

4A. Alternator, Option, 12V/35A [Except 1GM10(C)]

The alternator serves to keep the battery constantly charged. It is installed on the cylinder block by a bracket, and is driven from the V-pulley at the end of the crankshaft by a V-belt.

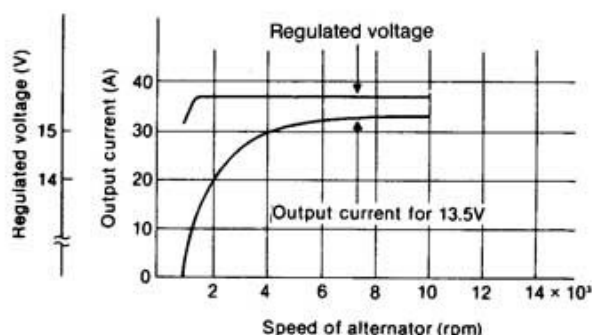
The type of alternator used in this engine is ideal for high speed engines having a wide range of engine speeds. It contains diodes that convert AC to DC, and an IC regulator that keep the generated voltage constant even when the engine speed changes.

4A-1. Features

The alternator contains a regulator using an IC, and has the following features.

- (1) The IC regulator, which is self-contained, has no moving part (mechanical contact point), therefore it has superior features such as, freedom from vibration, no fluctuation of voltage during use, and no need for readjustment. Also, it is of the over-heating compensating type and can automatically adjust the voltage to the most suitable level depending on the operating temperature.
- (2) The regulator is integrated within the alternator to simplify external wiring.
- (3) It is an alternator designed for compactness, light weight, and high output.
- (4) A newly developed U-shaped diode is used to provide increased reliability and easier checking and maintenance.
- (5) As the alternator is to be installed on board, the following countermeasures are taken to provide salt-proofing.
 - 1) The front and rear covers are salt-proofed.
 - 2) Salt-proof paint is applied to the diode.
 - 3) The terminal, where the harness inboard is connected to the alternator, is nickel plated.

