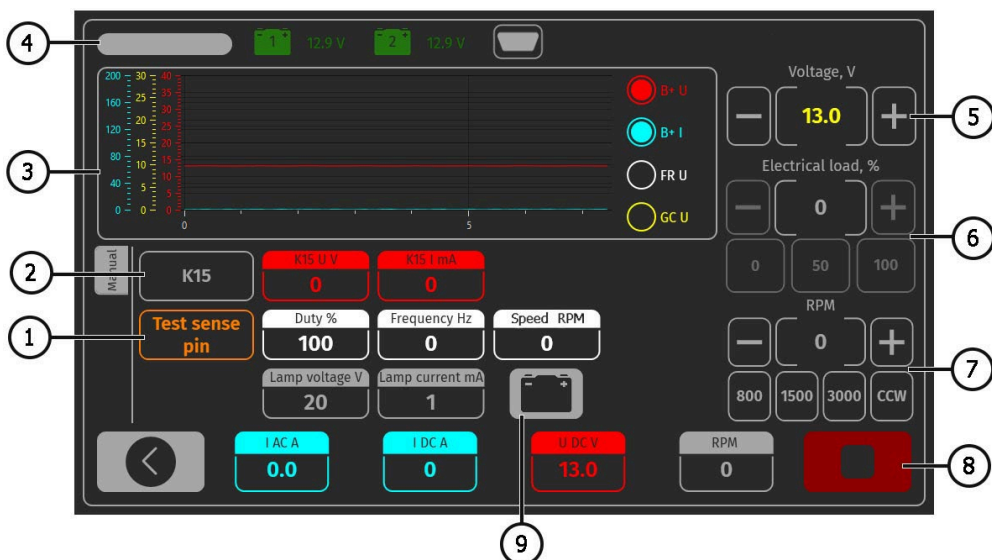


Figure 15. Alternator diagnostics menu view

- 1 – Test sense pin** button - press to check the terminal S performance capacity. The voltage regulator reads the actual battery voltage referring to terminal S (Sense) and increases the alternator output voltage to compensate charge losses.
- 2 – K15** button imitates the ignition start signal that is sent to the alternator voltage regulator. If the alternator configuration includes the terminal (A or IG, or 15), press K15 button prior to the alternator diagnostics.

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3 – Display field of measured parameter diagram

4 – Diagnosed alternator type.

5 – Alternator output voltage control buttons (if its design enables the voltage adjustment).

6 – Alternator load control buttons. The value is rated as % of the set value (fig. 9, ref. 3).

7 – Buttons to control the speed and direction of alternator rotation. By default, the bench rotates the alternator clockwise (if you look from the pulley side). If required, change the rotation direction by pressing **CCW** button.

8 – Diagnostics process stop button.

9 – Indicator of control lamp operation.

K15 U V – voltage value in the ignition circuit (K15).

K15 I mA – current value in the ignition circuit (K15).

Duty % - duty ratio of PWM signal received through FR, DFM, M channel (on-condition rate of rotor winding coil).

Frequency Hz - signal frequency value received through the channel FR, DFM, M.

Speed RPM - alternator rotation speed measured by regulator.

Lamp voltage V – voltage value on the control lamp.

Lamp current mA – value of electric current on the control lamp.

I AC A – value of alternating current in the circuit B+.

I DC A – value of direct current in the circuit B+.

U DC V – terminal B+ voltage value.

RPM – alternator pulley rotation speed. If the pulley dimension is not specified in the menu (fig. 9, ref. 7), the drive rotation speed value is indicated.

The menu of the COM alternator diagnostics (fig. 16) displays the following information:

Status – alternator connection status indicator.

COM protocol – voltage regulator protocol version indicator: BSS, LIN1 or LIN2.

ID – voltage regulator identification number.

COM speed – rate indicator for data transmission from control unit to voltage regulator. This parameter is displayed for the alternators that are controlled by LIN protocol. The following speed values can be displayed:

- **L** – 2400 Bod (low);
- **M** – 9600 Bod (medium);
- **H** – 19200 Bod (high).

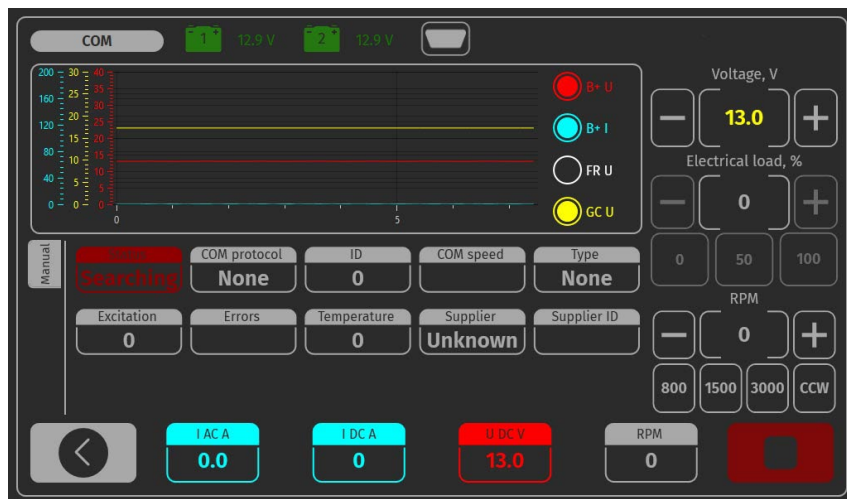


Figure 16. Menu of diagnostics of COM alternator type.

