

MAKUR Ltd

**TEST BENCH
FOR THE TECHNICAL DIAGNOSTICS
OF THE VEHICLE GENERATORS AND STARTERS
ME – 1**

OPERATION MANUAL



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Introduction

This Operation Manual is intended to familiarize the staff and customers with the specifications, design, principle of operation, terms of service, maintenance, storage and transportation of Auto Electrical Test Bench ME-1 (hereinafter – test bench), intended for diagnostic troubleshooting of the motor vehicles alternators and starters.

Test benches meet the requirements of the Technical Regulation BY 101044101.004-2015, the general safety requirements according to GOST 12.2.003 and fire safety requirements according to GOST 12.1.004.

Test benches belong to the class 1 with regard to protection against electric shock according to GOST 12.2.007.0.

Personnel, admitted to the installation, use, maintenance and repair of the instruments, must be over the age of 18, must study this Operation Manual, be trained in accordance with the correspondent qualification profile and safety trained with registration in the appropriate journal.

During manufacturing, some changes may be introduced to the instrument's construction that do not influence the specifications and, therefore, may be not specified in this manual.

1. Description and principle of operation.

1.1. Application.

1.1.1. Diagnosis is carried out without direct mounting of starters and generators on the vehicle.

1.1.2. Test bench provides:

- Functionality check of 12 V and 24 V generators with built-in voltage regulator and any kind of fastener, off- and on-load. Maximum permissible current load, provided by the activation of five independent active load modes during checking, is 105 A (by voltage regulation up to 140 A);
- check of the "A" and "B" type generators with external (remote) controllers;
- check of the generators with various of connection types (terminals): D +/-L, P-D, FR, SIG, DFM, COM, LIN, RLO;
- check of the data outputs DFM (LOW and HIGH), COM/LIN;
- check of the starters with rated voltage of 12 V and 24 V and rated power up to 5.5 kW in idle mode;
- digital display of measured characteristics (current, voltage), at appropriate specified characteristics (number of revolutions);
- testing of the accumulator battery from the test bench prior to the test, and recharging of the battery during the tests.

The design of the test bench drive allows continuous adjustment of motor shaft speed in forward and reverse modes in the range from 0 to 3000 revolutions per minute.

1.2. Test benches modifications.

1.2.1. Test benches are available in two modifications: ME-1A and ME-1B. The test benches Specifications are shown in Table 1.

1.2.2. The test benches are not designed for continuous alternators and starters checking. Test time must not exceed the values specified in the technical specifications.

1.3. Specifications.

Table 1.

Designation of the test bench	ME-1A	ME-1B
Parameter	Parameter value	
1. Test bench power supply - AC power with the ground conductor	Monophase	Three-phase
1.1 voltage, V	230±10	80±19
1.2 frequency, Hz	50 ±0.5	
1.3 installed capacity, kW, no more than	3,0	5,0
2. Supplementary power supply	Battery	
2.1 battery type	Lead-acid starter battery	
2.2 voltage, V	12	
2.3 rated capacity, Ah	65	
2.4 number of batteries	2 (are not included in the delivery kit)	
2.5 external charger connection	Is provided for two batteries	
3. Generator shaft drive	Induction motor	
3.1 motor version	AIR 80 B2	AIR 100 S2
3.2 power capacity, kW	2.2	4,0
3.3 rotation speed, rpm	3000	
3.4 ingress protection	IP 54, GOST 14254	
3.5 adjustable speed range, rpm	0...3000 in direct and reversing modes	
3.6 speed control of the motor shaft	manually, with the potentiometer on the control and indication board	
3.7 operating system	Electronic frequency inverter of the VFD-EL series	
3.8 inverter power capacity, kW	2,2	3,6
4. Type of transmission from the motor to the generator shaft	Belt drive	
4.1 Belt type	V-belt, poly-V-Belt	
4.2 belt pulley diameter, mm, no more than	120	
5. Digital devices reading range:	Range	Accuracy
- ammeter, A	0...200	In accordance with the calibration certificate
- voltmeter, V	0...200	
6. Continuous operation of the test bench in the generator testing mode: min, max	30	
7. Test interval, min, no less than	10	
8. Starter testing time, s, max	12	
9. Test bench climatic category	Temperate climate, indoors without artificial regulation of climatic conditions, GOST 15150	
10. Reliability:		
- mean time between failures, h	1000	
- average service life, years	8	
11. Overall dimensions, mm, no more than	560 x 560 x 940	
12. Weight (without the battery), kg, no more than	90	120

1.4. Test bench design.

1.4.1. The test bench has a block structure and is composed of (Figure 1):

- housing;
- multipurpose fixture for products under test;
- electric-powered drive;
- drive belt tensioner;
- control and indication board;
- instrument panel;
- electrical equipment;
- set of the replaceable wires and clips.

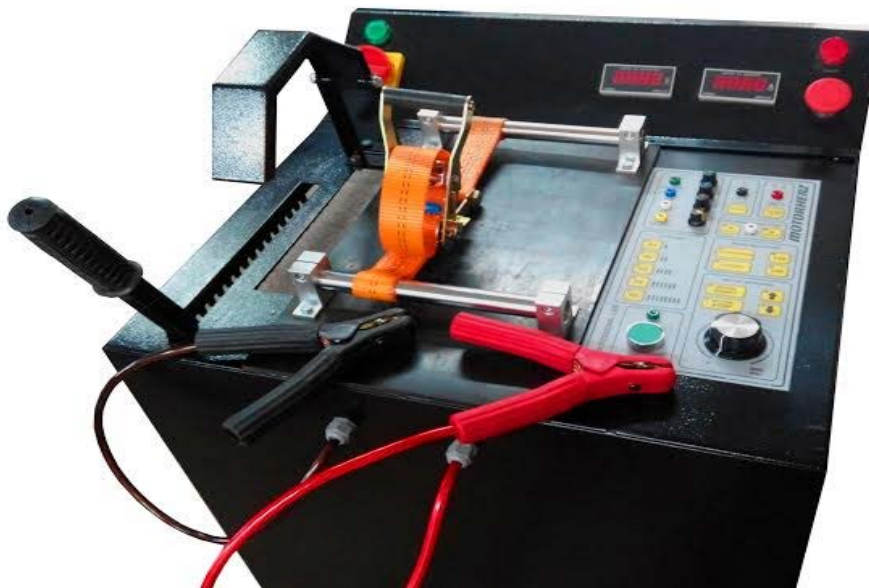


Figure 1.

1.4.2. The housing has a solid and rigid metal welded structure coated with a dielectric polymer, and is placed on the floor with adjustable feet.

