ENGINE ELECTRICAL

CONTENTS

E16AA--

 PWDE9104-B REVISED

CHARGING SYSTEM

SPECIFICATIONS

GENERAL SPECIFICATIONS

E16BA–

ALTERNATOR

<4G93>

Items	M/T – standard (Vehicles with catalytic converter)	A/T – standard (Vehicles with catalytic converter)	Vehicles for cold climate zone and vehicles without catalytic converter
Type	Battery voltage sensing	Battery voltage sensing	Battery voltage sensing
Rated output V/A	12/60	12/65	12/75 (70*)
Voltage regulator	Electronic built-in type	Electronic built-in type	Electronic built-in type

NOTE
*: Vehicles built from August 1992

<4G63, 4G64>

Items	Specifications
Type	Battery voltage sensing
Rated output V/A	12/75
Voltage regulator	Electronic built-in type

<4D65, 4D68>

Items	Specifications
Type	Battery voltage sensing
Rated output V/A	12/65
Voltage regulator	Electronic built-in type

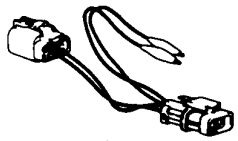
SERVICE SPECIFICATIONS

E16BB–

Items	Specifications
Alternator	
Standard value	
Regulated voltage	
Ambient temp. at voltage regulator V	
–20°C (–4°F)	14.2–15.4
20°C (68°F)	13.9–14.9
60°C (140°F)	13.4–14.6
80°C (176°F)	13.1–14.5
Limit	
Output current	70 % of nominal output current

SPECIAL TOOL

E16BF--

Tool	Number	Name	Use
	MD998467	Alternator harness connector	Checking the alternator (S terminal voltage)

NOTES

SERVICE ADJUSTMENT PROCEDURES

E16BGAG

This test determines whether the wiring from the alternator "B" terminal to the battery (+) terminal (including the fusible link) is in a good condition or not.

(1) Always be sure to check the following before the test.
- Alternator installation
- Alternator drive belt tension (Refer to GROUP 11 – Service Adjustment Procedures.)
- Fusible link
- Abnormal noise from the alternator while the engine is running

(2) Turn the ignition switch to the OFF position.

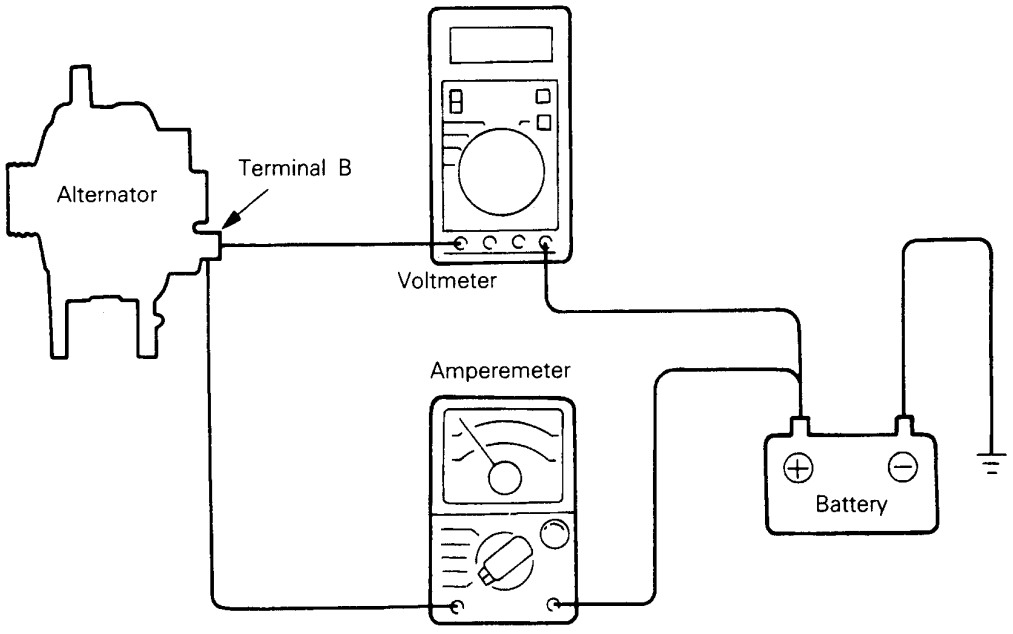
(3) Disconnect the negative battery cable.

(4) Disconnect the alternator output wire from the alternator "B" terminal and connect a DC test ammeter with a range of 0 – 100 A in series between the "B" terminal and the disconnected output wire. (Connect the (+) lead of the ammeter to the "B" terminal, and then connect the (–) lead of the ammeter to the disconnected output wire.)

NOTE
A clamp-type ammeter which enables measurements to be taken without disconnecting the alternator output wire should be recommended. Because, if a vehicle in which the voltage may have dropped due to an imperfect connection at the alternator "B" terminal is being inspected, and so if the alternator "B" terminal is loosened and a test ammeter is connected, the connection will be complete at the time of connection and the possibility of finding problems will be reduced.

(5) Connect a digital-type voltmeter between the alternator "B" terminal and the battery (+) terminal. (Connect the (+) lead of the voltmeter to the "B" terminal, and then connect the (–) lead of the voltmeter to the battery (+) cable.)

VOLTAGE DROP TEST OF ALTERNATOR OUTPUT LINE



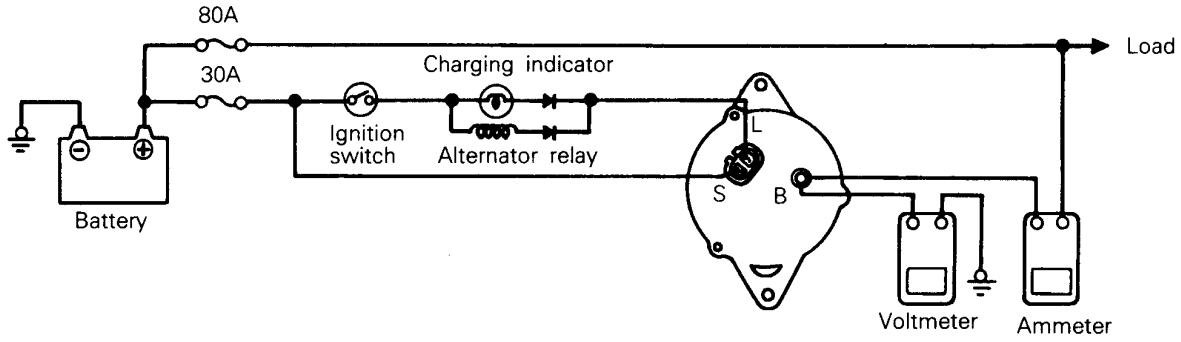
5EL0015

(6) Connect a tachometer. (For the procedure for connecting the tachometer, refer to GROUP 11 – Service Adjustment Procedures.)
(7) Reconnect the negative battery cable.
(8) Leave the hood open.
(9) Start the engine.
(10) With the engine running at 2500 r/min., turn the headlamps and other lamps on and off to adjust the alternator load so that the value displayed on the ammeter is slightly above 30 A.
Adjust the engine speed by gradually decreasing it until the value displayed on the ammeter is 30 A. Take a reading of the value displayed on the voltmeter at this time.
Limit value: Max. 0.3 V

NOTE
When the alternator output is high and the value displayed on the ammeter does not decrease until 30A, set the value to 40A. Read the value displayed on the voltmeter at this time.
In this case the limit value becomes max. 0.4V.

(11) If the value displayed on the voltmeter is above the limit value, there is probably a malfunction in the alternator output wire, so check the wiring between the alternator "B" terminal and the battery (+) terminal (including fusible link).
If a terminal is not sufficiently tight or if the harness has become discolored due to overheating, repair and then test again.
(12) After the test, run the engine at idle.
(13) Turn off all lamps and turn the ignition switch to the OFF position.
(14) Disconnect the negative battery cable.
(15) Disconnect the ammeter, voltmeter and tachometer.
(16) Connect the alternator output wire to the alternator "B" terminal.
(17) Connect the negative battery cable.

OUTPUT CURRENT TEST



16P0482

This test determines whether the alternator outputs normal current.

(1) Before the test, always be sure to check the following.
- Alternator installation
- Battery (Refer to GROUP 54 – Battery.)

NOTE
The battery to be used should be slightly discharged. The load in a fully-charged battery will be insufficient and the test may not be able to be carried out correctly.
- Alternator drive belt tension (Refer to GROUP 11 – Service Adjustment Procedures.) dures.)
- Fusible link
- Abnormal noise from the alternator while the engine is running.

(2) Turn the ignition switch to the OFF position.
(3) Disconnect the negative battery cable.
(4) Disconnect the alternator output wire from the alternator "B" terminal and connect a DC test ammeter with a range of 0 – 100 A in series between the "B" terminal and the disconnected output wire. (Connect the (+) lead of the ammeter to the "B" terminal, and then connect the (–) lead of the ammeter to the disconnected output wire.)

Caution
Never use clips but tighten bolts and nuts to connect the line. Otherwise loose connections (e.g. using clips) will lead to a serious accident because of high current.

NOTE
A clamp-type ammeter which enables measurements to be taken without disconnecting the alternator output wire should be recommended.

(5) Connect a voltmeter with a range of 0–20 V between the alternator "B" terminal and the earth. (Connect the (+) lead of the voltmeter to the "B" terminal, and then connect the (–) lead of the voltmeter to the earth.)
(6) Connect a tachometer. (For the procedure for connecting the tachometer, refer to GROUP 11 – Service Adjustment Procedures.)
(7) Connect the negative battery cable.
(8) Leave the hood open.
(9) Check to be sure that the reading on the voltmeter is equal to the battery voltage.

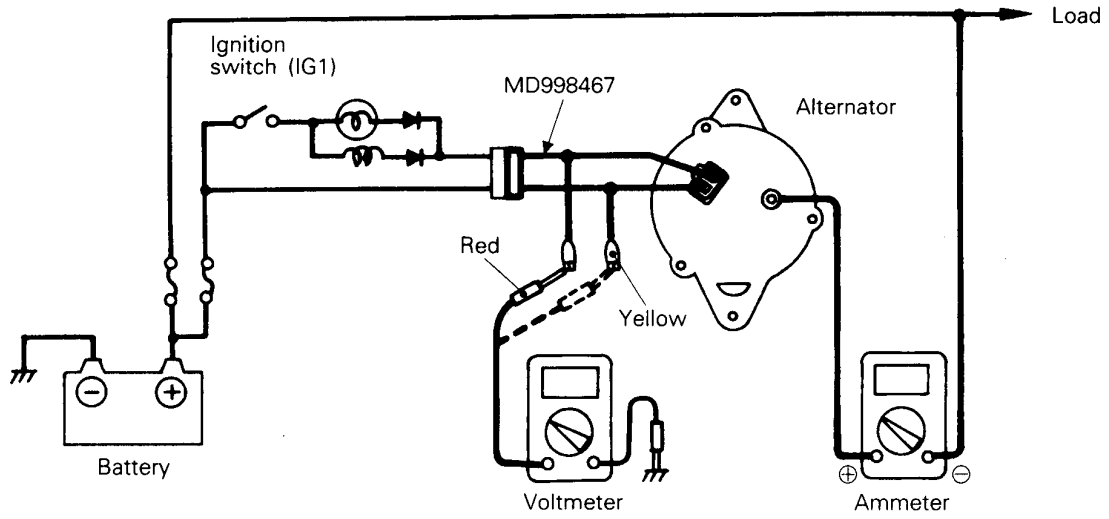
NOTE
If the voltage is 0 V, the cause is probably an open circuit in the wire or fusible link between the alternator "B" terminal and the battery (+) terminal.