TYPE – displaying of the type code for the LIN protocol regulator: A1, A2, A3, A4, B1, B2, B3, B4, C3, D1, D2, E1.

EXCITATION – current value in the winding coil of alternator excitation. This parameter is read from the voltage regulator by LIN protocol.

ERRORS – indicator of errors that the regulator transmits to engine control unit. The following errors may happen:

- **E** (electrical) – electrical failures;
- **M** (mechanical) – mechanical failures;
- **T** (thermal) – overheating.

TEMPERATURE – the measured by regulator its own temperature.

Supplier – manufacturer of the alternator voltage regulator.

Supplier ID – manufacturer identification number of the alternator voltage regulator.

4.3. Alternator diagnostics in manual mode

1. Once the alternator is fixed and connected, enter the menu 'Alternator' on the start window (fig. 8).

2. In the opened window, choose the rated voltage of the diagnosed alternator (12 or 24V), the alternator type, the maximum diagnostics current, pulley diameter. When using the bench alternator database, the diagnostics parameters are set automatically.

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3. To start diagnostics, press button «Manual test».

⚠ WARNING! The diagnostics can be started only when the bench diagnostic outputs have been connected to the alternator voltage regulator terminals.

3.1. If the diagnosed alternator is of COM type, wait until the bench identifies ID and TYPE of alternator. The notification on the mechanical failure MEC shall appear near the indicator ERRORS.

3.2. If the alternator configuration includes the terminal A or IG, or 15, activate the button K15.

3.4. If the alternator configuration includes the control lamp, its indicator shall light up (fig. 15, ref. 9).

4. Alternator drive control buttons (fig. 15, ref. 7) can be used to set the rotation speed within the limits of 100-150 rpm.

⚠ WARNING! For the alternators with the freewheel clutches, be more cautious when choosing the rotation direction.

4.1. Visually inspect if the alternator rotates properly. If there are the abnormal noises or alternator vibrations that may inform on the mechanical failure of alternator, stop the diagnostics.

5. Check the rotation speed when the generation starts as follows:

5.1. With drive control buttons, increase gradually the speed until the output voltage is equal to rated voltage. Most of the operative alternators start generation from 700-850 rpm. Some alternators of COM type start generation at the speed higher than 1200 rpm, besides, there are LRC alternators (Load Response Control) that have the temporary delay at the output voltage variation.

5.2. For Lamp type alternators, the stabilizing voltage value shall be set within 14-14.8V for 12V alternators, and within 28-29.8V for 24V alternators.

5.3. If the alternator is equipped with the control lamp indicator it shall go off.

5.4. If the diagnosed alternator is of COM type, the mechanical error shall disappear.

6. Check the voltage regulator as follows:

6.1. Set the rotation speed within 1500-2000 rpm.

6.2*. Press the output voltage control buttons (fig. 15, ref. 5) to gradually adjust the alternator output voltage (from min. to max.). The measured voltage shall change proportionally

***For the Lamp type alternators without voltage control, this paragraph is skipped.**

6.3. For the alternator of C JAPAN type, set the rated stabilizing voltage to **0** mode – the measured stabilizing voltage value shall set equal to battery voltage value (fig. 8 ref. 5). Then, set the rated stabilizing voltage to **1** mode – the measured stabilizing voltage value shall set within 14-14.7V.


7. Check the alternator operation under the load as follows:


7.1. Set the rotation speed within the limits of 2500-3000 rpm.

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7.2. Set the generation voltage within 14-14,8V. For the alternators of C JAPAN type, turn on the mode 1.

7.3. Press electric load control buttons (fig. 15, ref. 6) to gradually increase the alternator load. At the same time, the output voltage value shall remain constant while the alternating current value (I, AC) in the circuit B+ shall not exceed 10% of the nominated load value (e.g., at the load of 50A, the value I, AC shall not exceed 5A). The current oscillogram shall not have the big peaks, the values should vary within the equal limits.

 To check the technical condition of the alternator, the load from 50 up to 80A will be enough.

8. To finish the alternator diagnostics, press button  to stop the alternator drive, then click the «back» button to exit the mode and remove power from the power clamps. Now the alternator can be dismantled from the bench.