The housing withstands mechanical shocks in accordance with Section 5 and by normal operating condition.

1.4.2.1. The front and back housing panels are protected with metal sheets, and on the side panels are provided quick-detachable guards.

1.4.2.2. Through the holes with bushings in the front wall are led two power wires (+) red wire, and (-) black wire with alligator clips to connect batteries and testable products.

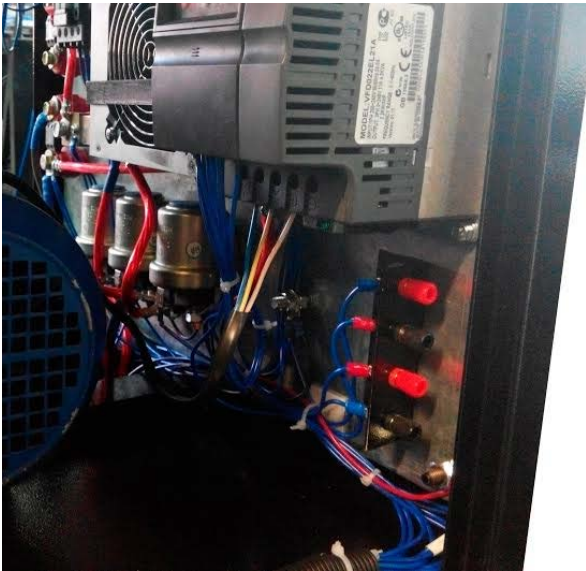
1.4.2.3. On the housing guards are provided slots for the electric equipment ventilation.

1.4.2.4. Inside the housing are located:

- mounting plate for electric-powered drive and the drive belt tensioner fastening (Figure 3);
- space for two rechargeable 12 V car batteries connected to the power supply of the test bench.

1.4.2.5. On the front and back housing panels inside the housing there are panels with electric boxes (Section 1.4.8.2).

1.4.2.6. On the back panel on the right side are fastened the terminal connectors for external charger to charge the batteries if needed (Figure 2a) with fuses (20A - 2 pcs). On the left side (Figure 2b) are placed fuses (300A - 2 pcs) as a short-circuit protection.



a)



b)

Figure 2.

1.4.2.7 On the upper surface of the housing are located:

- multipurpose fixture;
- instrument panel;
- control and indication board;
- hinged cowl to protect the generator pulley;
- V-belt tensioning handle.

1.4.3. Fixation of alternators and starters of all modifications during testing is provided by multipurpose fixture performed on the element base of the load fastening mechanism, according to the EN 12195-2 standard. The clamping is carried out by means of the lever with the clickwork for tensioning the belt and its fixation on the controlled item.

1.4.4. Electromechanical drive (Figure 3) transmits torque through the belt increaser from the asynchronous motor pulley (AIR type) to the rotor pulley of the generator under test.

For this purpose on the motor shaft using the locking key is installed the multiple-purpose pulley for V-belts and poly-V-belts. Drive pulley is statically balanced.

1.4.4.1. On the plate, under the pulley, is fixed the two-piece bracket separating belts and restricting them from shifting along the axis of the engine in the free (non-stretched) condition.

1.4.4.2. Stepless motor shaft rpm adjustment in the range from 0 to 3000 rpm is provided by the frequency converter of the VFD-EL Series.

1.4.4.3. The drive controlled by the frequency converter, provides direct and reverse rotation of the rotor of the generator under test, smooth acceleration of the motor up to maximum speed and its smooth stop in case of emergency.

1.4.5. The drive belt tensioner provides:

- installing before the testing the required belt on generator pulley fixed to the device;
- the required belt tension, preventing its slipping on the generator and electric motor pulleys;
- belt fixation during the test;
- easing of the belt tension after the test termination for easy removal of the generator from the test bench.

1.4.5.1. Belt tensioner is composed of the bracket welded to the housing plate, with the hollow rectangular pivoted lever installed inside it on the axle. On the outer surface of the lever there is a special tension roller, and inside is built a mechanism of the lever step-wise fixing with a rubber hand grip.

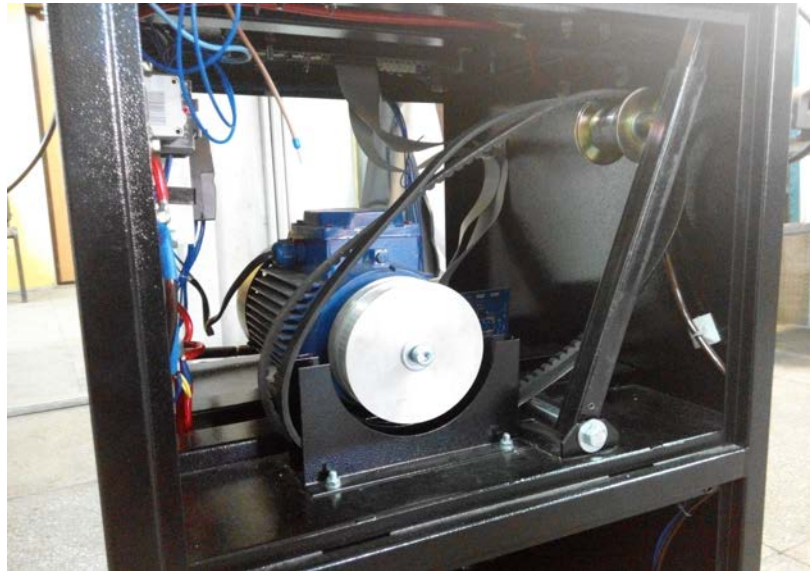


Figure 3.

1.4.6. Instrument panel (Figure 1) is angled 35 degrees to upper surface of the housing. On the panel are placed:

- Packet switch «OFF - ON» of the test bench with a green power supply indicator light;
- Mushroom shaped push button of the emergency stop (test bench power off) with red indicator light;
- Digital ammeter DC with the current measuring range from 0 to 200 A;
- Digital voltmeter DC with the voltage range of measurement from 0 to 200 V.

To connect the test bench ME-1A to the single phase circuit with the voltage 220 - 240 V is provided a power cord with a plug according to GOST 30849.1 supplied with the grounded contact. Cord length is 3500 mm.

1.4.6.2. The cord connecting the test bench ME-1B to a three-phase power supply circuit has a grounding conductor and an earth connection plug.

1.4.7. Control and indication board is made as shown in Figure 4.

1.4.7.1. Identification and functionality of controls and placed on the panel are shown in Table 2.

Note: Item number in the Table 2 indicates the number of the footnote on the Figure 4.