(10) After turning the light switch on and turning on the headlamps, start the engine.
(11) Immediately after setting the headlamps to high beam and turning the heater blower switch to the high revolution position, increase the engine speed to 2,500 r/min. and read the maximum current output value displayed on the ammeter.
Limit value: 70% of normal current output

NOTE
- For the nominal current output, refer to the Alternator Specifications.
- Because the current from the battery will soon drop after the engine is started, the above step should be carried out as quickly as possible in order to obtain the maximum current output value.
- The current output value will depend on the electrical load and the temperature of the alternator body.
- If the electrical load is small while testing, the specified level of current may not be output even though the alternator is normal. In such cases, increase the electrical load by leaving the headlamps turned on for some time to discharge the battery or by using the lighting system in another vehicle, and then test again.
- The specified level of current also may not be output if the temperature of the alternator body or the ambient temperature is too high. In such cases, cool the alternator and then test again.

(12) The reading on the ammeter should be above the limit value. If the reading is below the limit value and the alternator output wire is normal, remove the alternator from the engine and check the alternator.
(13) Run the engine at idle speed after the test.
(14) Turn the ignition switch to the OFF position.
(15) Disconnect the negative battery cable.
(16) Disconnect the ammeter, voltmeter and tachometer.
(17) Connect the alternator output wire to the alternator "B" terminal.
(18) Connect the negative battery cable.

REGULATED VOLTAGE TEST



This test determines whether the voltage regulator is correctly controlling the alternator output voltage.

(1) Always be sure to check the following before the test.
- Alternator installation
- Check to be sure that the battery installed in the vehicle is fully charged. (Refer to GROUP 54 – Battery.)
- Alternator drive belt tension (Refer to GROUP 11 – Service Adjustment Procedures.)
- Fusible link
- Abnormal noise from the alternator while the engine is running

(2) Turn the ignition switch to the OFF position.
(3) Disconnect the negative battery cable.
(4) Connect a digital-type voltmeter between the alternator "S" terminal and the earth. (Connect the (+) lead of the voltmeter to the "S" terminal, and then connect the (–) lead of the voltmeter to a secure earth or to the battery (–) terminal.)
(5) Disconnect the alternator output wire from the alternator "B" terminal.
(6) Connect a DC test ammeter with a range of 0 – 100 A in series between the "B" terminal and the disconnected output wire. (Connect the (+) lead of the ammeter to the "B" terminal, and then connect the (–) lead of the ammeter to the disconnected output wire.)
(7) Connect a tachometer. (Refer to GROUP 11 – Service Adjustment Procedures.)
(8) Reconnect the negative battery cable.
(9) Turn the ignition switch to the ON position and check that the reading on the voltmeter is equal to the battery voltage.

NOTE
If the voltage is 0 V, the cause is probably an open circuit in the wire or fusible link between the alternator "S" terminal and the battery (+) terminal.

(10) Check to be sure that all lamps and accessories are off.

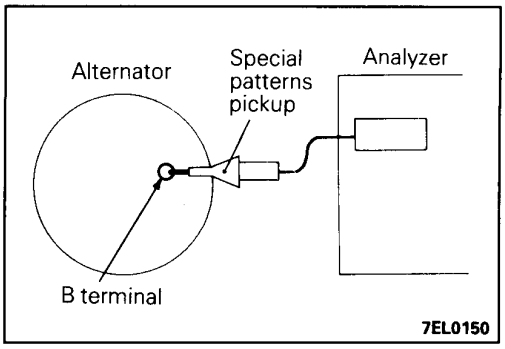
(11)Start the engine.
(12)Increase the engine speed to 2,500 r/min.
(13)Read the value displayed on the voltmeter when the current output by the alternator becomes 10 A or less.
(14)If the voltage reading conforms to the value in the voltage regulation table, then the voltage regulator is operating normally.
If the voltage is outside the standard value, there is a malfunction of the voltage regulator or of the alternator.

Voltage Regulation Table

Inspection terminal	Voltage regulator ambient temperature °C (°F)	Standard value V
Terminal "S"	–20 (–4)	14.2–15.4
	20 (68)	13.9–14.9
	60 (140)	13.4–14.6
	80 (176)	13.1–14.5

(15)After the test, lower the engine speed to the idle speed.
(16)Turn the ignition switch to the "OFF" position.
(17)Disconnect the negative battery cable.
(18)Disconnect the ammeter, voltmeter and tachometer.
(19)Connect the alternator output wire to the alternator "B" terminal.
(20)Connect the negative battery cable.

NOTES



CHECKING WITH AN ANALYZER

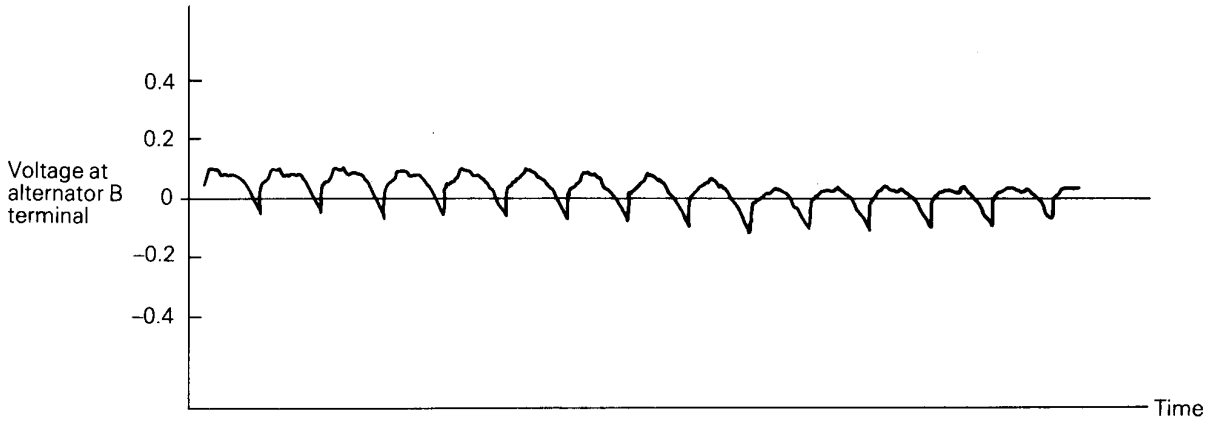
MEASUREMENT METHOD

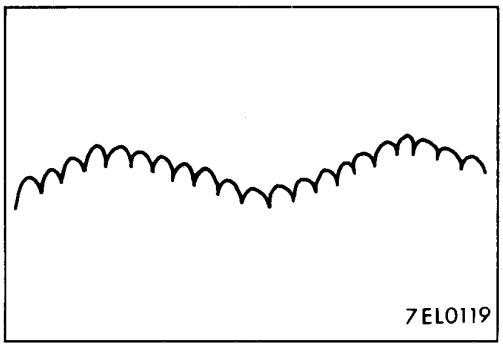
Connect the analyzer special patterns pick-up to the alternator B terminal.

STANDARD WAVEFORM

Observation Conditions

FUNCTION	SPECIAL PATTERNS
PATTERN HEIGHT	VARIABLE
VARIABLE knob	Adjust while viewing the wave pattern
PATTERN SELECTOR	RASTER
Engine revolutions	Idle (Vehicles with catalytic converter: 800 r/min., Vehicles without catalytic converter: 700 r/min.)

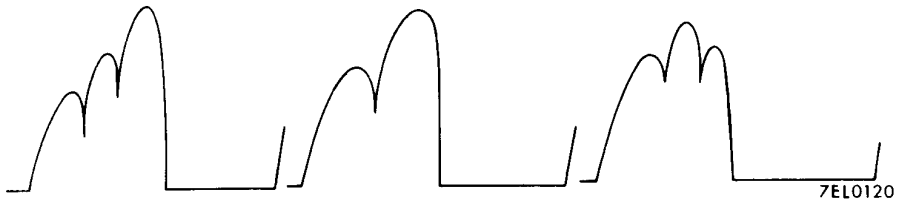
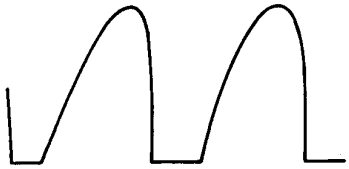




NOTE
Furthermore, the voltage waveform of the alternator B terminal can undulate as shown at left. This waveform is produced when the regulator operates according to fluctuations in the alternator load (current), and is normal for the alternator.

EXAMPLES OF ABNORMAL WAVEFORMS

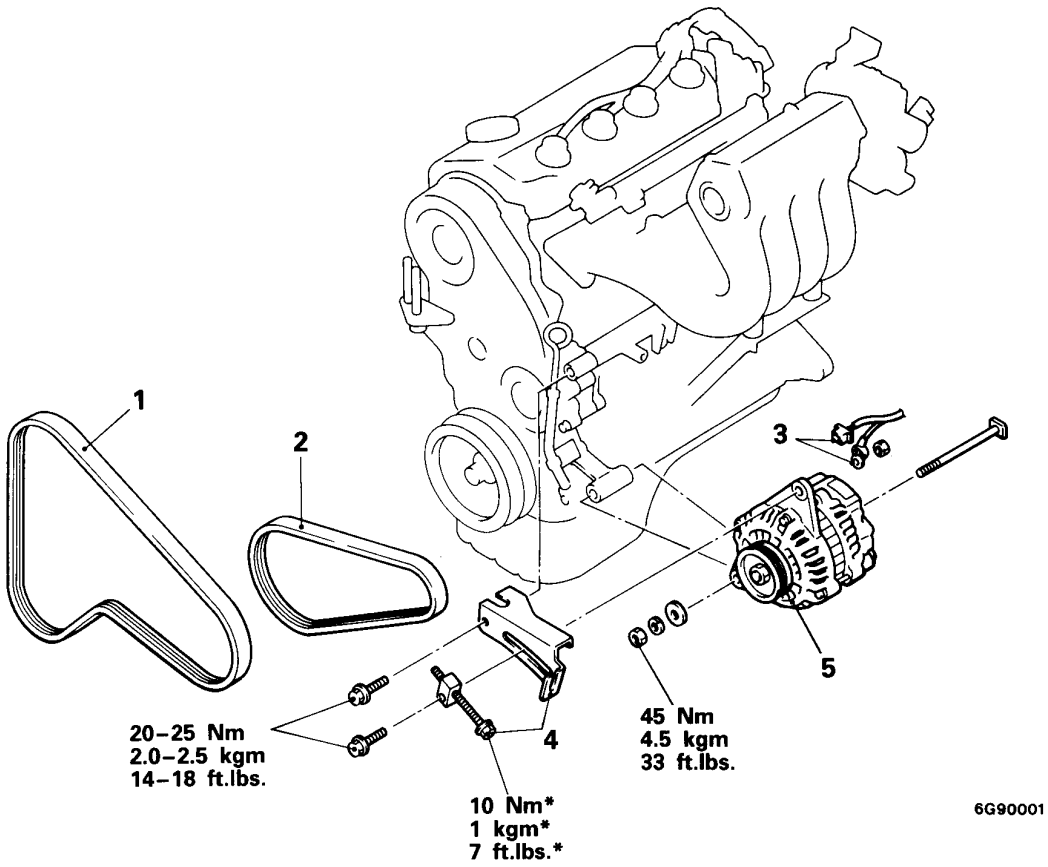
NOTE
1. The size of the waveform patterns differs largely depending on the adjustment of the variable knob on the analyzer.
2. Identification of abnormal waveforms is easier when there is a large output current (regulator is not operating). (Waveforms can be observed when the headlamps are illuminated.)
3. Check the conditions of the charge lamp (illuminated/ not illuminated) also, and carry out a total check.