9. Failure to comply with the one of the paragraphs 3.1, 3.4, 5 – 7.3 points to the alternator defects.

4.4. Alternator diagnostics in automatic mode

1. After fixing and connecting the alternator on the start screen (fig. 8), go to the menu «Alternator».

2. In the opened window, choose: rated voltage of the diagnosed alternator 12V or 24V, type of alternator, maximum test current, diameter of the pulley (if the value is known). When using the alternator base, the verification parameters are set automatically.

3. To start the diagnostic process in automatic mode, click «Automatic test».

4. After pressing the button «Automatic test» there will appear a window with setting the speed of the pre-test of the alternator (see fig. 17). With «+» «-» buttons set the value of the rotation speed in the range of 100 to 150 rpm.

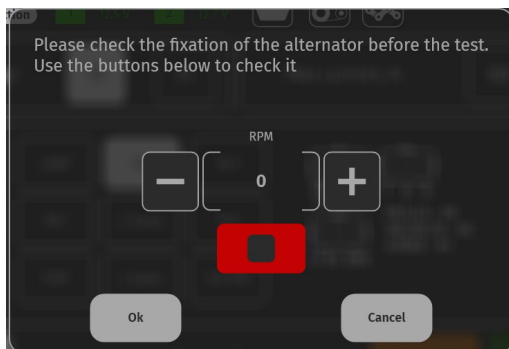


Figure 17. Alternator preview speed setting window

4.1. Visually evaluate if the alternator rotates normally. If there is a noise or vibration of the alternator indicating a mechanical failure, stop the diagnosis by pressing the «CANCEL» button.

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4.2. If the alternator rotates normally and there are no signs of mechanical failure of the unit, press the button «OK» - the window of automatic verification mode will open. fig. 18

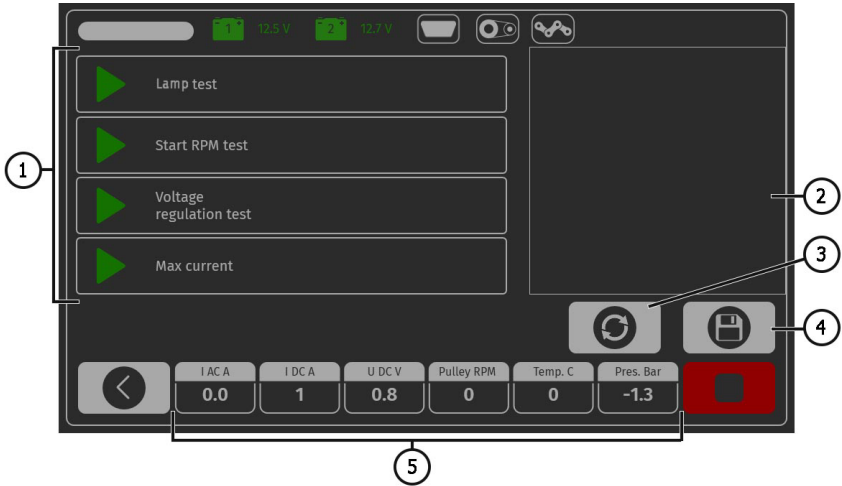


Figure 18. Automatic check mode menu *:

1 – Activation buttons for alternator validation phase:

Lamp test – check of control lamp circuit performance;

Start RPM test – determination of the alternator pulley speed at which generation starts;

Voltage regulator test – checking the performance of controlled regulators;

Max current – determination of the maximum current that the alternator is able to produce.

2 – Field for displaying test results.

3 – Reset button for a new test cycle.

4 – The button to save the results of the test.

5 – Current values of the measured parameters.

*** The automatic test steps are individual for each type of alternator.**

5. In the Automatic Check menu, activate each step of the check sequentially. After completion of all stages of testing the result can be stored in the memory of the bench, and the alternator can be dismantled from the bench.

5. VOLTAGE REGULATOR DIAGNOSTICS

Commonly the diagnostics of the most regulators is carried out as follows:

- 1) Connection of regulator to the bench;
- 2) Selecting the type and the rated voltage of the diagnosed regulator;
- 3) Control lamp performance capacity evaluation. If the rotation speed value is 0, the indicator of the battery charge shall be red. Once the speed is higher than 800-1200 rpm. The indicator shall go off.
- 4) Evaluating of the performance of the terminal S;
- 5) Checking if the regulator can adapt to the stabilization rated voltage.

⚠ WARNING! The bench tests the voltage regulators without load, that's why the diagnostics of some Bosch regulators on the bench is not possible.

5.1. Voltage regulator connection

For the accurate evaluation of the technical condition of alternator, you shall properly connect it to the bench diagnostic outputs.

Referring to the voltage regulator OEM, find the information on the regulator connector terminal references in the bench database (fig. 19): Then connect the diagnostic cable wires and bench outputs to the regulator, referring to the provided layout.



Figure 19. Regulator database search display

Once the regulator has been connected press . The bench gets to the appropriate diagnostics mode. Now you can start the diagnostics of the regulator (the process is described below).