4A-3. Characteristics



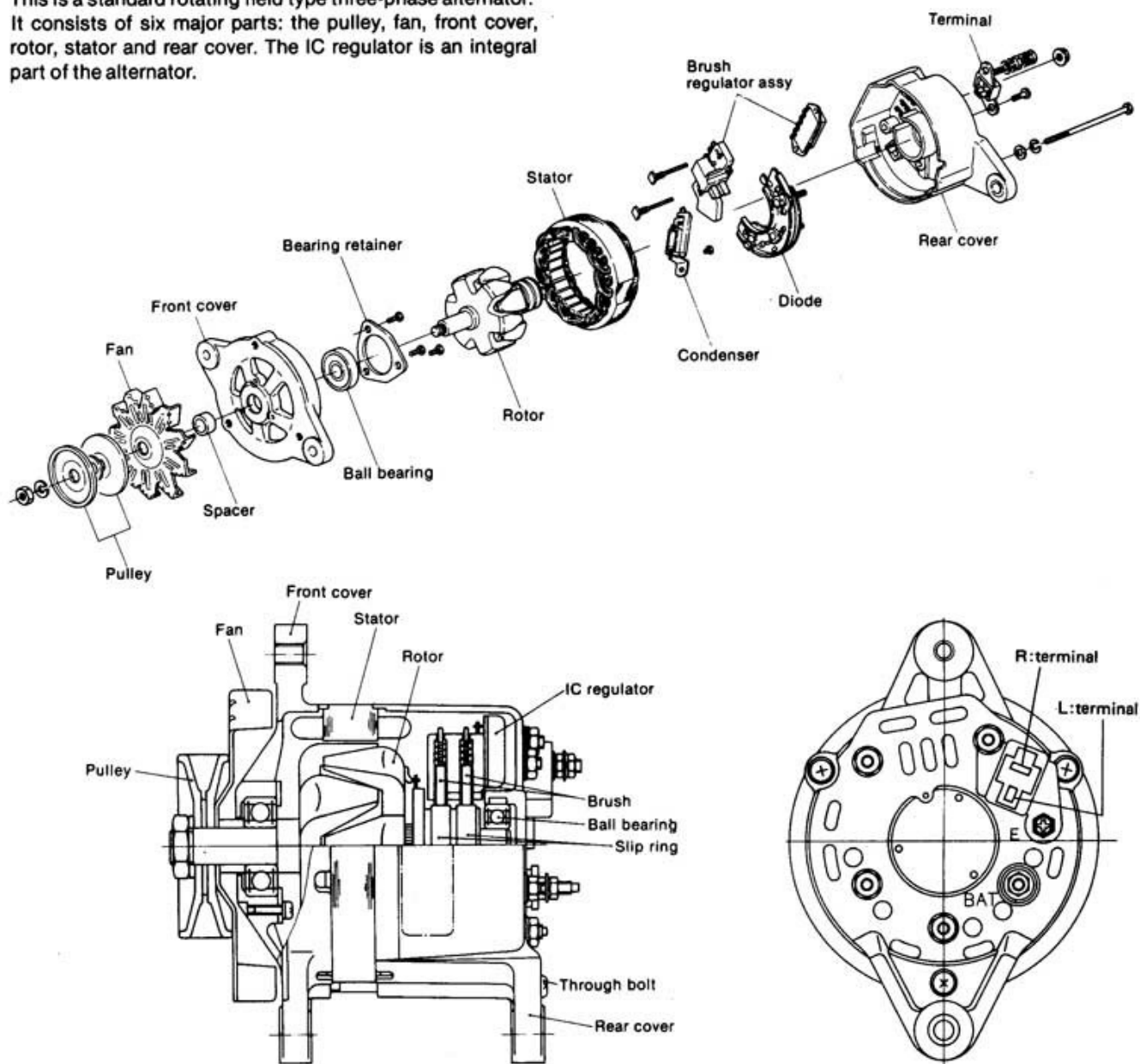
4A-2. Specifications

Model of alternator	LR135-105 (HITACHI)
Model of IC regulator	TR1Z-63 (HITACHI)
Battery voltage	12V
Nominal output	12V, 35A
Earth polarity	Negative earth
Direction of rotation (viewed from pulley end)	Clockwise
Weight	3.5 kg (7.7 lb)
Rated speed	5000 rpm
Operating speed	900 ~ 8000 rpm
Speed for 13.5V	900 rpm or less
Output current (when heated)	5000 rpm 32±2A
Regulated voltage	14.5±0.3V (at 20°C, Full battery)
Standard temperature/voltage gradient	-0.01V/°C

LR135-74

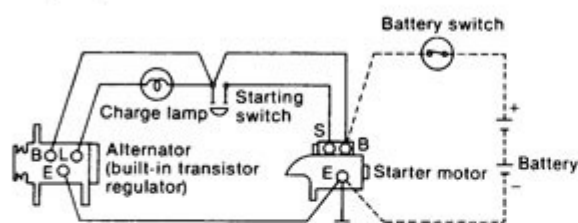
4A-4. Construction

This is a standard rotating field type three-phase alternator. It consists of six major parts: the pulley, fan, front cover, rotor, stator and rear cover. The IC regulator is an integral part of the alternator.



4A-5. Wiring

(1) Wiring diagram



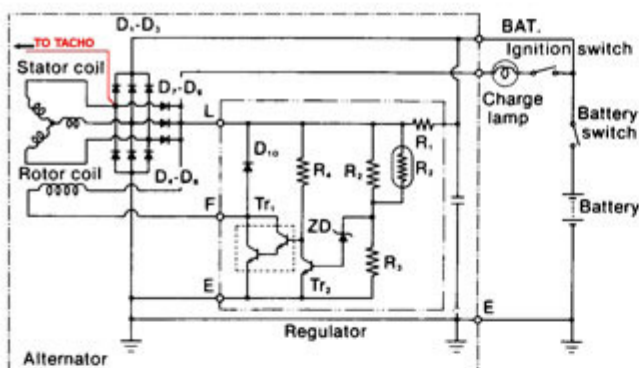
(2) Terminal connections

The alternator has the following terminals. Connect these terminals as indicated below.