Abnormal waveforms	Problem cause
Example 1  7EL0120	• Open diode
Example 2  7EL0121	• Short in diode
Example 3  7EL0122	• Broken wire in stator coil
Example 4  7EL0123	• Short in stator coil
Example 5  NOTE: At this time, the charge lamp is illuminated. 7EL0124	• Open supplementary diode

ALTERNATOR <4G93>

REMOVAL AND INSTALLATION

Post-installation Operation
- Adjustment of Drive Belt Tension (Refer to GROUP 11 – Service Adjustment Procedures.)



Removal steps

1. Drive belt (Power steering, Air conditioner)
2. Drive belt (Alternator)
3. Alternator connector
4. Alternator brace assembly
5. Alternator

NOTE
The tightening locations marked with * should be finally tightened to the specified torque after adjustment of belt tension.

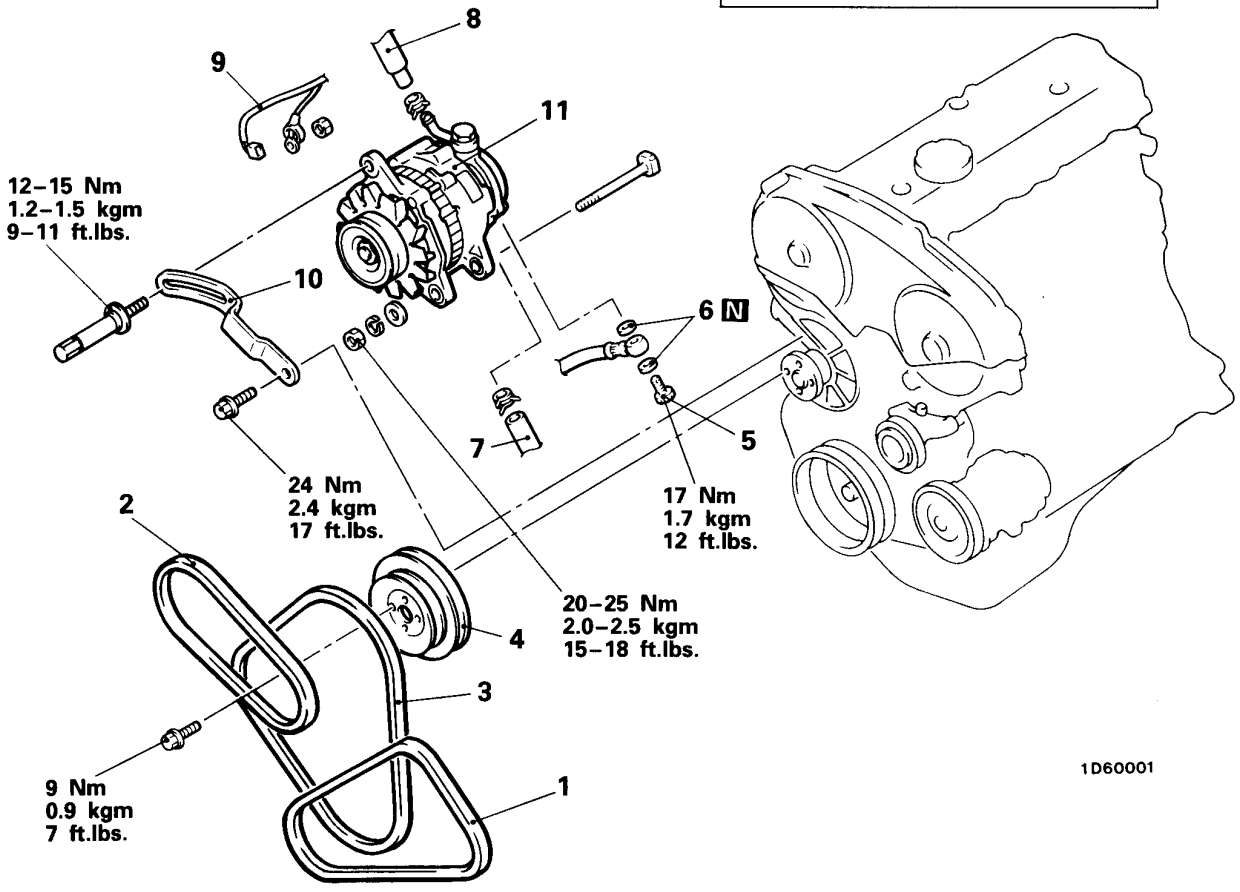
ALTERNATOR <4D65>

E16BH-C

REMOVAL AND INSTALLATION

Pre-removal Operation
- Removal of Under Cover

Post-installation Operation
- Adjustment of Drive Belt Tension (Refer to GROUP 11 – Service Adjustment Procedures.)
- Installation of Under Cover



Removal steps

1. Drive belt (Air conditioner)
2. Drive belt (Power steering)
3. Drive belt (Alternator)
4. Water pump-pulley
5. Eye bolt
6. Gasket
7. Oil hose connection
8. Vacuum hose connection
9. Alternator connector
10. Alternator brace
11. Alternator

SERVICE POINTS OF REMOVAL

4. REMOVAL OF WATER PUMP PULLEY

(1) First loosen the water pump pulley mounting bolts before removing the drive belt.

(2) The water pump pulley cannot be removed as it is because the clearance is too narrow, so slide it to the side so that the bolts at the base of the alternator brace can be loosened.

STARTING SYSTEM

SPECIFICATIONS

GENERAL SPECIFICATIONS

STARTER

<4G93>

Items		M/T A/T – Standard	A/T – cold climate zone
Type		Direct drive	Reduction drive with planetary gear
Rated output	kW/V	0.9/12	1.0/12
No. of pinion teeth		8	8

<4G63, 4G64>

Items		M/T – Standard	M/T – Cold climate zone A/T – Standard
Type		Reduction drive	Reduction drive with planetary gear
Rated output	kW/V	0.9/12	1.2/12
No. of pinion teeth		8	8

<4D65>

Items		Standard	Cold climate zone
Type		Reduction drive	Reduction drive
Rated output	kW/V	2.0/12	2.2/12
No. of pinion teeth		10	13

<4D68>

Items		Standard	Cold climate zone
Type		Reduction drive	Reduction drive
Rated output	kW/V	2.0/12	2.2/12
No. of pinion teeth		10	10

IGNITION SYSTEM

SPECIFICATIONS

GENERAL SPECIFICATIONS

DISTRIBUTOR

Items	Specifications
Type	Contact pointless with built-in ignition coil
Advance mechanism	Electronic
Firing order	1–3–4–2

SPARK PLUG

Items	<4G93> Vehicles with catalytic converter	<4G93> Vehicles without catalytic converter	<4G63, 4G64>
NGK	BKR6E-11	BKR6E	BKR5E-11
NIPPON DENSO	K20PR-U11	K20PR-U	K16PR-U11

SERVICE SPECIFICATIONS

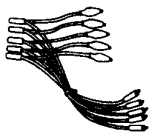
IGNITION COIL

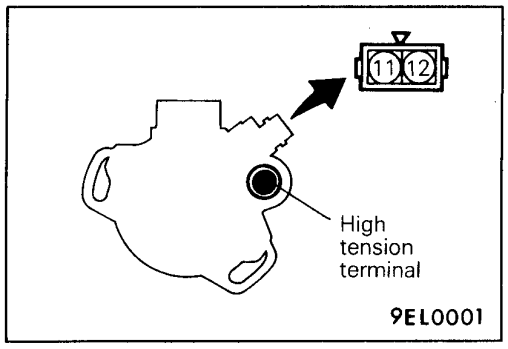
Items		Specifications
Primary coil resistance	Ω	0.9–1.2
Secondary coil resistance	kΩ	20–29

SPARK PLUG

Items		Vehicles with catalytic converter	Vehicles without catalytic converter
Spark plug gap	mm (in.)	1.0–1.1 (0.039–0.043)	0.7–0.8 (0.028–0.031)

SPECIAL TOOL

Tool	Number	Name	Use
	MB991348	Test harness set	Inspection of ignition primary voltage



SERVICE ADJUSTMENT PROCEDURES

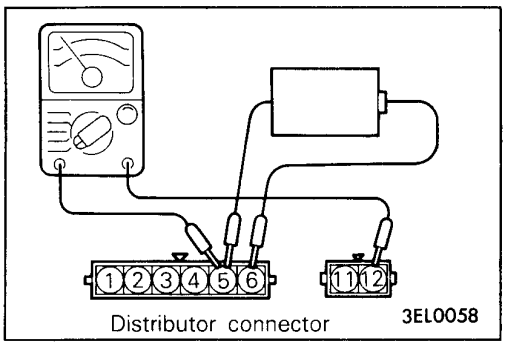
IGNITION COIL INSPECTION

(1) Measurement of the primary coil resistance
Measure the resistance between connector terminals ⑪ and ⑫ of the distributor.

Standard value: 0.9–1.2 Ω

(2) Measurement of secondary coil resistance
Measure the resistance between the high-voltage terminals and connector terminals ⑪ or ⑫.

Standard value: 20–29 kΩ



POWER TRANSISTOR INSPECTION

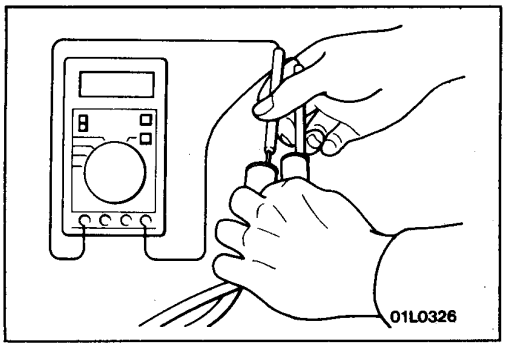
NOTE
An analog-type circuit tester should be used.