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⚠ WARNING! Be cautious when connecting the crocodile clips with the connector - to prevent the regulator from the damaging. Use the crocodile clip completely isolated (fig. 20) or use the relevant wire (fig. 5).

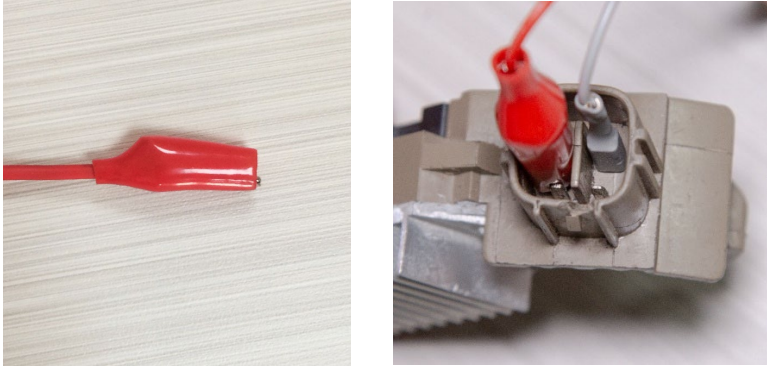


Figure 20. Connector terminal connection

If you haven't found the regulator in the database, look for the information on the regulator terminal references on the Internet. In addition, you can refer to the Appendix 3 where the most common voltage regulator connections are specified. Referring to the found layout of the regulator terminal references, connect the diagnostics cable and bench outputs with the regulator referring to the examples below.

Figure 21 illustrates the example of the connection layout for the regulator ARE1054.

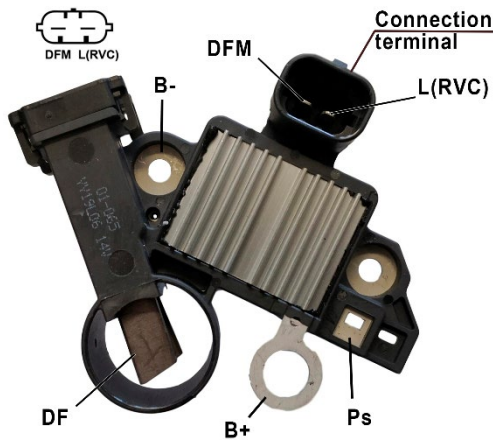


Figure 21. Regulator ARE1054

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Use the information in the Appendix 1 to determine the regulator type referring to the connector terminals (fig. 21). The terminal **L(RVC)** points to **RVC** regulator type. Then, referring to the Appendix 1, determine what diagnostics cable and bench outputs shall be connected with the regulator. The layout of the connection of the regulator ARE1054 to the bench is provided in the table 5.

Table 5 – Connection of voltage regulator ARE1054 to the bench

Voltage regulator terminal	Bench output	Diagnostic cable wire	Wire colour
DFM		FR	white
L(RVC)		GC	yellow
Ps	ST1		blue
B+	B+		red
DF	FLD1		green
	FLD2		green
B-	B-		black

Figure 22 illustrates the example of connection layout of ARE6076 regulator.

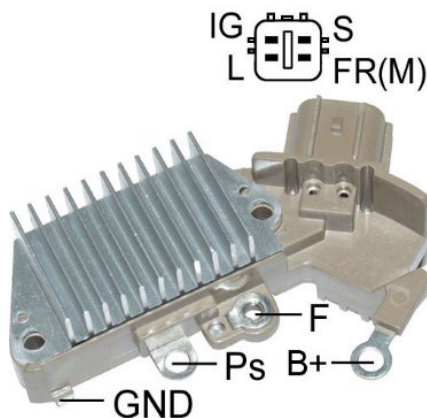


Figure 22. Regulator ARE6076

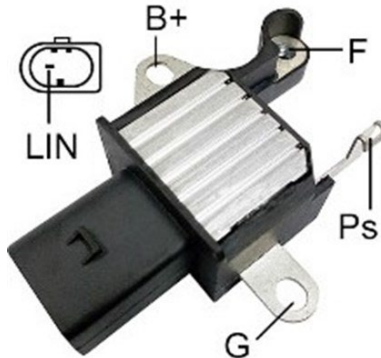
Referring to the connector terminals and the information in the Appendix 1, determine the regulator type. In this case, the terminals **IG**, **S** и **FR(M)** don't determine the regulator type. The terminal **L** points to **Lamp** regulator type. Now, referring to the Appendix 1, determine what diagnostics cable and bench outputs shall be connected with the regulator. The layout of the connection of the regulator ARE6076 to the bench is provided in the table 6.

Table 6 – Connection of voltage regulator ARE6076 to the bench

Voltage regulator terminal	Bench output	Diagnostic cable wire	Wire colour
IG		IG	red
L		D+	gray
S		S	orange
FR(M)		FR	white
B+	B+		red
	FLD2		green
F	FLD1		green
Ps	ST1		blue
GND	B-		black

There's a specific thing about the connection of ARE6076 regulator. The figure 22 illustrates only the terminal **F** which we connect with the bench output **FLD1**. The bench output **FLD2** shall be connected to the terminal **B+** since one of the relay brushes is permanently connected to **B+** while the excitation winding coil is being controlled through the brush connected to the alternator 'negative' (A-circuit breaking type).