Symbol	Terminal name	Connection to external wiring
B	Battery terminal	To battery (+) side
E	Ground terminal	To battery (-) side
L	Lamp (charge) terminal	To charge lamp terminal

4A-6. Circuit diagram

4A-6.1 Circuit diagram



BAT: Battery output terminal
L: Charge lamp terminal
E: Earth
D₁ ~ D₆: Diodes for rectifying the output current
D₁ ~ D₄: Diodes for switching the charge lamp
D₅: Diode for protecting the IC
ZD: Zener diode
Tr₁, Tr₂: Transistors
R₁ ~ R₁₀: Resistors
F: Rotor current
Rn: Thermistor (resistors with current/temperature gradient)

4A-6.2 Principle of IC regulator function

The IC regulator controls the output voltage of the alternator by switching the rotor current (exciting current) on or off by means of the transistor Tr, which is connected in series with the rotor coil.

When the output voltage of the alternator is within the regulated values, transistor Tr, is "ON" but when the voltage is outside the regulated value, the Zener diode ZD comes "ON", and regulates the output voltage rise by turning transistor Tr, "OFF".

The output voltage is kept within the regulated values by repeating the "ON"—"OFF" operation.

4A-7. Alternator handling precautions

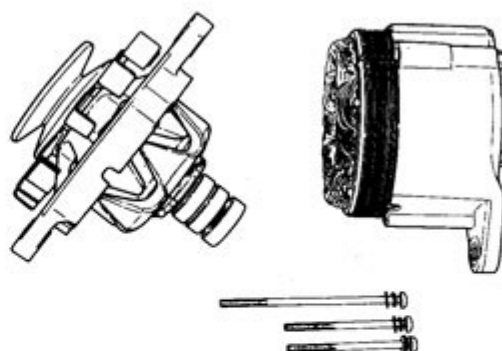
- (1) Pay attention to the polarity of the battery; be careful not to connect it in reverse polarity. If the battery is connected in reverse polarity, the battery will be shorted by the diode of the alternator, an overcurrent will result, the diodes and transistor regulator will be destroyed, and the wiring harness will be burned.
- (2) Connect the terminals correctly.
- (3) When charging the battery from outside, such as during rapid charging, disconnect the alternator B terminal or the battery terminals.
- (4) Do not short the terminals.
- (5) Never test the alternator with a high voltage meter.

4A-8. Alternator disassembly

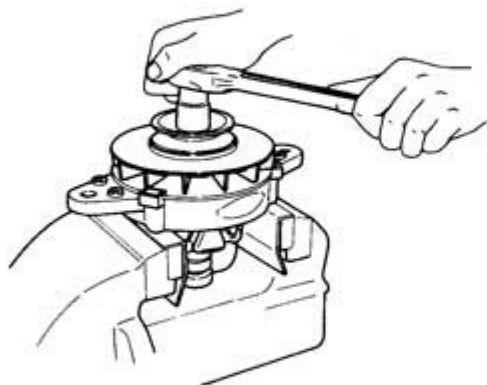
Disassemble the alternator as follows.

The major points of disassembly are the removal of the cover, the separation of the front and rear sides, and detailed disassembly.

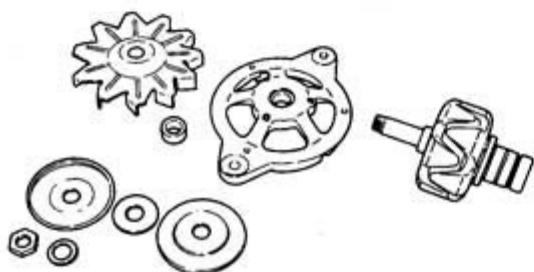
- (1) Remove the cover attached to the rear cover, remove the through bolts, and disassemble into front and rear sides.