(1) Connect the negative (–) terminal of the 1.5 V power supply to terminal ⑤ of the power transistor; then check whether there is continuity between terminal ⑤ and terminal ⑫ when terminal ⑥ and the positive (+) terminal are connected and disconnected.

NOTE
Connect the negative (–) probe of the circuit tester to terminal ⑫.

Terminal ⑥ and (+) terminal	Terminal ⑤ and terminal ⑫
Connected	Continuity
Unconnected	No continuity

(2) Replace the power transistor if there ia a malfuction.



RESISTIVE CODE INSPECTION

Measure the resistance of the all spark plug leads.
(1) Check cap and coating for cracks.
(2) Measure resistance.

Unit: kΩ

Spark plug cable			
No. 1	No. 2	No. 3	No. 4
Approx. 12.5	Approx. 11.5	Approx. 9.0	Approx. 8.5

CHECKING THE DETONATION SENSOR <Vehicles with catalytic converter>

Check the detonation sensor circuit if self-diagnosis code No. 31 is displayed.

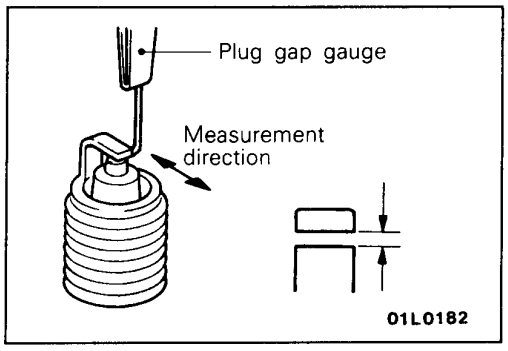
NOTE
For information concerning the self-diagnosis codes, refer to GROUP 13 – Troubleshooting.

SPARK PLUG CHECK AND CLEANING E11FRAF

(1) Remove the spark plug cables.

Caution
When pulling off the spark plug cable from the plug always hold the cable cap, not the cable.

(2) Remove the spark plugs
(3) Check for burned out electrode or damaged insulator. Check for even burning.
(4) Remove carbon deposits with wire brush or plug cleaner. Remove sand from plug screw with compressed air.



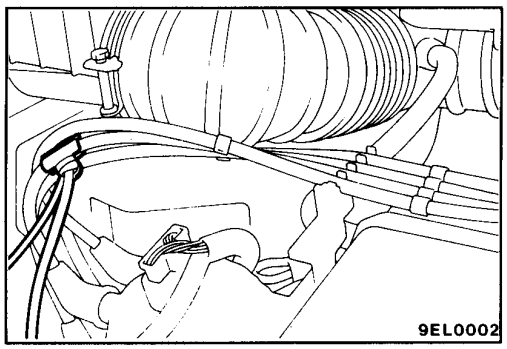
(5) Use a plug gap gauge to check that the plug gap is within the standard value range.

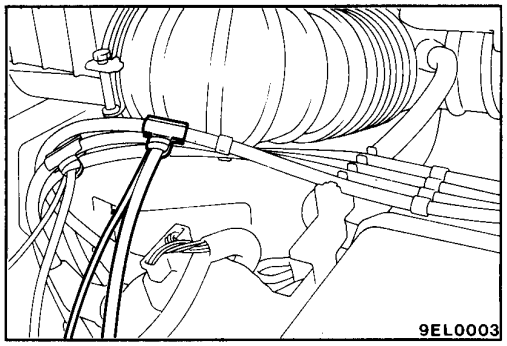
Standard value:
Vehicles with catalytic converter
1.0–1.1 mm (0.040–0.043 in.)
Vehicles without catalytic converter
0.7–0.8 mm (0.028–0.031 in.)

If the plug gap is not within the standard value range adjust by bending the ground electrode.
(6) Clean the engine plug holes.

Caution
Use care not to allow foreign matter in cylinders.

(7) Install the spark plugs.





WAVE PATTERN INSPECTION USING AN ANALYZER (Ignition primary and secondary voltage wave forms)

IGNITION SECONDARY VOLTAGE INSPECTION

MEASUREMENT METHOD

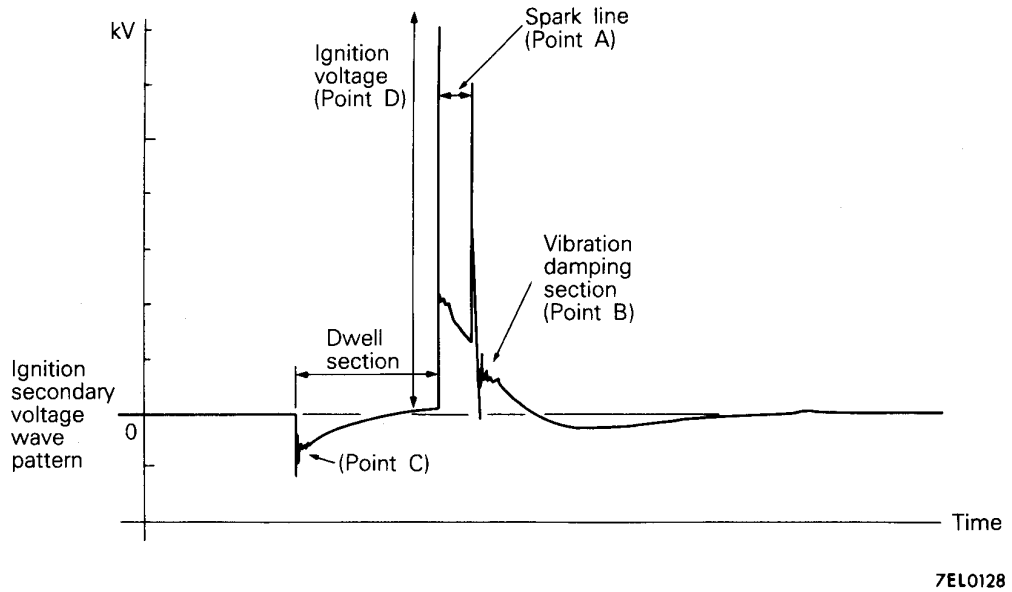
(1) Clamp the spark plug cable (No.1, No.2, No.3 or No.4) with the secondary pickup.

(2) Clamp the No.1 cylinder spark plug cable with the trigger pickup.

STANDARD WABE PATTERN

Observation conditions

FUNCTION	SECONDARY
PATTERN HEIGHT	HIGH (or LOW)
PATTERN SELECTOR	RASTER
Engine revolutions	Idle (Vehicles with catalytic converter: 800 r/min., Vehicles without catalytic converter: 700 r/min.)



WAVEFORM OBSERVATION POINTS

Point A : The height, length and slope of the spark line (refer to abnormal waveform examples 1, 2, 3 and 4) show the following trends.

Spark line		Plug gap	Condition of electrode	Compression force	Concentration of air mixture	Ignition timing	Spark plug cable
Length	Long	Small	Normal	Low	Rich	Advanced	Leak
	Short	Large	Large wear	High	Lean	Retarded	High resistance
Height	High	Large	Large wear	High	Lean	Retarded	High resistance
	Low	Small	Normal	Low	Rich	Advanced	Leak
Slope		Large	Plug is fouled	–	–	–	–

Point B : Number of vibrations in reduction vibration section (Refer to abnormal waveform example 5)

Number of vibrations	Coil and condenser
Three or more	Normal
Except above	Abnormal

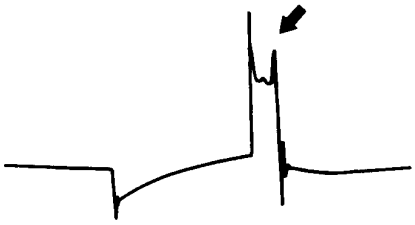
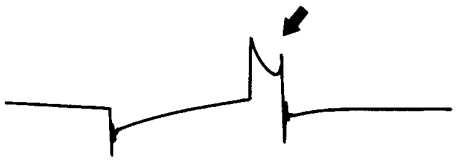
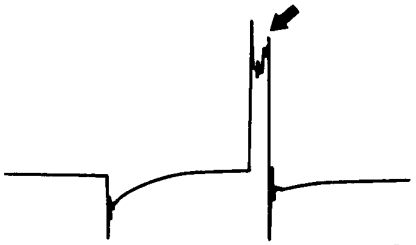
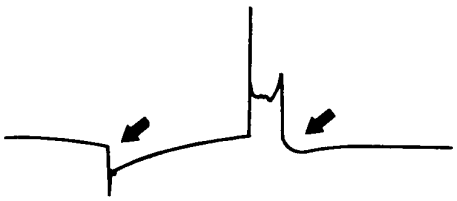
Point C : Number of vibrations at beginning of dwell section (Refer to abnormal waveform example 5)

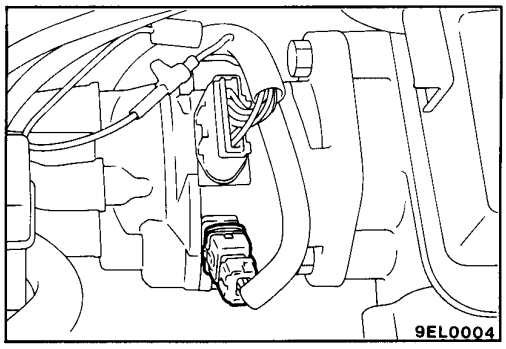
Number of vibrations	Coil
5–6 or higher	Normal
Except above	Abnormal

Point D : Ignition voltage height (distribution per each cylinder) shows the following trends.

Ignition voltage	Plug gap	Condition of electrode	Compression force	Concentration of air mixture	Ignition timing	Spark plug cable
High	Large	Large wear	High	Lean	Retarded	High resistance
Low	Small	Normal	Low	Rich	Advanced	Leak

EXAMPLES OF ABNORMAL WAVEFORMS

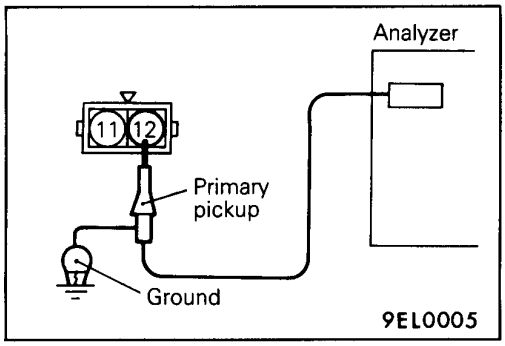
Abnormal waveform	Wave characteristics	Cause of problem
Example 1  01P0215	Spark line is high and short.	Spark plug gap is too large.
Example 2  01P0216	Spark line is low and long, and is sloping. ALso, the second half of the spark line is distorted. This could be a result of mis-firing.	Spark plug gap is too small.
Example 3  01P0217	Spark line is low and long, and is sloping. However, there is almost no spark line distortion.	Spark plug gap is fouled.
Example 4  01P0218	Spark line is high and short. Difficult to distinguish between this and abnormal wave pattern example 1.	Spark plug cable is nearly falling off. (Causing a dual ignition)
Example 5  01P0219	No waves in wave damping section.	Rare short in ignition coil.