Figure 23 illustrates the example of connection layout of ARE6149P regulator.

**Figure 23. Regulator ARE6149P**

Referring to the voltage regulator connector terminals and the Appendix 1, identify the regulator type. Here we have just one LIN terminal that points to **COM** regulator.

Now, referring to the Appendix 1, determine what diagnostics cable and bench outputs shall be connected with the regulator. The layout of the connection of the regulator ARE6149P to the bench is provided in the table 7.

Table 7 – Connection of voltage regulator ARE6149P to the bench

Voltage regulator terminal	Bench output	Diagnostic cable wire	Wire colour
B+	B+		red
F	FLD1		green
Ps	ST1		blue
LIN		GC	yellow
G	B-		black
	FLD2		green

There's a specific thing about the connection of ARE6149P regulator. The figure 23 illustrates only the terminal **F** which we connect with the bench output **FLD1**. The bench output **FLD2** shall be connected to the terminal **B-** since one of the relay brushes is permanently connected to **B-** while the excitation winding coil is being controlled through the brush connected to the alternator 'positive' (B-circuit breaking type).

5.2. Voltage regulator diagnostics menu

The window of the diagnostics of the regulators such as Lamp, SIG, RLO, RVC, C KOREA, P-D, C JAPAN can display the following information (fig. 24):

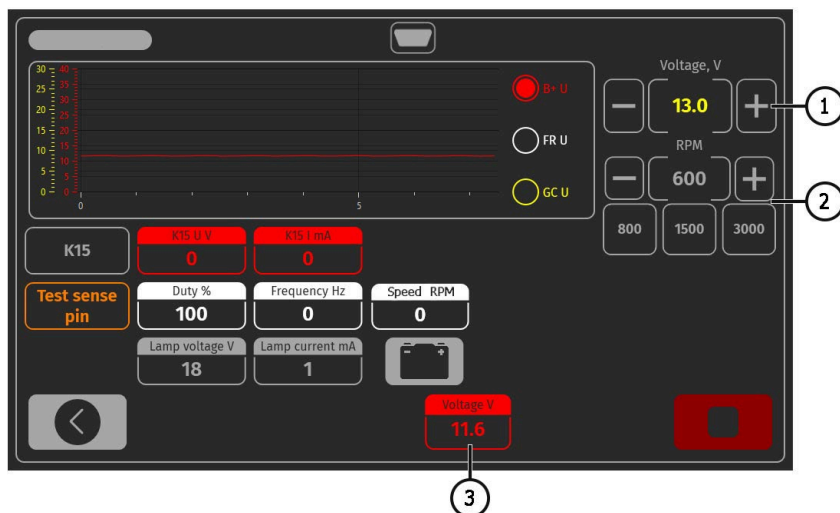


Figure 24. Voltage regulator diagnostics menu

1 – Regulator output voltage- control buttons (if its design enables the voltage adjustment).

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2 – Buttons that imitate the alternator rotor rotation for the regulator.

3 – Measured value of stabilizing voltage.

⚠ The rest parameters conform with the parameters on the window of diagnostics of the alternator of similar type.

The diagnostics menu for COM voltage regulators will display the following information (fig. 25):

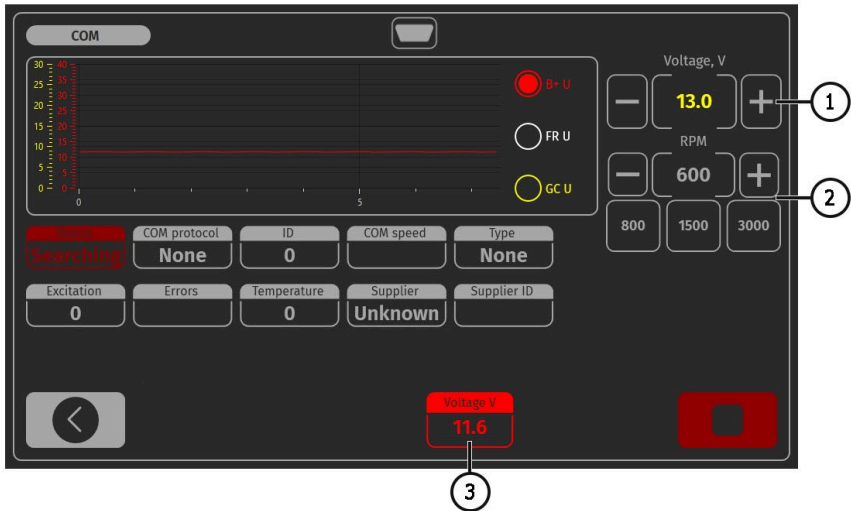


Figure 25. Menu of diagnostics of COM voltage regulator type

1 – Stabilization output voltage control buttons.