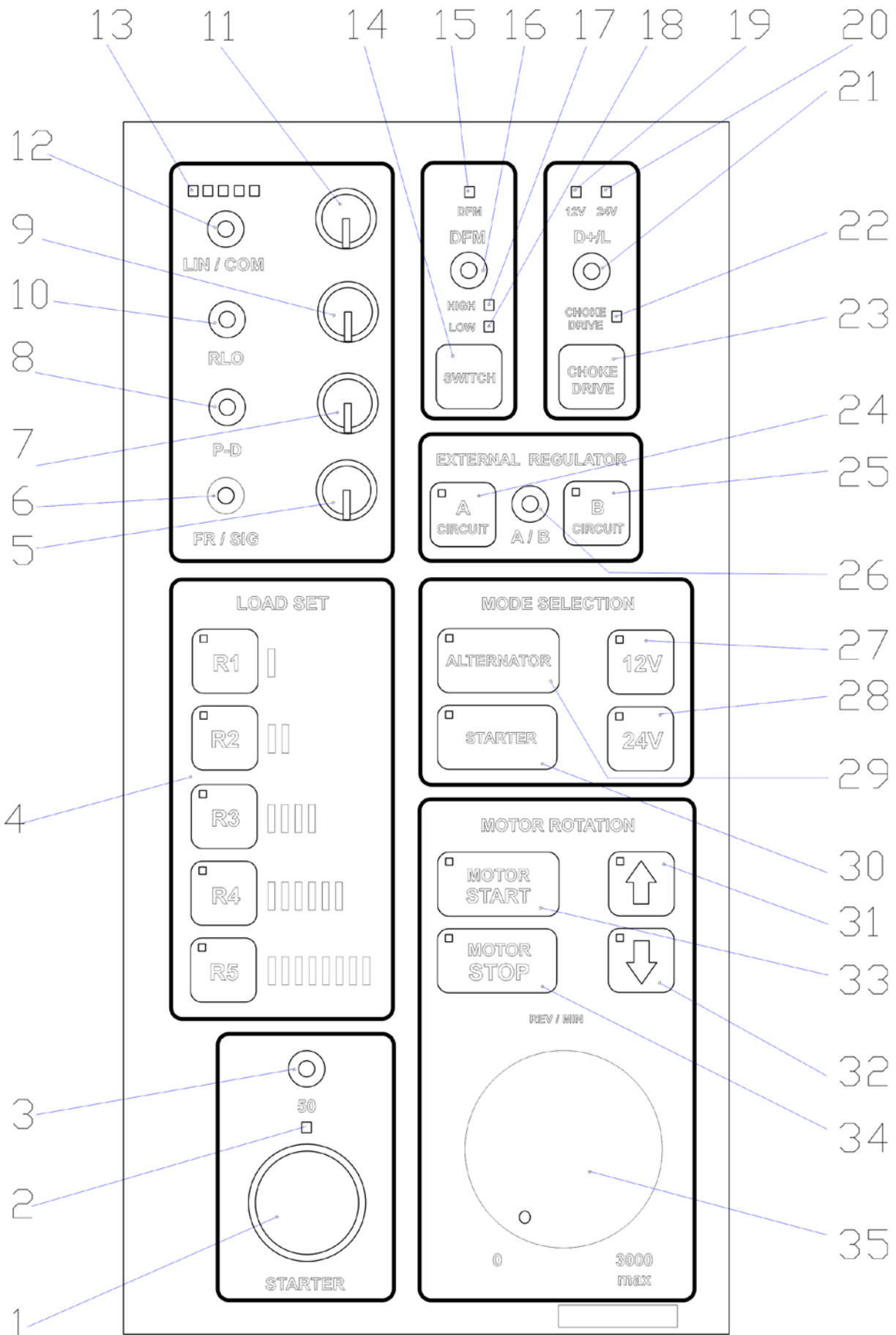


Figure 4. Control and indication board

Table 2.

№	Control element marking	Control element type	Colour	Functionality
1	STARTER	Button	green	Starter start button
2	50	CD	red	Starter power indicator
3	50 (STARTER)	bus slot	red	starter control terminal slot (12 or 24V)
4	LOAD SET R1...R5	button with LED and hold down lock	red	Loads connection keys (5, 10, 20, 30, 40) A
5	FR/SIG	Regulator	yellow	Bus regulation FR/SIG
6		bus slot	yellow	Bus slot FR/SIG
7	P-D	Regulator	red	Bus regulation P-D
8		bus slot	white	Bus slot P-D
9	RLO	Regulator	blue	Bus regulation RLO
10		bus slot	blue	Bus slot RLO
11	LIN/COM	Regulator	green	Bus regulation LIN/COM
12		bus slot	green	Bus slot LIN/COM
13		CD block 1, 2, 3, 4, 5	1-3 red 4 green 5 yellow	Code generator fault indication transmitted via buses LIN/COM
14	SWITCH	button with hold down lock	yellow	DFM mode enabling
15	DFM	CD		DFM mode indication
16	DFM	bus slot	black	DFM terminal slot
17	HIGH	CD	red	DFM output signal low frequency indicator
18	LOW	CD	red	DFM output signal high frequency indicator
19	12V	CD	red	12 V voltage indication
20	24V	CD	red	24 V voltage indication
21	D+/L	bus slot	black	D+/L terminal slot
22	CHOKE DRIVE	CD	red	CHOKE DRIVE mode indication
23	CHOKE DRIVE	button	yellow	Enabling of the CHOKE DRIVE active light checking mode
EXTERNAL REGULATOR				
24	A CIRCUIT	button with LED and hold down lock	yellow	Enabling of the control mode with A type regulators
25	B CIRCUIT	button with LED and hold down lock	yellow	Enabling of the control mode with B type regulators
26	A/B	bus slot	white	A and B external regulators connection
MODE SELECTION				
27	12V	button with LED and hold down lock	yellow	12 V voltage connection
28	24V	button with LED and hold down lock	yellow	24 V voltage connection
29	ALTERNATOR	button with LED and hold down lock	yellow	Selecting of the generator test mode
30	STARTER	button with LED and hold down lock	green	Selecting of the starter test mode
MOTOR ROTATION				
31	↑ ↓	button with LED and hold down lock	black	Drive motor forward rotation
32		button with LED and hold down lock	black	Drive motor reversive rotation
33	MOTOR	button with LED and	yellow	Drive motor switching on

	START	hold down lock		
34	MOTOR STOP	button with LED and hold down lock	yellow	Drive motor switching off
35	REV/MIN	Regulator	metal	Drive motor speed control

1.4.7.1. Symbolic notation of the control and indication board elements:

- button (without indication and fixation);
- button with LED;
- button with LED and hold down lock;
- button with hold down lock;
- bus slot;
- LED indicator;
- Regulator – «continuous potentiometer» with control knob.