IGNITION PRIMARY VOLTAGE WAVE PATTERN CHECK

MEASUREMENT METHOD

(1) Disconnect the distributor 2 pin connector and connect the special tool (test harness: MB991348) in between. (All of the terminals should be connected.)



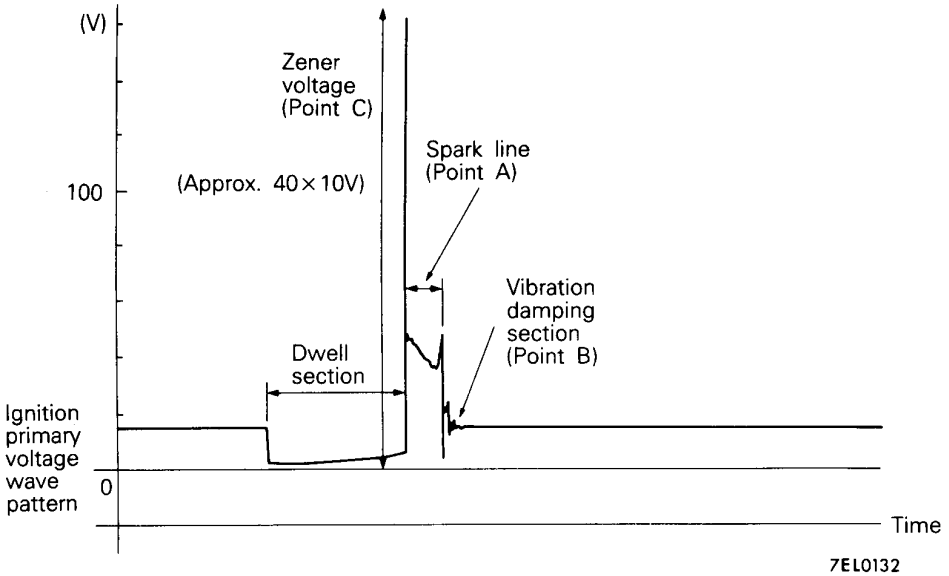
(2) Connect the analyzer primary pickup to the distributor connector terminal ⑫.
(3) Connect the primary pickup earth terminal.
(4) Clamp the spark plug cable with the trigger pickup.

NOTE
The wave pattern of the cylinder clamped to the trigger pickup will appear at the left edge of the screen.

STANDARD WAVE PATTERN

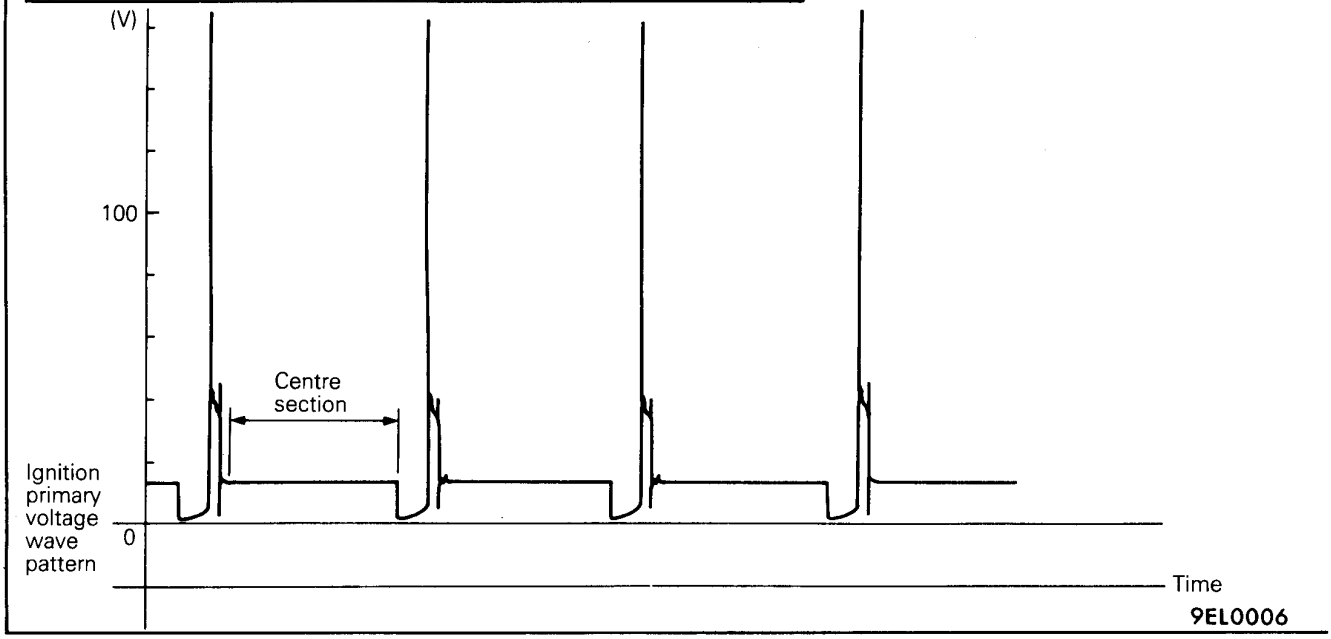
Observation conditions

FUNCTION	PRIMARY
PATTERN HEIGHT	HIGH (or LOW)
PATTERN SELECTOR	RASTER
Engine revolutions	Idle (Vehicles with catalytic converter: 800 r/min., Vehicles without catalytic converter: 700 r/min.)



Observation conditions (Only the pattern selector shown below changes from the previous conditions)

PATTERN SELECTOR	DISPLAY



WAVEFORM OBSERVATION POINTS

Point A : The height, length and slope of the spark line (refer to abnormal waveform examples 1, 2, 3 and 4) show the following trends.

Spark line		Plug gap	Condition of electrode	Compression force	Concentration of air mixture	Ignition timing	High tension cable
Length	Long	Small	Normal	Low	Rich	Advanced	Leak
	Short	Large	Large wear	High	Lean	Retarded	High resistance
Height	High	Large	Large wear	High	Lean	Retarded	High resistance
	Low	Small	Normal	Low	Rich	Advanced	Leak
Slope		Large	Plug is fouled	–	–	–	–

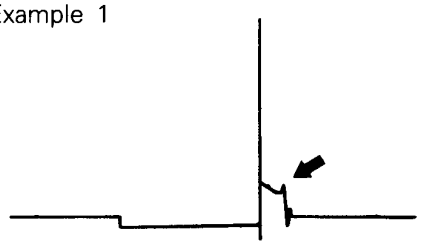
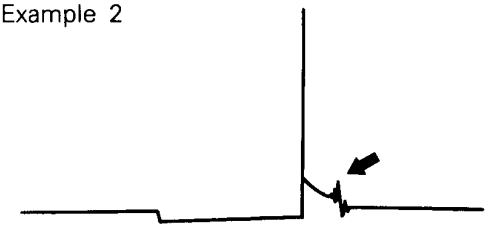
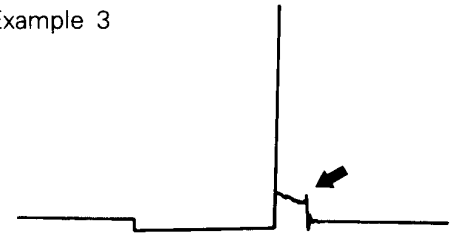
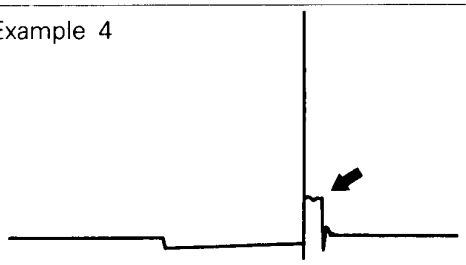
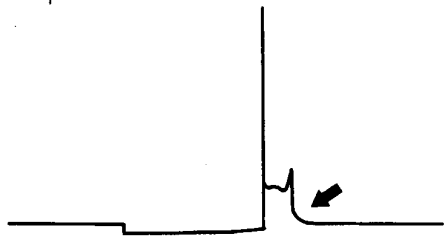
Point B : Number of vibrations in reduction vibration section (Refer to abnormal waveform example 5)

Number of vibrations	Coil, condenser
3 or higher Except above	Normal Abnormal

Point C : Height of Zener voltage

Height of Zener voltage	Probable cause
High Low	Problem in Zener diode Abnormal resistance in primary coil circuit

EXAMPLES OF ABNORMAL WAVEFORMS

Abnormal waveform	Wave characteristics	Cause of problem
Example 1  01P0210	Spark line is high and short.	Spark plug gap is too large.
Example 2  01P0211	Spark line is low and long, and is sloping. Also, the second half of the spark line is distorted. This could be a result of mis-firing.	Spark plug gap is too small.
Example 3  01P0212	Spark line is low and long, and is sloping. However, there is almost no spark line distortion.	Spark plug gap is fouled.
Example 4  01P0213	Spark line is high and short	Spark plug cable is nearly falling off. (Causing a dual ignition)
Example 5  01P0214	No waves in wave damping section.	Rare short in ignition coil.