2 – Buttons that imitate the alternator rotor rotation for the regulator.

3 – Measured value of stabilizing voltage.

Status – regulator connection indicator.

COM protocol – voltage regulator protocol version indicator: BSS, LIN1 or LIN2.

ID – regulator identification number.

COM speed – the indicator of the data transmission speed through LIN protocol - from control unit to the voltage regulator. The following the speed rates can be displayed:

- **L** – 2400 Bd (low);
- **M** – 9600 Bd (medium);
- **H** – 19200 Bd (high).

TYPE – displaying of the type code for the LIN protocol regulator: A1, A2, A3, A4, B1, B2, B3, B4, C3, D1, D2, E1.

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EXCITATION – current value in the winding coil of alternator excitation. This parameter is read from the voltage regulator by LIN protocol.

ERRORS – indicator of errors that the regulator transmits to engine control unit. The following errors may happen:

- **E** (electrical) – electrical failures;
- **M** (mechanical) – mechanical failures;
- **T** (thermal) – overheating.

TEMPERATURE – the measured by regulator its own temperature.

Supplier – manufacturer of the alternator voltage regulator.

Supplier ID – manufacturer identification number of the alternator voltage regulator.

5.3. Lamp regulator diagnostics

1. Connect the regulator to the bench referring to the examples described in the p. 5.1.
2. In the menu for choosing of the regulator type, choose the rated voltage for the diagnosed regulator (12V or 24V) and the **Lamp** diagnostics mode.
3. If the regulator uses the stator signal (ST), to check the performance of the control lamp, set the rotor speed to 0 (zero) - the red indicator of battery charge shall light up. Increase the speed higher than 800-900 rpm - the indicator of control lamp shall go off.
4. Increase the speed up to maximum. Yet, the output voltage shall be within 14-14.8V for 12V regulators and within 28-29.8V for 24V regulators as well as shall conform with the regulator specifications.
5. If the regulator has the terminal S, check its performance capacity. Press **Test sense pin** button. The stabilizing voltage, however, shall increase. Press **Test sense pin** button one more time. The stabilizing voltage shall get back to the previous value.
6. Failure to comply with the one of the paragraphs 3 – 5 indicates the regulator defects.
7. Press BACK button to exit the diagnostics mode. Disconnect the cables from regulator.

5.4. Diagnostics of RLO, RVC, C KOREA regulator types

1. Connect the regulator to the bench.
2. In the menu for choosing of the regulator type, choose the rated voltage for the diagnosed regulator (12V) and the diagnostics mode corresponding to the regulator type.
3. If the regulator has the terminals A or IG, or 15, activate the button K15.

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4. To check the performance of the control lamp, set the rotor speed to 0 (zero) - the red indicator of battery charge shall light up. Increase the speed higher than 800-1200 rpm - the indicator of control lamp shall go off.
5. Adjust the rated stabilizing voltage from minimum to maximum. The measured value of the stabilizing voltage shall vary in proportion to the rated value.
6. Press BACK button to exit the diagnostics mode. Disconnect the terminals from regulator.
7. Failure to comply with the one of the paragraphs 4, 5 indicates the voltage regulator defects.

5.5. Diagnostics of C JAPAN regulator type

1. Connect the regulator to the bench.
2. In the menu for choosing of the regulator type, choose the rated voltage for the diagnosed regulator (12V) and **C JAPAN** diagnostics mode.
3. If the regulator has the terminals A or IG, or 15, activate the button K15.
4. To check the performance of the control lamp, set the rotor speed to 0 (zero) - the red indicator of battery charge shall light up. Increase the speed higher than 800-1200 rpm - the indicator of control lamp shall go off.
5. Set the rated stabilizing voltage to 0 mode – the measured stabilizing voltage value shall set equal to battery voltage value (fig. 8 ref. 5). Then, set the rated stabilizing voltage to 1 mode – the measured stabilizing voltage value shall set within 14-14.7V.
6. If the regulator has the terminal S, check its performance capacity. Press **Test sense pin** button. The stabilizing voltage, however, shall increase. Press Test sense pin button one more time. The stabilizing voltage shall get back to the previous value.
7. Press BACK button to exit the diagnostics mode. Disconnect the terminals from regulator.
8. Failure to comply with the one of the paragraphs 4 – 6 indicates the voltage regulator defects.

5.6. P/D regulator diagnostics

1. Connect the regulator to the bench.
2. In the menu for choosing of the regulator type, choose the rated voltage for the diagnosed regulator (12V) and **P/D** diagnostics mode.
3. Adjust the rated stabilizing voltage from minimum to maximum. However, the measured value of the stabilizing voltage shall vary in proportion to the rated value.
4. Press BACK button to exit the diagnostics mode. Disconnect the terminals from regulator.
5. Failure to comply with the paragraph 3 indicates the regulator defect.