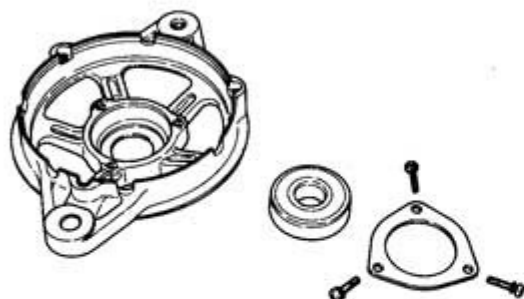
- (2) When disassembling the front side pulley and fan, front cover and rotor, clamp the rotor in a vice within copper plates and loosen the pulley nut, as shown in the figure.



- (3) When the fan and pulley have been removed, the rotor can be pulled from the front cover by hand.

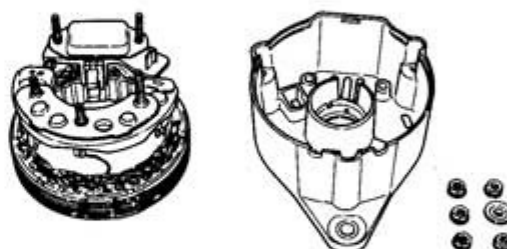


- (4) Next, remove the bearing attached to the front cover. Loosen the bearing protector mounting bolts (M4) and pull the bearing by applying pressure to the bearing from the front cover.



- (5) Remove the nut at the threaded part of the BAT terminal on the rear cover, the fixing nut of the diode, and the bolt of E terminal.

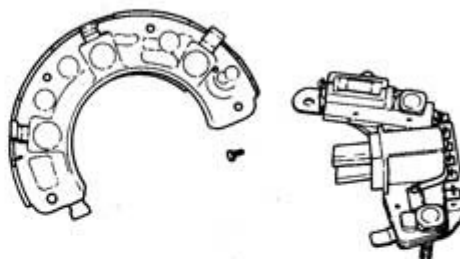
After removing the L terminal assembly, separate the alternator into rear cover and stator (with attached diode and brush holder).



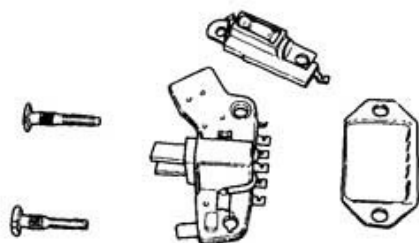
- (6) Unsolder the lead wire connection and remove the diode assembly together with the regulator assembly.



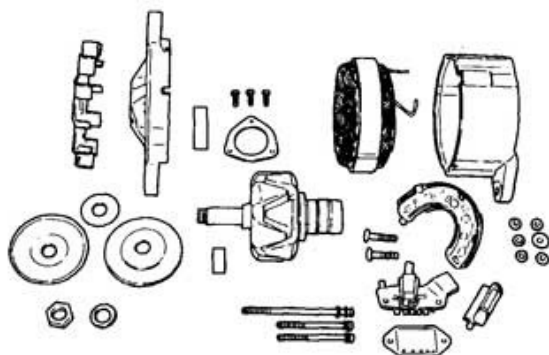
- (7) Separate the diode assembly and the brush regulator assembly by removing the 3mm dia rivet which connects these two parts and then unsolder the L terminal connection.



- (8) When replacing the IC regulator, it can be removed by unsoldering the regulator's terminals and removing two bolts. Never remove these two bolts except when the regulator is replaced.



- (9) When (1)–(8) above are completed, the alternator is completely disassembled.