GLOW SYSTEM

SPECIFICATIONS

SERVICE SPECIFICATIONS

Items	Specifications
Standard	
Glow plug resistance [at 20°C (68°F)] Ω	
<Super quick glow system>	0.20–0.26
<Self-regulating glow system>	0.4–0.6
Dropping resistor resistance [at 20°C (68°F)] Ω	
<Super quick glow system>	0.15–0.17
Engine coolant temperature sensor resistance [at 20°C (68°F)] kΩ	2.92–3.58

SEALANT

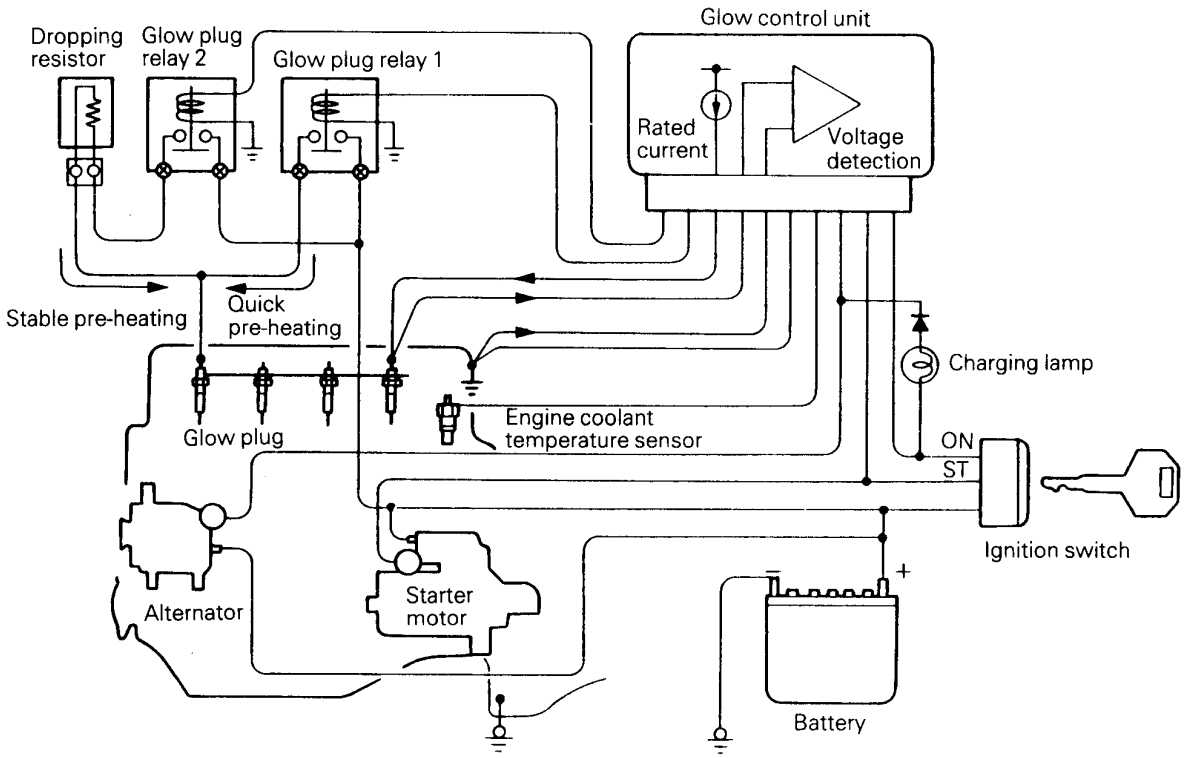
Item	Specified sealant	Remark
Engine coolant temperature sensor	3M Nut Locking Part No. 4171 or equivalent	Drying sealant

SERVICE ADJUSTMENT PROCEDURES

E16EGAI

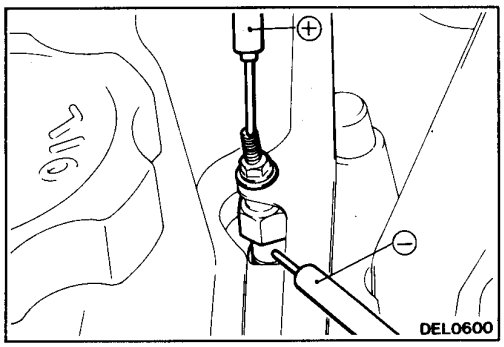
SUPER QUICK GLOW SYSTEM

SUPER QUICK GLOW SYSTEM INSPECTION



(1) Check that the battery voltage is 11–13V.
(2) Check that the engine coolant temperature is 40°C (104°F) or less.

NOTE
If the engine coolant temperature is too high, disconnect the engine coolant temperature sensor connector.

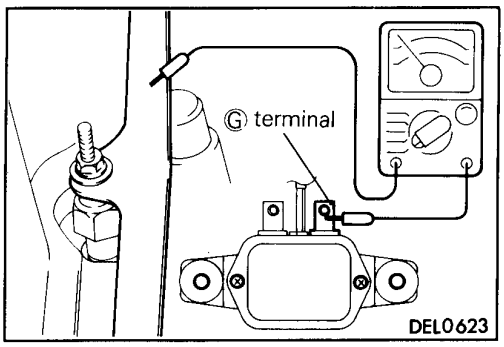


(3) Measure the resistance between the glow plug plate and the glow plug body (earth).

Standard value: 0.05–0.07 Ω [at 20°C (68°F)]

NOTE
The resistance value is the parallel resistance value for the four glow plugs.

PWDE9104



(4) Measure the resistance between the (G) terminal of glow plug relay 2 and the glow plug plate.

Standard value: 0.15–0.17 Ω

Caution
Measure the resistance after checking that battery voltage is not applied to the (G) terminal.

(5) Connect the voltmeter between the glow plug plate and the glow plug body.

(6) Measure the voltage immediately after the ignition switch is turned to "ON" (without starting the engine).

Standard value: 9–11V (after approx. 2–4 seconds it drops to 0V)

NOTE
The time taken for the voltage to drop will vary depending on the temperature of the glow plugs and the voltage applied. (Refer to the reference illustration.)

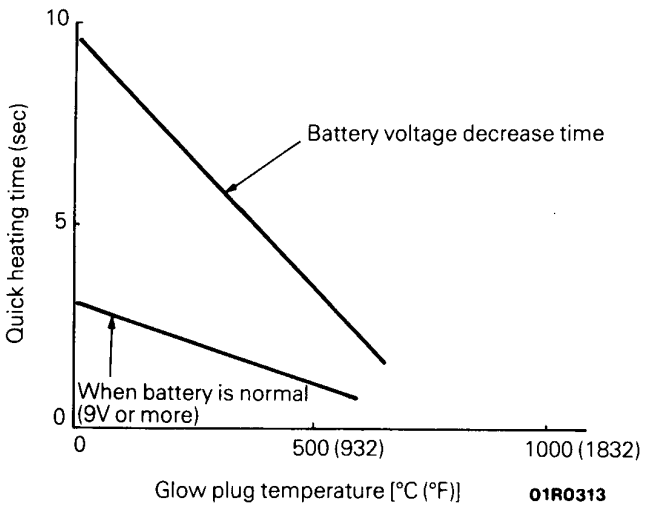
(7) Measure the voltage while the engine is cranking.

Standard value: 4V or more

(8) Start the engine and measure the voltage while the engine is warming up. However, if the engine coolant temperature increases to 55°C (131°F) or more, or if 180 seconds have elapsed since the engine was started, the voltage will normally become 0V. (Refer to the reference illustration on the next page.)

Standard value: 5–7 V

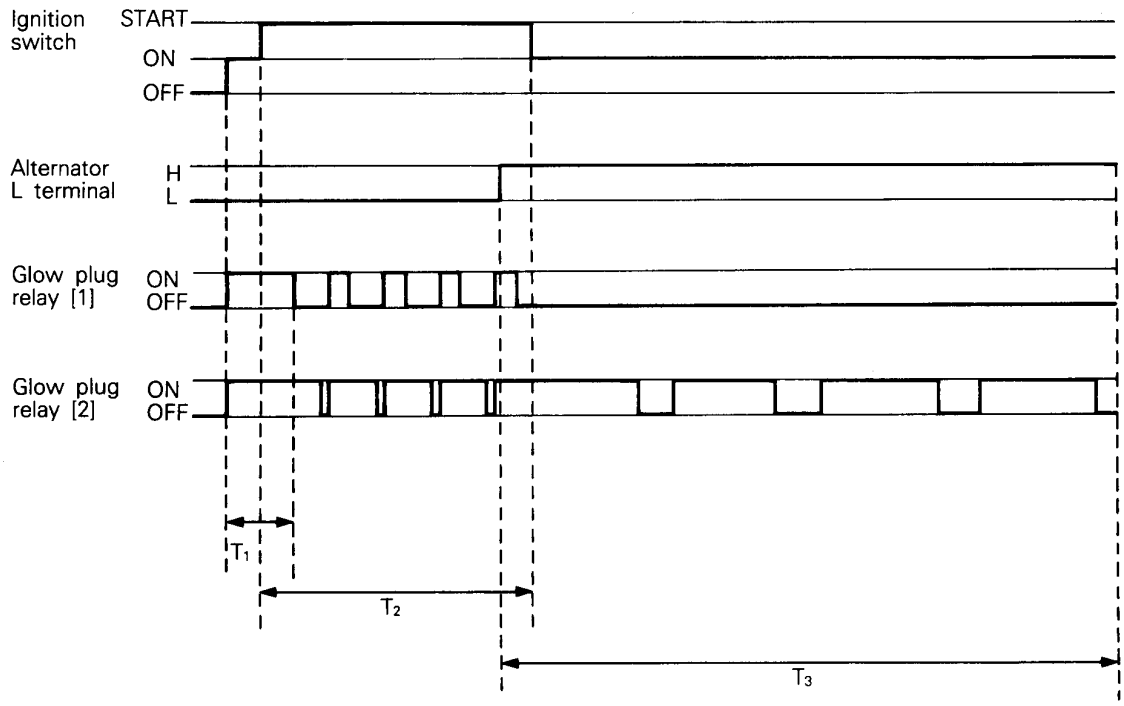
Reference
Relationship between glow plug temperature (resistance value) and current flow time



Example
① When battery voltage is normal (9V or above) and the glow plugs are cold, even to heat the plugs to 900°C (1652°F) or more takes approximately 3 seconds.
② On the other hand, when battery voltage is normal (9V or more) and the glow plugs are hot [500°C (932°F)] or more, the time taken for current to flow is reduced.

Reference

Glow plug current timing chart

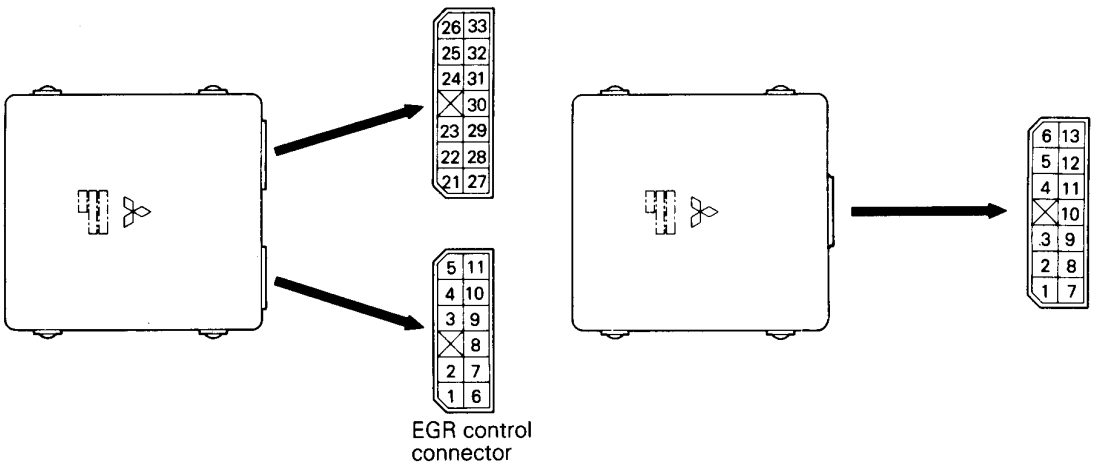


T_1: Quick heating time
T_2: Glow plug relay [1] drive time when engine is cranking
T_3: Glow plug relay [2] drive time after engine starts (after glow)

DEL0601

NOTE
After glow occurs only when engine coolant temperature is approximately 55°C (131°F) or less, and for approximately 180 seconds after the engine is started, it turns ON and OFF to prevent the temperature of the glow plugs from exceeding the target temperature [approx. 900°C (1,652°F)].