Note: Pressing any button activates the buzzer, and pressing the button with indication activates the built-in LED;

1.4.7.2. The operating sequence of electrical components after pressing the button of the “Button with LED and hold down lock” type is shown in Table 3.

Table 3.

Keys marking	Table 2 item №	Sequence of the modes switching
«12V»	27	First pressing of the button switches to the 12 V power supply, second pressing - switches the power supply off. If the «24V» button was already pressed, then the first pressing switches the 24 V power supply off, second pressing switches to the 12 V power supply.
22«24V» «24V»	28	First pressing of the button switches to the 24 V power supply, second pressing - switches the power supply off. If the «12V» button was already pressed, then the first pressing switches the 12 V power supply off, second pressing switches to the 24 V power supply.
«MOTOR START»	33	Pressing disables the «MOTOR STOP» button
«MOTOR STOP»	34	Pressing disables the «MOTOR START» button and all the connected loads R1, R2, R3, R4, R5.
«A CIRCUIT»	24	If the «B CIRCUIT» button was already pressed, then the first pressing switches this button off, and second pressing switches the "A CIRCUIT» button on
«B CIRCUIT»	25	If the «A CIRCUIT» button was already pressed, then the first pressing switches this button off, and second pressing switches the "B CIRCUIT» button on

1.4.8. Electrical equipment provides all the necessary testing modes of the starters and generators in manual and semi-automatic modes using the control panel buttons.

1.4.8.1. Electrical equipment complies with the GOST 12.2.007.0 requirements, has unit construction, is composed with the standard components and provides the possibility of easy repair and modules replacement.

1.4.8.2. Units are consisting of:

- load resistors unit with relay switching the load resistors and with the cooling fans;
- board comprising the generators signal processing unit and switching relay control unit.
- control panel with the microprocessor unit of the testing modes switching, motor control, power mode selection 12/24 V and starter circuit switching key;
- 12/24V batteries switching relay unit;
- starter circuit switching relay;
- ammeter, shunt, voltmeter in the 12/24 V circuit;
- power supply 12 V;
- automatic 220 V circuit breaker unit;
- emergency 220 V circuit shutdown unit.

1.4.8.3. All the components meet the requirements of state standards.

1.4.8.4. Electrical equipment of the test bench provides the following lockouts (protection modes) and indications:

- short-circuit protection;
- electric motor protection against overload and overvoltage;
- emergency stop light indication;
- voltage supply light indication;
- control panel buttons sound.

1.4.8.4.1. In order to protect the batteries from overload by synchronous switching of a starter and load resistors when operating in the «STARTER» mode the loads connection keys R1- R5 are blocked (no signal to the load resistors switching unit).

1.4.8.5. Possibility of an emergency stop of the drive during the tests is provided by pressing the corresponding mushroom button on the instrument panel.

1.4.8.6. Insulation between the live parts and the test bench housing stands during 1 minute the exposure to the sinusoidal alternating current of 50 Hz and 1500 V without damage (breakdown).

1.4.8.7. Resistance of the main insulation between the shorted circuits, insulated from the housing, and other circuits available for touching from the outside and the housing, with the 500 V voltage - not less than 2 MΩ.

1.4.8.8. To connect the items under test to the test bench is provided the set of electrical wires or probes (3 pcs.).

1.4.8.8.1. Probes are removable accessory, and their design meets the requirements of GOST IEC 61010-031.

1.4.8.9. Test bench operation conditions:

- ambient air temperature from +5 to +40 °C;
- relative humidity up to 98 % at 25 °C;
- atmospheric pressure from 84 to 106,7 kPa (630 to 800 MmHg)

1.4.8.10. During transportation in container test bench is resistant to shocks with peak acceleration 30 m/s², shock rate 80 - 120 shocks/min for 2.5 hours or 12.000 shocks with the same acceleration.

1.4.8.11. During transportation in container test bench is resistant to ambient temperature from minus 40 to plus 50 °C and relative humidity up to 90% at 35 °C.

1.4.8.12. EMC in terms of resistance to EMI during operation in industrial areas corresponds to the STB IEC 61000-6-2 requirements.

1.4.8.13. The test bench is resistant to:

- the radio frequency magnetic field, the housing port in the frequency range from 26 MHz to 1 GHz (Test Severity Level 2, performance criteria A) according to STB IEC 61000-4-3;
- the Dynamic Voltage Scaling (power failure, interruption). Test Severity Level 2 according to STB IEC 61000-4-11.

1.4.8.14. The hole in the housing sidewall for the power cord output is equipped with insulating sleeve, preventing the pushing through of the cord.

Note: The electrical circuit for the test bench is the developer's intellectual property and is not shared with third parties. If you have any questions, please contact your nearest **Motorherz Equipment** sales representative.

2. Device operation.

2.1. Operating limitations.

2.1.1 Test bench is designed for indoor use.

2.1.2 Operating conditions: room explosive and fire danger class "G" - no explosion- and fire risk.

2.1.3 Test bench ME-1A must be connected only to a single phase circuit with 220 V voltage with the protective grounding conductor, and the test bench ME-1B must be connected to a three-phase circuit with 380 V voltage with the protection grounding and neutral conductors.

2.1.4 Personnel, admitted to the operation of the test bench, must study this Operation Manual, be trained in accordance with the correspondent qualification profile and safety trained with registration in the appropriate journal.

2.2. Pre-operation.

2.2.1 Transportation of the test bench to the installation site should be carried out in a manufacturer container.

2.2.2 The pre-operation procedure:

- Unpack the test bench and remove the conservation grease (if any);
- Check the test bench elements, control panel, instrument panel, power cord, seals on the electrical equipment for possible damages.
- Check the motor and pulley bolts gripping.

2.2.3 Do not install the test bench in immediate proximity to thermal devices, avoid exposure to magnetic fields, steam, smoke, etc.

2.2.4 Do not block the ventilation slots in the side covers of the housing.

2.2.5 Install two 12V batteries in the lower section of the test bench. Batteries should be fully charged and tested in accordance with GOST 53165 and the Guidelines for starter batteries maintenance and repair IR 3012165-0302-94.

2.2.6 Switch the test bench off before the batteries installation.

CAUTION! To avoid short-circuit do not put the metal objects on battery.



Figure 5. Batteries connection.

CAUTION! The battery contains electrolyte. In case of contact with skin or eyes, rinse immediately with water and consult a doctor.

2.2.8. After storing the test bench in a cold room or after transportation in winter conditions, it is allowed switching the test bench on no earlier than after 3 hours of uncovered stay at room temperature.