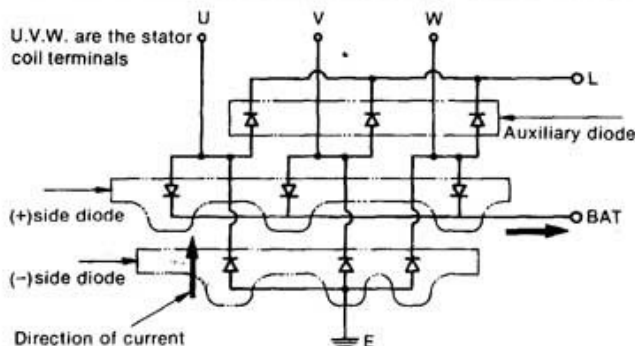


4A-9. Inspection and adjustment

4A-9.1 Diodes

	Between terminal		BAT (+ side diode)	
	Tester pin		(+) side	(-) side
U.V.W	(+) side	—	—	Continuity No
	(-) side	Continuity Yes	—	—

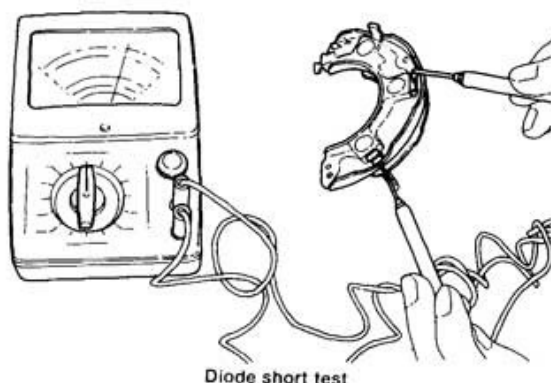
	Between terminal		E (- side diode)	
	Tester pin		(+) side	(-) side
U.V.W	(+) side	—	Continuity Yes	—
	(-) side	Continuity No	—	—



Electric current flows only in one direction in the diode as shown on the previous page. By testing the continuity between terminals (e.g. BAT and U) with the continuity tester, (as shown in the picture), the diode is determined as usable when the continuity is "Yes", but is faulty when it "No".

Connect the tester in the reverse way, and then the diode is usable when continuity is "No", but faulty when "Yes". If a faulty diode is found in this test, replace it with a complete new diode assembly.

As the auxiliary diode does not have a terminal, check the continuity between its ends.



CAUTION: If a high voltage meter is used, a high voltage will be applied to the diode and the diode will be destroyed. Therefore, never test the diodes with a high voltage meter, etc.

4A-9.2 Rotor

(1) Slip ring wear

Because the slip rings wear very little, the diameter of the rings must be measured with a micrometer. Replace the rings (rotor assembly) when wear exceeds the maintenance standard by 1mm. (0.0393in.)

	Maintenance standard	Wear limit
Slip ring outside diameter	ø31.6 (1.2441)	ø30.6 (1.2047)

(2) Slip ring roughness

The slip ring should be smooth with no surface oil, etc. If the surface of the rings is rough, polish with #500 ~ #600 sandpaper, and if the surface is soiled, clean with a cloth dipped in alcohol.

(3) Rotor coil short test

Check the continuity between the rotor coil and slip ring with a tester. The resistance should be near the prescribed value.

If the resistance is extremely low, there is a layer short at the rotor coil; if the resistance is infinite, the coil is open. In either case, replace the rotor.



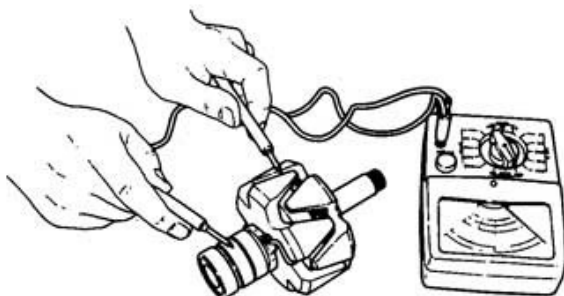
Resistance value	Approx. 3.1 Ω (at 20°C)	LR135-105
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(4) Rotor coil ground test

Check the rotor coil for grounding with a tester, or by checking the continuity between one slip ring and the rotor core or shaft.