GLOW CONTROL UNIT INSPECTION



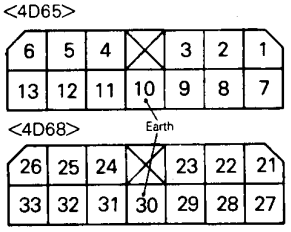
DEN0734

(1) Measure the voltage at the control unit terminals.
NOTE
1. Inspect with the control unit connector connected.
2. When measuring the voltage, connect the control unit terminal (10) to the earth.

Terminal Voltage Reference Table

Control unit inspection terminal	Inspection item	Inspection conditions		Standard value
1 (21)	Ignition switch (IG power supply)	Ignition switch	"OFF" → "ON"	Battery voltage
			"ON" → "OFF"	0 – 0.5V
2 (22)	Ignition switch (ST power supply)	Ignition switch	"OFF" → "START"	More than 8V
6 (26)	Alternator L–terminal	Ignition switch	"OFF" → "ON"	1 – 4V
		Idle		More than 11V
7 (27)	Glow plug relay 1	Ignition switch	"OFF → "ON"	9 – 12V After approx. 3 seconds 0 – 0.5V
8 (28)	Glow plug relay 2	Ignition switch	"OFF" → "ON"	9 – 12V After approx. 3 seconds 0 – 0.5V
13 (33)	Engine coolant temperature sensor	Ignition switch "OFF → "ON"	When engine coolant temperature is –20°C (–4°F)	4.3 – 4.5V
			When engine coolant temperature is 0°C (32°F)	3.7 – 3.9V
			When engine coolant temperature is 20°C (68°F)	2.8 – 3.0V
			When engine coolant temperature is 40°C (104°F)	1.9 – 2.1V
			When engine coolant temperature is 80°C (176°F)	0.5 – 0.7V

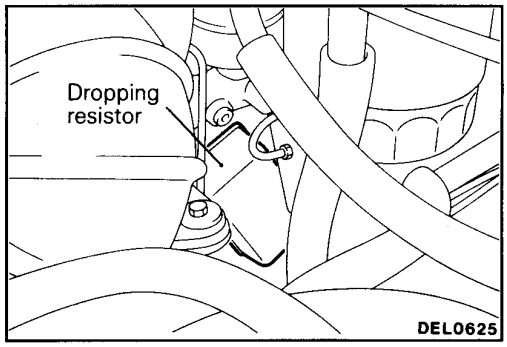
View of harness-side connector of glow control unit from terminal side (13P)



DEN0735

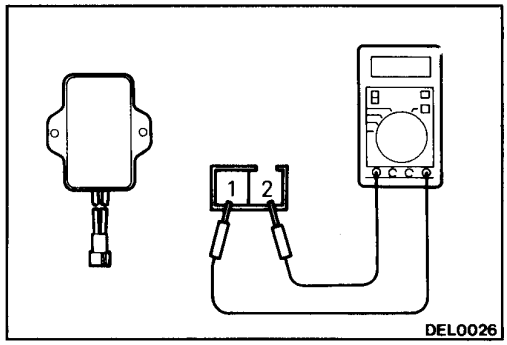
(2) Remove the control unit connector and check the continuity between the harness-side connector terminals.

Inspection terminal	Inspection item	Continuity (resistance value)
4 – 10	Glow plug constant current circuit	Continuity (approx. 0.06Ω)
5 – 11	Glow plug voltage measurement circuit	Continuity (approx. 0.06Ω)
7 – 10	Glow plug relay 1	Continuity (approx. 20 Ω)
8 – 10	Glow plug relay 2	Continuity (approx. 20 Ω)



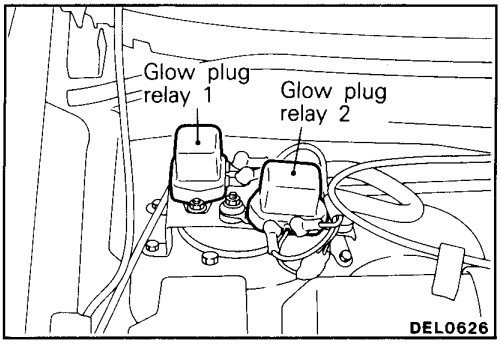
DROPPING RESISTOR INSPECTION

(1) Disconnect the dropping resistor connector.

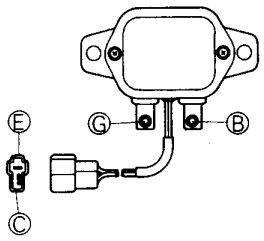


(2) Measure the resistance between the dropping resistor terminals.

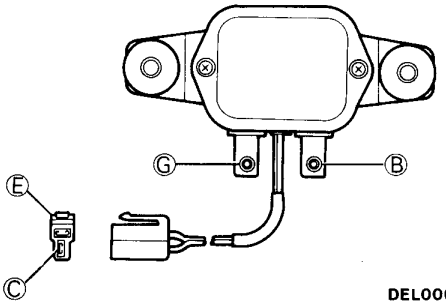
Standard value: 0.15–0.17 Ω [at 20°C (68°F)]

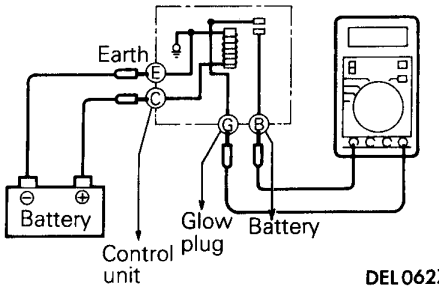


Glow plug relay (No. 1)



Glow plug relay (No. 2)





GLOW PLUG RELAY INSPECTION

(1) Check to be sure that there is continuity (approx. 20 Ω) between glow plug relay terminals (C)–(E).

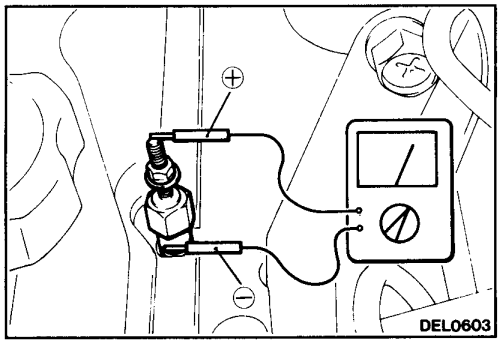
(2) Use jumper leads to connect the glow plug relay terminal (C) with the battery (+) terminal and terminal (E) with the battery (–) terminal.

Caution

1. **Before using the jumper leads, the harnesses connected to glow plug relay (B) and (G) terminals must always be disconnected.**
2. **Do not short out the disconnected harness-side terminals to the earth.**
3. **Be extremely careful when connecting the jumper leads, as if the terminals are connected incorrectly, it will damage the relays.**

(3) Check the continuity between glow plug relay (B) and (G) terminals with the jumper lead connected to the battery (–) terminal and with the jumper lead disconnected.

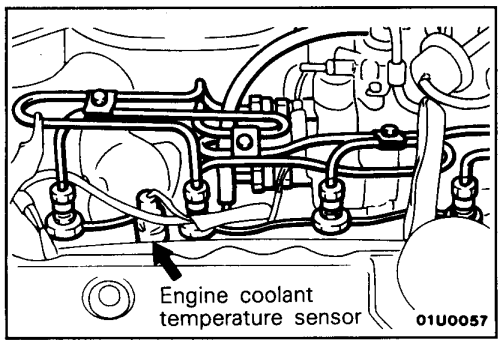
Jumper lead from battery (–) terminal	Continuity between terminals (B) – (G)
Connected	Continuity (0.01 Ω or less)
Disconnected	No continuity (∞ Ω)



GLOW PLUG INSPECTION

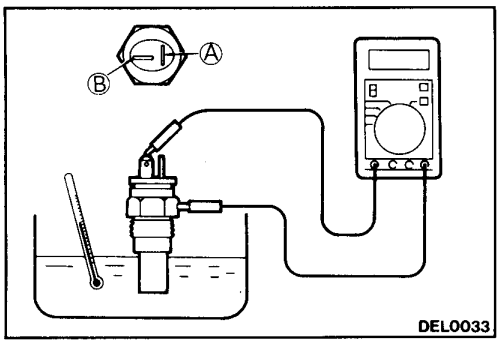
(1) Remove the glow plug plate.
(2) Measure the resistance between the glow plug terminals and the body.

Standard value: 0.20–0.26 Ω [at 20°C (68°F)]



ENGINE COOLANT TEMPERATURE SENSOR INSPECTION

(1) Remove the engine coolant temperature sensor.



(2) While the sensor section of the engine coolant temperature sensor is submerged, measure the resistance between (B) terminal and the body.

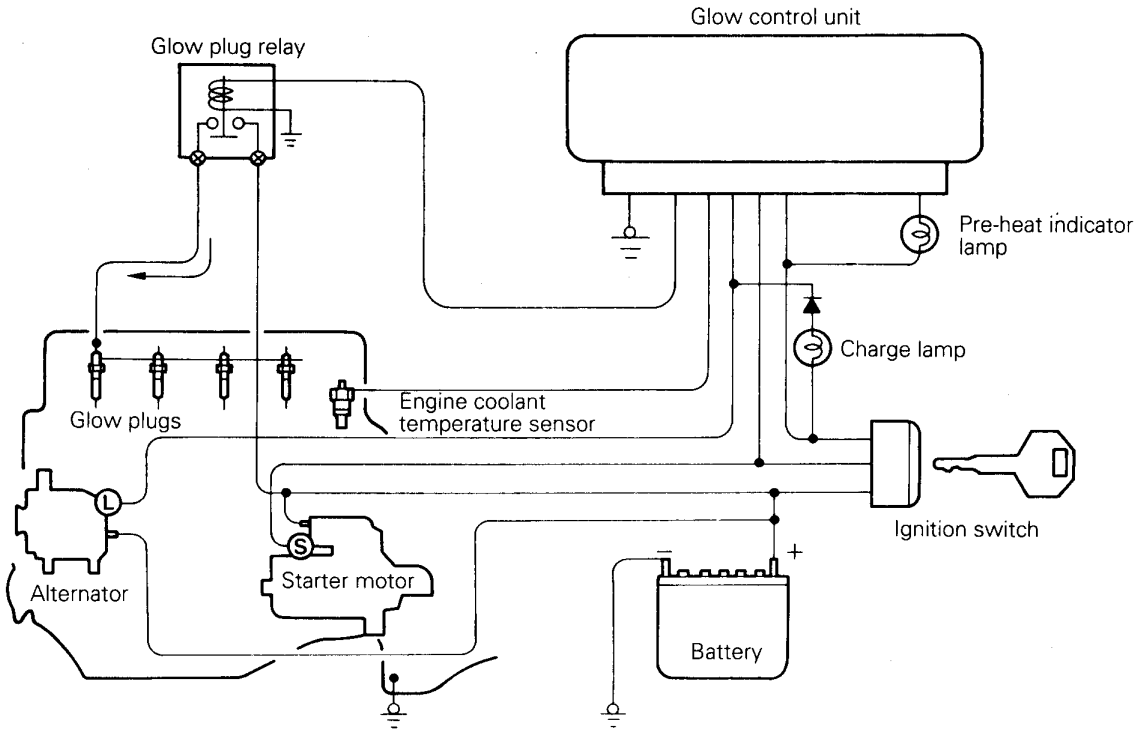
Temperature [°C (°F)]	Resistance value (kΩ)
−20 (−4)	24.8±2.5
0 (32)	8.6
20 (68)	3.25±0.33
40 (104)	1.5
80 (176)	0.3

(3) After applying specified sealant to the thread, tighten to the specified torque.