2.2.9. Depending on the modification, connect the plug to the electrical outlet of 380 V or 220 V. The packet switch on the instrument panel must be turned off (OFF position).

2.2.10. Motor (35) and voltage controls (5, 7, 9, 11) (Figure 4) have to be turned to normal position.

2.2.11. To check the batteries charge level:

- set the packet switch into the «ON» position. The green indication light turns on;
- press the 12V battery connecting button (Figure 4).

Digital voltmeter on the instrument panel indicates voltage of at least 13.0 V.

- press the 24V button - digital voltmeter should indicate voltage of at least 27 V.

Note: Order of the buttons switching is shown in Table 3.

2.2.12. Charging of the test bench batteries is carried out during the automobile generators testing, with equal amount of starters and generators (typical situation for most of the car service stations). This is enough to not use the additional external charger.

CAUTION! If among the units under test prevail the starters, it is necessary to recharge the batteries with external charger connected to the terminals located on the back panel of the test bench (Figure 2a).

If the most of the items under test have operating voltage of 12 V, it is necessary to exchange the working and unused batteries to avoid discharging.

2.3. Generators testing mode.

2.3.1. Inspect the generator subject to the test. If there are signs of strain, strong oxidation, melting, the terminals are broken; the generator must be replaced or repaired.

CAUTION! Prior to the test start check the insulation between (+) and (-) in the product subject to the test!

If the above signs are absent, you can start testing the generator performance.

2.3.2. It is necessary to identify correctly the generator manufacturer. It is possible to use the manufacturer's generators catalogue with connections (terminals) type: **D +/L; P-D; FR; SIG; COM, LIN; RLO**, as well as data outputs designation: **DFM, COM/LIN (BSS)**.

Symbolic notation of the modern generators voltage regulator outputs are shown in Appendix B.

2.3.3. To fix the generator subject to the test on the test bench in the following way:

- fix the generator on the test bench (if necessary, place the rubber pad from the delivery kit under the generator housing to increase the V-belt tension. Clamp the generator housing with the ratchet (Figure 6).

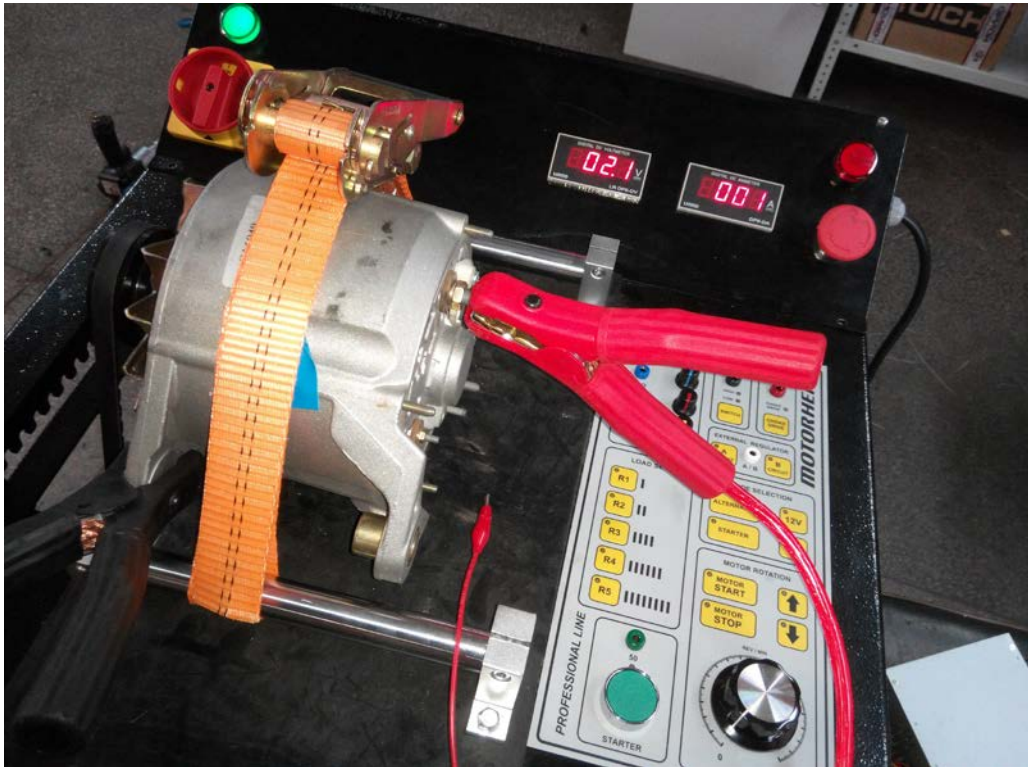


Figure 6.

CAUTION! The generator under test should be fastened so as to prevent its vibration caused by the rotor rotational speed up to 6000 rpm.

- throw the drive belt (V-belt or poly-V-belt) on the generator pulley. The belt must be installed without distortions and twisting (generator pulley grooves must be coaxial to the drive pulley grooves). Tolerance is no more than ± 1 mm.

- press the lever turning handle and pull it on, it will tighten the belt.

- release the handle and securely lock the lever in the top rack slot.

CAUTION! Proper belt installation and tensioning ensures the optimal power transfer from the motor to the generator. Bad belt tension does not allow controlling the generator parameters. Belts are heated in the pulley grooves and wear out quickly. Overloaded belt causes the rapid runout of the motor bearings, exceeding of the maximum allowable torque and, as a consequence, test bench emergency power off.

To check belt tension apply to its outer surface the force of 100 N (10 kgf) in the middle of the span between the pulleys. The bending deflection of the belt must be within 5 ... 10 mm.

- Close the guards;

- Ensure the secure generator fixation.

Note: Testing methods are shown using the examples of generators operating at a vehicle system voltage of the 12 V.

2.4. Testing of the generator with «D+/L» connection.

- Install and fix the generator in accordance with section 2.3.3.

- Connect to the generator the battery alligator clips: black clip (-), red clip (+);

- Connect the terminal «D+/L» connection input 21 (Figure 4) on the control panel to the generator light control terminal D + using cable-probe;

- Set the packet switch on the instrument panel into the «ON» position. The green indication light turns on;

CAUTION! In the test bench electrical circuit are by default provided some automatic mode configurations. Following keys with LED indicate their activation (Figure 4):

- 29 – the test mode selection key - **ALTERNATOR** (generator);
- 31 - the direct motor rotation key (clockwise direction);
- 34 - the **MOTOR STOP** key (motor off).

2.4.1. Press subsequently the following keys in accordance with Table 3:

- 27 - the voltage selection key - 12V, the battery charging control LED 22 **CHOKE DRIVE** turns on, imitating the control lamp on the vehicle dashboard;
- 33 - the motor start key.