5.7. SIG regulator diagnostics

1. Connect the regulator to the bench.
2. In the menu for choosing of the regulator type, choose the rated voltage for the diagnosed regulator (12V) and **SIG** diagnostics mode.
3. If the regulator has the terminals A or IG, or 15, activate the button K15.
4. Set the stabilizing voltage rate at 14V and the rotation speed - higher than 1200 rpm. At the same time the measured stabilizing voltage shall also get to 14V.
5. Set the speed to 0 (zero) - the measured stabilizing voltage value shall lower to battery voltage value (fig. 8, ref. 5). Increase the speed higher than 1200 rpm - the stabilizing voltage shall increase up to 14V again.
6. Adjust the rated stabilizing voltage from minimum to maximum. However, the measured value of the stabilizing voltage shall vary in proportion to the rated value.
7. Press BACK button to exit the diagnostics mode. Disconnect the terminals from regulator.
8. Failure to comply with the one of the paragraphs 4 – 6 indicates the voltage regulator defects.

5.8. Diagnostics of COM regulators (12V and 24V)

1. Connect the regulator to the bench.
2. In the menu for choosing of the regulator type, choose the rated voltage for the diagnosed regulator (12V or 24V) and the **COM** diagnostics mode.
3. Wait until the tester reads the data. Once the values appear in the boxes ID, Version LIN, Type, proceed the diagnostics.
4. To check the performance of regulator self-diagnostics system, set the speed to 0 (zero) - the value M must appear in the box ERRORS. If the speed is higher than 800-1200 rpm, the value M in the ERRORS box won't be displayed anymore.
5. Adjust the rated stabilizing voltage from minimum to maximum. The measured stabilizing voltage rate shall change in proportion to the nominated one.
6. Failure to comply with the one of the paragraphs 3 - 5 indicates the regulator defects. If the values E or T appeared in the ERRORS box during the diagnostics, it also points to the regulator defect.
7. Press BACK button to exit the diagnostics mode. Disconnect the terminals from regulator.

6. STARTER DIAGNOSTICS

6.1. Starter diagnostics menu

Getting to the starter diagnostics mode, you'll see the following information on the display (fig. 26):

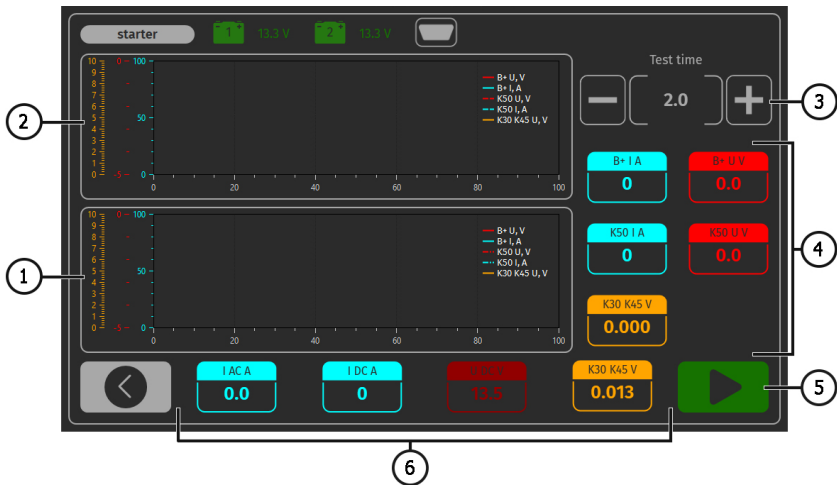


Figure 26. Starter diagnostics menu

- 1 – Diagram of the parameters measured during the whole test time.
- 2 – Diagram of the parameters at the starter start moment.
- 3 – Setting of the test duration.
- 4 – The parameters measured in a second after the test has started:
 - B+ I A** – electric current in the terminal 30 (B+);
 - B+ U V** – voltage in the terminal 30 (B+);
 - K50 I A** – electric current in the terminal 50;
 - K50 U V** – voltage in the terminal 50;
 - K30 K45 V** – K30, K45 solenoid terminal voltage drop – instant.
- 5 – Diagnostics start button.
- 6 – Current parameters:
 - I A C A** – alternating current in the circuit B+ (terminal 30);
 - I D C A** – direct current in the circuit B+ (terminal 30);
 - U D C V** – voltage in the circuit B+ (terminal 30);
 - K30 K45 V** – K30, K45 solenoid terminal voltage drop – average.

6.2. Starter diagnostics

1. Mount the starter on the working spot and fix it there.
2. Screw the adapter onto the positive terminal of the starter and connect with the power cable B+. The power cable B- connect to the unit body.
3. Connect the bench port 50 with the starter solenoid control connector (terminal 50 on the fig. 27).
4. Connect the cables K30 and K45 to the relevant starter terminals (fig. 27).
5. In the main menu, choose the starter diagnostics mode, then the rated voltage (12V or 24V) - referring to the diagnosed unit specifications.
6. Set the diagnostics duration and press start button.
7. When the set time expires, the bench will stop the diagnostics, and the measured parameters will be displayed. The charts with the voltage and current changes demonstrate the technical condition of starter and the probable reason of malfunctions.
8. Now the starter can be dismantled from the bench.