Usable if the continuity is "No".

If "Yes", replace it as the rotor coil is grounded.



4A-9.3 Stator coil

(1) Stator coil short test

Check the continuity between the terminals of the stator coil. Measure the resistance between the output terminals with a tester. The resistance should be near the prescribed value.

If the stator coil is open, indicated by infinite resistance, it must be replaced.



Resistance value	Approx. 0.16 Ω (at 20°C) 1-phase resistance	LR135-105
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(2) Stator coil ground test

Check the continuity between one of the stator coil leads and the stator core.

The stator coil is good if the resistance is infinite. If the stator core is grounded, indicated by continuity, it must be replaced.

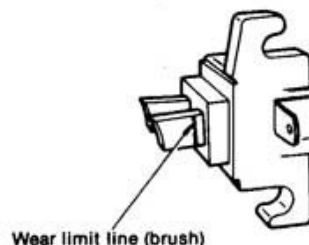


4A-9.4 Brush

(1) Brush wear

Check the brush length.

The brush wears very little, but replace the brush if worn over the wear limit line printed on the brush.

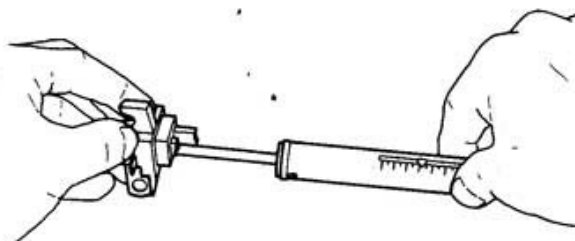


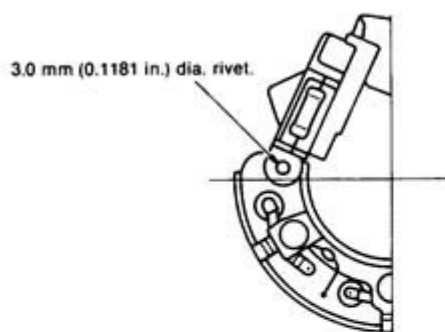
	mm (in.)	
	Maintenance standard	Wear limit
Brush length	16 (0.6299)	9 (0.3543)

(2) Brush spring pressure measurement.

Measure the pressure with the brush protruding 2mm from the brush holder, as shown in the figure. The spring is normal if the measured value is over 150 gr.

Confirm that the brush moves smoothly in the holder.





Rivetting pressure	500 kg (1102 lbs)
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(3) Assembling rear cover

Assemble the rear cover after inserting the pin from outside and fitting the brush into the brush holder.

(4) Tightening torque of each part

	kg-cm (ft.-lb)
Fixing flange holder	32 ~ 40 (2.31 ~ 2.89)
Fixing diode	32 ~ 40 (2.31 ~ 2.89)
Fixing bearing retainer	16 ~ 20 (1.16 ~ 1.45)
Tightening pulley nut	350 ~ 400 (25.32 ~ 28.93)
Tightening through bolt	32 ~ 40 (2.31 ~ 2.89)

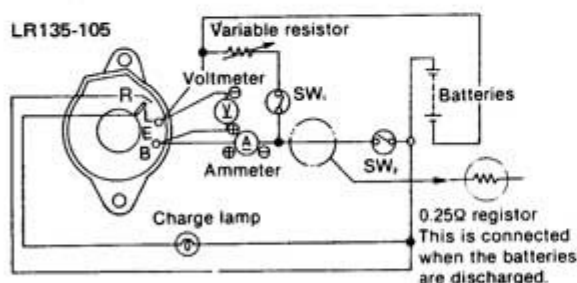
4A-11 Alternator performance test

4A-11.1 Test equipment

Test equipment	Quantity	Specifications
Battery	1	12V
DC voltmeter	1	0 ~ 30V Range 0.5
DC ammeter	1	0 ~ 50A Range 1.0
Variable resistor	1	0 ~ 0.25Ω capacity: 1 kW
Switch	2	Switch capacity: 40A
Tachometer	1	
0.25Ω resistor	1	25W

4A-11.2 Performance test circuit

When the circuit is connected the charge lamp will light.