2.4.2. Increase the motor speed by turning the adjuster 35 clockwise till the control LED **CHOKE DRIVE** light goes off.

2.4.3. Check the main characteristics: voltage (V); current (A) during the generator idle running according to the instruments indication;

2.4.4. The next pressing of the **CHOKE DRIVE** key will turn the LED indicator **CHOKE DRIVE** on, and releasing the key will turn it off (by the operable drive circuit).

2.4.5. Sequentially connect the load resistors (loads) «**R1 - R5**» by pressing the **LOAD SET** key on the control panel. Load values are shown in Table 4.

CAUTION! The maximum generator load (A) is shown on the generator marking label.

2.4.6. Check the voltage (V) and current (A) at maximum speed. Indicated values must correspond to the generators manufacturer catalog values.

Table 4.

Key marking	Load, A
R1	5
R2	10
R3	20
R4	30
R5	40
TOTAL	105

2.4.7. To turn off the test bench:

- Turn the adjuster 35 counterclockwise to decrease the drive motor rpm;
- Sequentially press the keys 4 **LOAD SET** to turn off the load resistors **R1- R5**;
- Set the speed control 35 to the starting position;
- Set the packet switch on the instrument panel into the «OFF» position. The green indication light turns off;
- Disconnect the cable-probe and the alligator clips from the generator;
- Open the guards;
- Unlock the tension lever by pushing the handle down and return it to its starting position;
- Remove the belt from the generator pulley;
- Loosen the fixture belt and remove the generator from the test bench.

Note: Switch the drive off with the 34 **MOTOR STOP** key, gradual decreasing the motor speed and stop the motor. All the loads **R1- R5** will be automatically disconnected.

2.5. Testing of the generator with «P-D» connection («MAZDA» type cars).

- Install and fix the generator in accordance with section 2.3.3.
- Connect to the generator the battery alligator clips: black clip (-), red clip (+);

- Plug the cable-probe into the slot 8 of the control panel to transmit the signal «P-D» to the generator;
- Set the packet switch on the instrument panel into the «ON» position. The green indication light turns on;
- Press subsequently the following keys:
 - 27 - the voltage selection key - 12V;
 - 33 - the MOTOR START key;

2.5.1. Increase the motor speed by turning the adjuster 35 clockwise and checking voltage (V) and current (A) during the generator idle running.

2.5.2. Increase the voltage by turning the adjuster 7 clockwise and monitor its value on the digital voltmeter.

2.5.3. Turn the adjuster 7 counterclockwise, reducing the voltage and monitoring its value.

2.5.4. Sequentially connect the load resistors «R1 - R5» and monitor the voltage and current values.

2.5.5. Rotate the adjuster 7 clockwise and counterclockwise adjusting the motor speed and monitor the voltage and current values in the load mode.

Indicated values must correspond to the generators manufacturer catalog values.

2.5.6. Turn off the test bench in accordance with section 2.4.7.

2.6. Testing of the generator with «SIG» connection («FORD» cars with continuous adjustment of the SIG signal).

- Install and fix the generator in accordance with section 2.3.3.
- Connect to the generator the battery alligator clips: black clip (-), red clip (+);
- Plug the cable-probe into the slot 6 of the control panel to transmit the signal «SIG» to the generator;
- Set the packet switch on the instrument panel into the «ON» position. The green indication light turns on;
- Press subsequently the following keys:
 - 27 - the voltage selection key - 12V;
 - 33 - the MOTOR START key;

2.6.1. Increase the motor speed by turning the adjuster 35 clockwise and checking voltage (V) and current (A) during the generator idle running.

2.6.2. Change the voltage value using the adjuster 5 (in «SIG» mode may vary from 13 V to 17 V) and set the optimum voltage value (14.5 ± 0.5) V. Check the current (A).

2.6.3. Sequentially connect the load resistors «R1 - R5» and set the maximum allowable load value indicated on the generator label.

Check the voltage and maximum current output.

2.6.4. Turn off the test bench in accordance with section 2.4.7.

2.7. Testing of the generator in «L/DFM» mode.

- Install and fix the generator in accordance with section 2.3.3.
- Connect to the generator the battery alligator clips: black clip (-), red clip (+);
- Plug the data-out cable-probes into the appropriate slots 16 DFM and 21 D+ to transmit the signal «L/DFM» to the generator;
- Set the packet switch on the instrument panel into the «ON» position. The green indication light turns on;
- Press subsequently the following keys:
 - 27 - the voltage selection key - 12V, the battery charging control LED 22 CHOKE DRIVE turns on, imitating the control lamp on the vehicle dashboard;
 - 33 - the motor start key.
- Increase the motor speed by turning the adjuster 35 clockwise till the control light 22 goes off.

2.7.1. Check the main characteristics: voltage (V), current (A) and «DFM» output during the generator idle running:

2.7.2. To control the «DFM» output are provided two indicator lights: 17 **HIGH** and 18 **LOW**. If the motor rpm increase, one of the indicator lights starts blinking at a certain frequency.

If the light is not blinking, press the 14 SWITCH key, changing the output signal frequency. The LED should start blinking.

2.7.3. Set the load appropriate to this generator type, the LED blinking frequency must change and the 15 DFM LED light turns on.

2.7.4. If the generator is operable the control LED CHOKE DRIVE should be on when the drive is switched off and the battery is connected.

If the signal from the «DFM» output is transmitted and control LED is turned on, the generator is operable. If the product is defective, the control LEDs HIGH and LOW are turned off.

2.7.5. Turn off the test bench in accordance with section 2.4.7.

2.8. Testing of the generators, controlled by the COM, LIN digital signals.

- Install and fix the generator in accordance with section 2.3.3;
- Connect to the generator the battery alligator clips: black clip (-), red clip (+);
- Plug the generator digital bus into the slot 12 of the «COM/LIN» signal;
- Set the packet switch on the instrument panel into the «ON» position. The green indication light turns on;
- Press subsequently the following keys:
 - 27 - the voltage selection key - 12V;
 - 33 - the MOTOR START key;

2.8.1. Connected unit automatically determines the digital bus type: COM or LIN, the LED unit 13 will indicate:

- yellow light - data bus COM;
- green light - data bus LIN.

2.8.2. Increase the motor speed by turning the adjuster 35 clockwise and checking voltage (V) and current (A) during the generator idle running.

2.8.3. If the generator is fully functional, the tests LEDs will periodically turn on.

2.8.4. The LEDs function (CD) and the trouble indication transmitted via the COM/LIN buses, are shown in Tables 2 and 6.

Table 6.