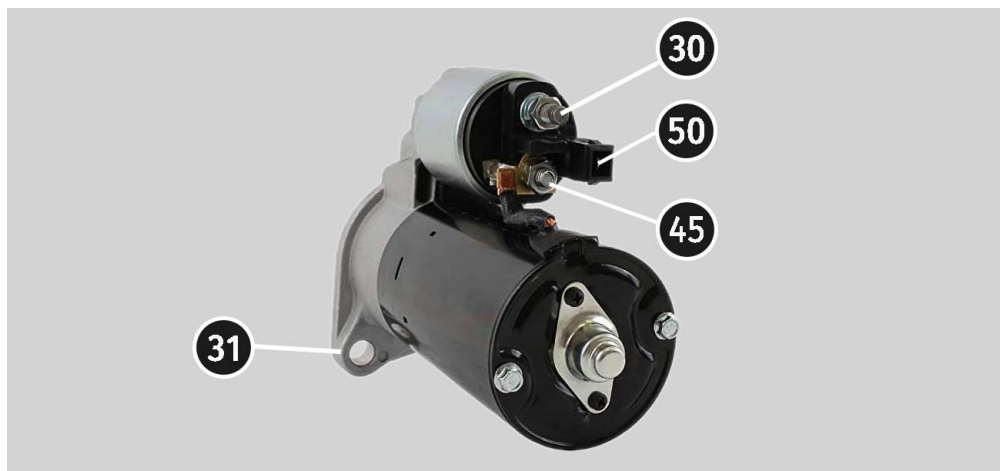


Figure 27. Position of terminals on the starter.

APPENDIX 1

Alternator connection terminals

Code	Application		Type of alternator	Diagnostic cable wire
B+	Battery (+)			
30				
A				
IG	(Ignition) Ignition start input			IG
15				
AS				
BVS	Battery Voltage Sense			
S	Sense			
B-	Battery (-)			B-
31				
E				
D+	For the connection of indicating lamp that supplies the initial voltage excitation and indicates the alternator performance capacity.		Lamp	D+
I	Indicator			
IL	Illumination			
L	(Lamp) Output for the alternator performance capacity indicating lamp			
61				
FR	(Field Report) Output for the control of the alternator load by the engine control unit			FR
DFM	Digital Field Monitor			
M	Monitor			
LI	(Load Indicator) Similar to FR, just with the inverted signal			
D	(Drive) Input for the P-D regulator control, for the alternators Mitsubishi (Mazda) and Hitachi (Kia Sephia 1997-2000)		P/D	GC

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Code	Application	Type of alternator	Diagnostic cable wire
SIG	(Signal) Voltage code setting input	SIG	GC
D	(Digital) Input for voltage code setting on the American Ford, similar to SIG		
RC	(Regulator Control) Similar to SIG		
L(RVC)	(Regulated Voltage Control) Similar to SIG, with just the voltage variation range 11.0-15.5V. The control signal is supplied to the terminal L	RVC	
L(PWM)			
C	(Communication) Input for the control of voltage regulator by engine control unit. Korean cars.	C KOREA	
C (G)	Input for the control of voltage regulator by engine control unit. Japanese cars.	C JAPAN	
RLO	(Regulated Load Output) Regulator stabilizing voltage control within 11.8-15V (TOYOTA)	RLO	
COM	(Communication) The general references of the physical control interface and alternator diagnostics. The protocols BSD (Bit Serial Device), BSS (Bit Synchronized Signal) or LIN (Local Interconnect Network) can be used	COM	
LIN	Direct reference to the control and diagnostics of alternator through the protocol LIN (Local Interconnect Network)		
Stop motor Mode	The control of the operation of Valeo alternator that are installed into the cars with the Start-Stop option	S/A PSA	
DF	Rotor winding coil output Connection of the regulator with the rotor winding coil		
F			
FLD			
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Code	Application	Type of alternator	Diagnostic cable wire
P	Output of one of the alternator stator winding coils It's used for the identification of the alternator excitation level by the voltage regulator		
S			
STA			
Stator			
W	(Wave) Output of one of the alternator stator winding coils - to connect the speed gauge in the diesel cars		
N	(Null) Stator winding coil centerpoint output For the control of the performance capacity indicating lamp of alternator with the mechanical voltage regulator		
D	(Dummy) Empty, no connection, mainly in Japanese cars		
N/C	(No connect) No connection		
LRC (Regulator option)	(Load Response Control) Option for the delay of voltage regulator reaction to the alternator load increasing. Within 2.5-15 seconds. At the load increasing (light, cooling fan), the regulator smoothly adds the excitation voltage that makes the engine speed stable. It can be easily seen at idle.		

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