4A-11.3 Performance test

(1) Speed measurement at 13.5V.

1) Run the alternator up to a speed of approx. 1500 rpm with SW₁ and SW₂ open.

Then reduce speed gradually and measure the rpm when the voltage reaches 13.5V.

2) This value is called the "rpm at 13V" and is acceptable if 1000 rpm or below.

(The alternator speed at which the lamp goes on or off is 1500 rpm, or 1000 rpm or below, respectively, and there are different conditions for each of the two cases.)

(2) Voltage measurement. Acceptable within the range of 14.3 ± 1.3V and when the generator rpm is 5000, SW₁ is open and SW₂ is closed, the temperature is 20°C and using two batteries.

(Confirm that the ammeter is 5A or below. If over 5A, connect the 0.25Ω resistor.)

(3) Measurement of output current

1) In the circuit shown in figure, set the variable resistor at the minimum value, close SW₁ and SW₂, and run the alternator.

2) While keeping the voltage at 13.5V by adjusting the variable resistor, increase the alternator speed, and measure the current at 2500 rpm and 5000 rpm.

Acceptable current values	32A at 5000 rpm	LR135-105
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(4) Remarks on performance test

a) For the test leads, use cable with a cross-sectional area of 8mm² or more and with a length not exceeding 2.5m between the alternator B terminal and the positive terminal of the battery, and between the S terminal and the negative terminal of the battery.

b) Switches with low contact resistance are to be used in the circuit.

4A-12. Standards of adjustment

	LR135-105
Standard height of brush	16mm (0.6299in.)
Limit of reduced height	9mm (0.3543in.)
Strength of brush spring	255 ~ 345g (0.56 ~ 0.76 lb)
Standard dimension of shaft at front end	15mm (0.5906in.)
Part No. of ball bearing	6302 BM
Standard dimension of shaft at rear end	12mm (0.4724in.)
Part No. of ball bearing	6201 SD
Resistance of rotor coil (at 20°C)	3.1Ω
Resistance of stator coil single phase (at 20°C)	1.6Ω
Standard O.D. of slip ring	31.6mm (1.244in.)
Limit of reduced size (diameter)	1mm (0.0394in.)
Limit of swing correction	0.3mm (0.0118in.)
Accuracy of swing correction	0.05mm (0.0070in.)

4A-13. Alternator troubleshooting and repair

(1) Failure to charge

Problem	Cause	Corrective action
Wiring, current	Open, shorted, or disconnected	Repair or replace
Alternator	Open, grounded, or shorted coil Terminal insulator missing Diode faulty	Replace Repair Replace
Transistor regulator	Transistor regulator faulty	Replace regulator

(2) Battery charge insufficient and discharge occurs easily

Problem	Cause	Corrective action
Wiring	Wiring shorted or loose, wiring thickness or length unsuitable	Repair or replace Replace
Generator	Rotor coil layer short Stator coil layer short; One phase of stator coil open Slip ring dirty V-belt loose Brush contact faulty Diode faulty	Replace Replace Clean or polish Retighten Repair Replace

(3) Battery overcharged

Problem	Cause	Corrective action
Battery	Electrolyte low or unsuitable	Add distilled water Adjust specific weight Replace
Transistor regulator	Regulator transistor shorted	Replace regulator

(4) Current charge unstable

Problem	Cause	Corrective action
Wiring	Wiring shorted at a break in the covering due to hull vibration or intermittent contact at break	Repair or replace
Alternator	Layer short Balance spring damaged Slip ring dirty Coil open	Replace Replace Replace Repair or replace