№ of the CD	CD status	Form of failure
1	On	COM/LIN data bus failure Ground fault COM/LIN bus break *CD 4 and 5 are off
2	On	Voltage generator stop Generator mechanism failure
3	On	Voltage regulator electronic assembly failure
4	On	LIN data bus is connected
5	On	COM data bus is connected

2.8.5. Change the voltage value within the specified range using the adjuster 11.

2.8.6. Check the main characteristics: voltage (V), current (A) and LEDs (Table 6) during the generator idle running and under load.

Alternating LEDs (CD) 1-2-3 blinking with the **COM** or **LIN** LEDs turned on during the operating cycle means that the generator is operable.

2.8.7. Turn off the test bench in accordance with section 2.4.7.

2.9. Testing of the generators with «FR» and «RLO» connections.

2.9.1 Testing is carried out following the procedure described in Section 2.6 “Testing of the generator with «SIG» connection”.

2.10. Testing of the generators without an integrated voltage regulator.

2.10.1. On the remote control panel is provided EXTERNAL REGULATOR with the A/B input (Figure 4 pos. 26) for generators without the built-in voltage regulator.

2.10.2. The regulator type is specified by the polarity control of the armature current and is set with the keys 24 A CIRCUIT and 25 B CIRCUIT.

Regulator type data are given in generator manufacturer catalogs.

2.10.3. Voltage regulators are built directly into the test bench and are connected to appropriate generator wires and probes before the testing start.

2.10.4. Further generators testing is carried out according to the procedures, depending on the generator type and given in the previous Operation Manual sections.

2.11. Starter testing mode.

CAUTION! Prior to the test start check the insulation between (+) and (-) in the product subject to the test!

2.11.1. Plug the terminal, imitating the car engine start, in the slot 3 50 (Figure 4).

2.11.2. Set the packet switch on the instrument panel into the «ON» position. The green indication light turns on.

2.11.3. Select the testing mode with the key 30 «STARTER».

2.11.4. The car starters are one 12V battery powered. To connect the battery press the key 27 on the test bench control panel.

The truck starters are powered from two series-connected 12V batteries (24V). To connect the batteries press the key 28 on the test bench control panel.

2.11.5. To start the starter press the 30 STARTER key (at the start the voltage increases), then the ammeter indicates the starter no-load current.

2.11.6. Check the main characteristics: voltage (V); current (A) during the idle running according to the instruments indication.

The parameters must comply with the technical characteristics specified in the starters' manufacturer catalog.

2.11.7. To test the starting relay press the 1 STARTER key, hold it for 2 seconds, then release.

Gear should come full circle and, when the button is released, return easy to the starting position.

2.11.8. After the starter shaft complete stop repeat the test (s. 2.10.7) twice at 5 seconds intervals.

CAUTION! Main parameters control time should not exceed 12 seconds.

2.12. Interlocking and indication.

2.12.1. Short-circuit protection is provided by safety devices 20A - 2 pcs. and 300A - 2 pcs.

2.12.2. Motor protection against overload and overvoltage during the operation with the misalignment and overloading of the drive belt, as well as with the faults of the generator mechanical parts.

Protection is provided by the motor control unit (VFD-EL inverter), which stops the motor and activates the audible alarm.

2.12.3. In order to protect the batteries from overload by synchronous switching of a starter and load resistors when operating in the «STARTER» mode the loads connection keys R1- R5 are blocked (no signal to the load resistors switching unit, resistors are released).

2.13. Test bench emergency shutdown.

In the test mode in case of emergency, press the red mushroom button of the test bench emergency stop.

The test bench will be de-energized and the emergency shutdown red indicator light will turn on.

Turn the mushroom button clockwise to return it to the stat position.

3. Safety measures.

3.1. Test bench complies with TU BY 101044101.004-2015, general safety requirements for industrial and garage equipment according to STB 960, GOST 12.2.003, general safety requirements to working area safety GOST 12.2.061 and general requirements to the vibration level GOST 12.1.012.

3.2. According to the electric shock protection degree test bench belongs to the class 1 according to GOST 12.2.007.0.

3.3. Test bench belongs to the class 1 with regard to protection against electric shock. Test bench Ingress Protection Rating is IP 40 according to GOST 14254.

3.4. Personnel, admitted to the test bench operation must study its structure, operating conditions and these safety requirements.

3.5. Operator must be safety and fire safety trained, must study the industrial hygiene requirements.

3.6. It is not allowed to operate the test bench with removed side covers and open generator pulley protection hinged cowl.

3.7. Generators and starters under test should be secured with the fixture.

3.8. Replacing and maintenance of the batteries should be carried out according to "The safety instructions of the batteries operation".

3.9. Batteries installed on the test bench must be connected with wires and terminals eliminating the possibility of sparking.

3.10. Connection and disconnection of the batteries must be carried out only on the disconnected test bench.

Strictly forbidden:

- to operate the test bench in the absence of operational documentation;
- to test the generators and starters with parameters not complying with the performance characteristics of the test bench;
- to use the safety devices other than specified in the technical specifications;
- to change the circuit and electrical installation of the test bench;
- to perform the maintenance and repair of the connected test bench;
- to open the sealed electrical components of the test bench;
- to install and remove the connected test bench elements;
- to affect the operation of the test bench;
- to use clamps and probes with impurities that could reduce the dielectric strength of the insulation.

3.12. The rest of the requirements for electrical equipment operation are presented in the "Rules of technical operation and safe servicing of the industrial electrical installations".

3.13. During the long service interruption test bench must be disconnected from the wall outlet.

4. Maintenance.

4.1. Test bench does not require special maintenance.

4.2. Periodically the routine inspection and maintenance should be carried out, which includes:

- dust removal from the equipment located within the housing of the test bench, from the instrument panel, the control and indication board and the outer surface of the housing;
- checking of the terminals contact surfaces (especially in high-circuits) and probe connectors, their cleaning or replacement, if necessary;
- checking of the power cord and plug technical condition;
- checking of the batteries technical condition;
- checking of the poly-V-belts. Following defects can be detected:
 - runout and hardening of the edges of the V-ribs;
 - transverse cracks on the reverse side of the belt;
 - mashing of the belt end edges;
 - transverse cracks and destruction of individual ribs;

In the presence of the above described defects the belt must be replaced.

4.3. Once a month checking of the motor pulley should be carried out. The grooves for V-belt and poly-V-belt should be smooth, without damage, burrs, dents, defects and impurities (especially grease and oil).

4.4. Maintenance of the motor drive should be made in accordance with the operating instructions for induction motors of AIR series.