Specified sealant: 3M Nut Locking Part No. 4171 or equivalent
Tightening torque: 35 Nm (3.5 kgm, 25 ft.lbs.)

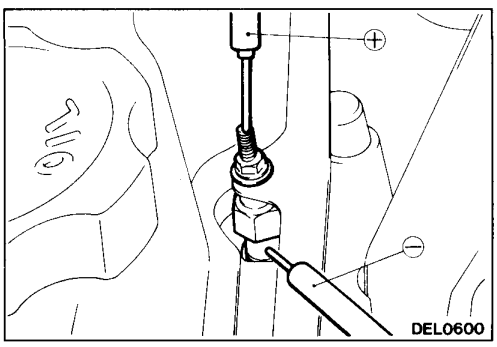
SELF-REGULATING GLOW SYSTEM

SELF-REGULATING GLOW SYSTEM INSPECTION



(1) Check that the battery voltage is 11–13V.
(2) Check that the engine coolant temperature is 40°C (104°F) or less.

NOTE
If the engine coolant temperature is too high, disconnect the engine coolant temperature sensor connector.



(3) Measure the resistance between the glow plug plate and the glow plug body (earth).

Standard value: 0.1–0.15 Ω [at 20°C (68°F)]

NOTE
The resistance value is the parallel resistance value for the four glow plugs.

(4) Connect a voltmeter between the glow plug plate and the glow plug body (earth).
(5) Measure the voltage immediately after the ignition switch is turned to ON (without starting the engine).

Standard value: 9–11 V (Drops to 0 V after 4–8 seconds have passed)

In addition, check to be sure that the glow indicator lamp (red) illuminates immediately after the ignition switch is turned to ON.

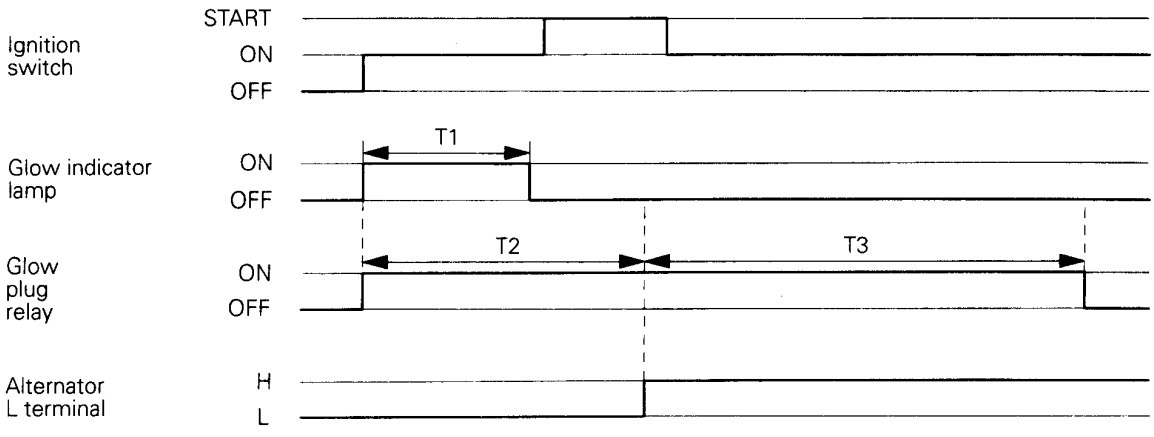
NOTE
The time during which the voltage appears (energising time) will depend on the engine coolant temperature.

(6) Measure the voltage while the engine is cranking.

Standard value:6 V or more

(7) Start the engine and measure the voltage while the engine is warming up.
However, if the engine coolant temperature rises above 60°C or when 180 seconds have passed since the engine was started, the voltage will always return to 0 V. (Refer to the Glow Plug Energisation Timing Chart.)
Standard value:12-15 V

<Reference>
Glow Plug Energisation Timing Chart

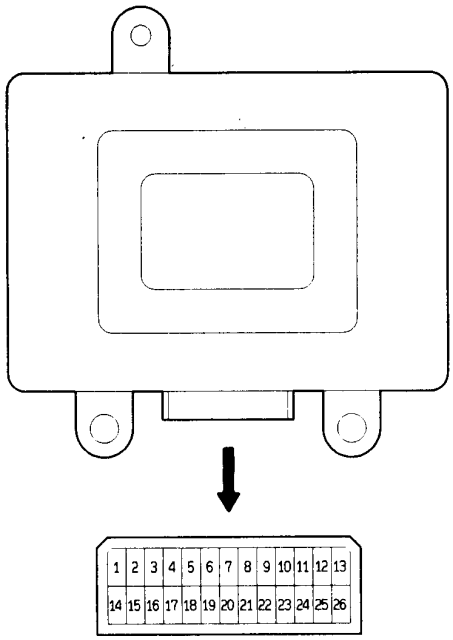


T_1: Glow indicator lamp
T_2: Glow plug relay drive time after ignition switch is turned ON
T_3: Glow plug relay drive time after engine starts (afterglow)

DEN0063

NOTE
Afterglow time T3 becomes longer as the engine coolant temperature drops.

GLOW AND EGR CONTROL UNIT INSPECTION



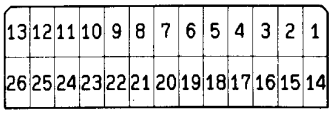
(1) Measure the voltage at the control unit terminals.

NOTE
1. Inspect with the control unit connector connected.
2. When measuring the voltage, connect the control unit terminal (13) to the earth.

Terminal Voltage Reference Table

Control unit inspection terminal	Inspection item	Inspection conditions		Standard value
1	Ignition switch (IG power supply)	Ignition switch	"OFF" → "ON"	Battery voltage
			"ON" → "OFF"	0 – 0.5 V
17	Glow indicator lamp	• Ignition switch • Engine coolant temperature	"OFF" → "ON" 40°C (104°F) or less	0 – 1 V after approximately 1 seconds (at 20°C (68°F)) 11 – 13 V
23	Alternator L terminal	Ignition switch	"OFF" → "ON"	1 4 V
		Idle		More than 11 V
14	Glow plug relay	• Ignition switch • Engine coolant temperature	"OFF" → "ON" 40°C (104°F) or less	9 – 12 V after approximately 8 seconds (at 20°C (68°F)) 0 – 0.5 V
12	Ignition switch (ST power supply)	Ignition switch	"OFF" → "START"	More than 8 V
5	Engine coolant temperature sensor	Ignition switch "OFF" → "ON"	When engine coolant temperature is –20°C (–4°F)	4.3 – 4.5V
			When engine coolant temperature is 0°C (32°F)	3.7 – 3.9V
			When engine coolant temperature is 20°C (68°F)	2.8 – 3.0V
			When engine coolant temperature is 40°C (104°F)	1.9 – 2.1V
			When engine coolant temperature is 80°C (176°F)	0.5 – 0.7V

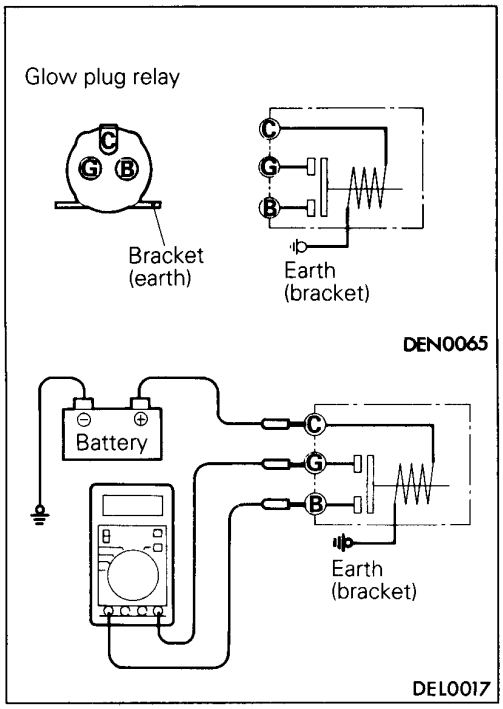
View of harness-side connector of glow control unit from terminal side (26P)



DEM0026

(2) Remove the control unit connector and check the continuity between the harness-side connector terminals.

Inspection terminal	Inspection item	Continuity (resistance value)
13 – 14	Glow plug relay	Continuity (approx. 3Ω)



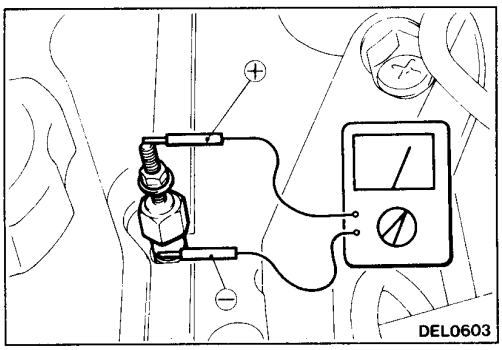
GLOW PLUG RELAY INSPECTION

(1) Check to be sure that there is continuity (approx. 3 Ω) between glow plug relay terminal (C) and the bracket (earth).
(2) Use jumper cables to connect terminal (C) of the glow plug relay to the battery (+) terminal and the bracket to the battery (–) terminal.

Caution
(1) Always be sure to disconnect the harnesses connected to glow plug relay terminals (B) and (G) before using the jumper cables.
(2) The terminals of the disconnected harnesses must not be shorted to earth.
(3) When connecting the jumper cables, be very careful not to make a mistake in connecting the terminals, as this will cause damage to the relay.

(3) Check the continuity between glow plug relay terminals (B) and (G) while disconnecting and connecting the jumper cable at the battery (+) terminal.

Jumper cable at battery (+) terminal	Continuity between terminals (B)-(G)
Connected	Continuity (0.01 Ω or less)
Disconnected	No continuity (∞ Ω)



GLOW PLUG INSPECTION

(1) Remove the glow plug plate.
(2) Measure the resistance between the glow plug terminals and the body

Standard value: 0.4 – 0.6 Ω [at 20°C (68°F)]

ENGINE COOLANT TEMPERATURE SENSOR INSPECTION

Refer to P.16 – 28.