4.5. Maintenance of the inverter should be made in accordance with the "Operation Manual for frequency inverters VFD-EL, Section 7".

Manufacturer - the DELTA ELECTRONICS Company.

5. Transportation and storage.

5.1. Transportation of the test benches is carried out in any roofed of transport under the following climatic conditions:

- ambient temperature from - 25 to + 40 ° C;
- relative humidity – up to 80% at + 25 °C.

5.2. By aircraft transportation the test benches should be placed in heated sealed compartments.

5.3. During handling operations should be followed the safety measures specified on the warning boards on the packaging.

5.4. For the test benches, packed in boxes according to GOST 2991 the transportation conditions, in terms of the of climatic factors impact – should correspond to the group 5 (OЖ4) GOST 15150, and terms of the of mechanical factors impact - should be average (C) according to GOST 23170.

5.5. Test benches can be transported without the package, provided that the consumer ensures reliable fixation and mounting of the test benches on the vehicle and protection it from atmosphere effect.

5.6. Other transportation and storage conditions are allowed, provided that it is specified in the documentation for a particular test bench.

5.7. Mechanical damage and surface contamination during transportation of the test bench are not permitted.

5.8. Test benches should be stored in a warehouse on the storage racks in their original packaging at ambient temperature from +5 to +40°C with relative humidity up to up to 80 % at 25°C.

5.9. The storage place should be free of dust, corrosive vapors (alkaline and acid vapors), gases, and other harmful corrosive impurities that can damage the wire insulation and cause metals corrosion.

5.10. Unpacked test benches are to be stored according to the following requirements: ambient air temperature - +25°C with relative humidity up to 80 %.

6. Disposal.

6.1. Test bench constitutes no danger to life, health and the environment, so disposal is performed in a regular way.

7. Manufacturer warranty.

7.1. Warranty period of the test bench ME-1 is 1 year from the date of sale, but not more than 18 months from the manufacturing date, provided that the customer follows the instructions for the operation of the instrument, shipping and storage described in the Operation manual.

7.2. The warranty period starts from the date of sale, confirmed in the appropriate section of Passport to the test bench.

7.3. Warranty period of the motor - in accordance with the motor manufacturer's warranty (see AIR motor Passport).

7.4. Manufacturer's warranty does not cover the V-belts, poly-V-belts and switching wire-probes.

7.5. Warranty does not cover the test bench in the presence of defects resulting from improper use, broken seals of the electrical components, self-modification of the test bench, as well as deferred maintenance (see Section 4 of the Operation Manual).

APPENDIX A

(obligatory)

Potential faults, their causes and remedies

Problem	Possible cause	Remedy
The test bench cannot power on	No supply voltage Safety device 300 A is broken	Check the supply voltage Replace the safety device
Battery doesn't charge from an external charger	Safety device 20 A is broken	Replace the safety device
Digital instruments display incorrect measured values	Bad contact between probes and panel slots or products under test Digital instrument is broken	Clear the contacts of the probes and panel slots or replace the probes Replace the digital voltmeter or the ammeter
Heavy test bench housing vibration during the generator test on a high speed	The test bench housing is not leveled on the foundation Motor is loose to the housing	Level the housing with the help of four adjustable feet Tighten motor bolts
Noise, screech sound and vibration accompany the V-belt or poly-V-belt operation	Overload and distortion of the belt during the generator installation Excessive wear of the belt or pulley	Adjust the coaxiality of the pulleys and the belt tension Replace the belt Replace the pulley
Motor overheating during operation	Motor ventilation breakdown	Clean the air channel on the cowl
At the beginning of the generator testing the rotor is not rotated when idle	Discharged battery There is a load that blocks the inverter	Charge the battery up to the level specified in the documentation Eliminate the cause of the frequency inverter overload
The control panel buttons are pressed, the mechanisms are switched on, but the buttons LEDs aren't on	Control panel elements failure	Repair or replace the control panel

Note: Troubleshooting of the motor and inverter is described in:

- the operating manual for the AIR series induction motors;
- the operating manual for the VFD-EL frequency inverters (manufactured by the DELTA ELECTRONICS company).

In the event of other faults please contact your nearest "Motorherz Equipment" trade representative.

APPENDIX B

(Informative)

TYPE CODES FOR THE TERMINALS OF THE GENERATOR VOLTAGE REGULATOR

"A" – the same as "IG"; "I" (Ignition) – ignition on/off input.

"AS" (Alternator Sense) – (Ford) – the same as "S".

"B+" – battery (+).

"B-" – battery (-).

"C" (Computer) – voltage regulator input from the engine control unit (Honda).

Voltage applied to this input (-) will not exceed 12,5V at the generator output. This is one of the ways of the generator load reduction, similar to the function of LRC regulator.

"COM" – bidirectional single-wire bus of the generator control and diagnostic with the "BSD" (Binary Serial Data) or "BSS" interfaces.

"D+" – (+) terminal of the additional diode bridge for the voltage regulator supply. Is used to connect the indicator light, carrying out the initial voltage supply and generator performance indication.

"D" (Drive) – regulator control input with the P-D terminal of the Mitsubishi (Mazda) and Hitachi generators.

"D" (Dummy) – Dummy, for example, in DENSO generators.

"DF" – the same as "F".

"DFM" (Digital Field Mode) – the same as "FR".

"E" (Earth) – ground, battery (-).

"F" (Field) – voltage regulator output.

"FLD" – the same as "F".

"FR" (Field Reports) – output to control the generator load with the engine control unit.

"L" (Lamp) – Output of the indicator light of the generator performance indication.

"LI" (Load Indicator) – (Ford) – the same as "FR", only with inversion.

"LIN" – bidirectional single-wire bus of the generator control and diagnostic with the "LIN" (Local Interconnect Network) interface.

"M" (Monitor) – the same as "FR".

"N" (Null) – output of the stator windings midpoint. Is used to control the generator performance indication light with the mechanical voltage regulator.

"P" (Phase) – output from one of the stator windings. Is used to identify the generator excited state with the voltage regulator.

"RC" (Regulator Control) – (Ford) – the same as "SIG".

"RLO" – (TOYOTA) – input of the voltage control of the regulator stabilization.

"RVC" (Regulated Voltage Control) – the same as "RLO".

"S" (Sense) – sensor, input for comparing the voltage at the check point. The check point is located in the fuse block near the battery (CHARGE fuse).

"SIG"; "S" (Signal) – (Ford, Magneti – Marelli) – input of the code voltage setting (PWM with 125Hz frequency).

"STA" (Stator) – the same as "P".

"W" (Wave) – output from one of the stator windings to connect tachometer in diesel engines vehicles.