ENGINE ELECTRICAL

CONTENTS

CHARGING SYSTEM

GENERAL

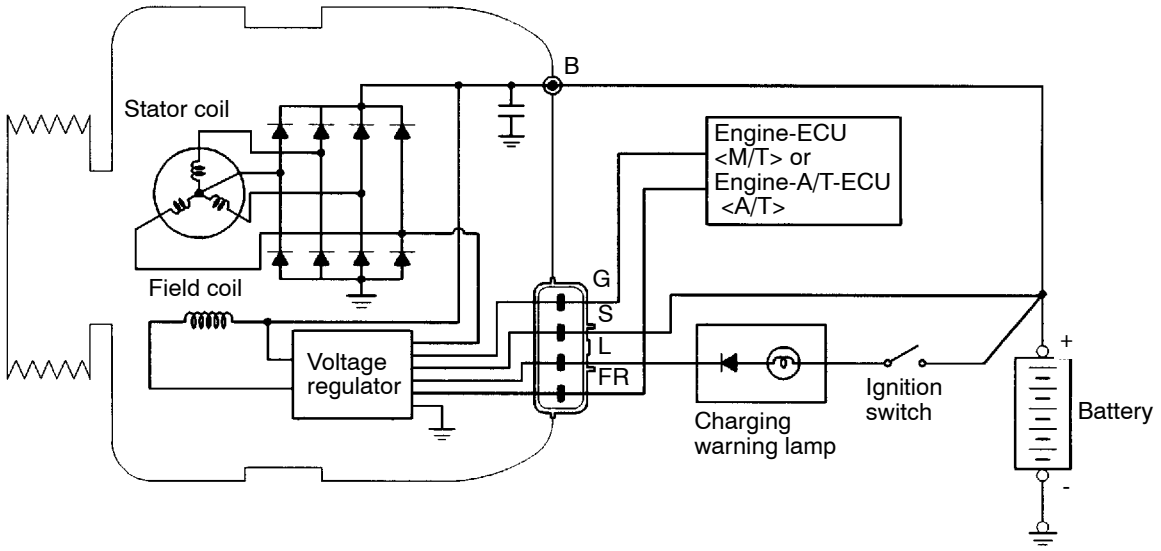
OUTLINE OF CHANGES

The following service procedures have been established to correspond to the addition of vehicles with 4G63-MPI engine. Items other than those given below are the same as for the 4G6-GDI engine mounted in the SPACE WAGON.

GENERAL INFORMATION

SYSTEM DIAGRAM

<4G63-MPI>



W6016AJ

STARTING SYSTEM

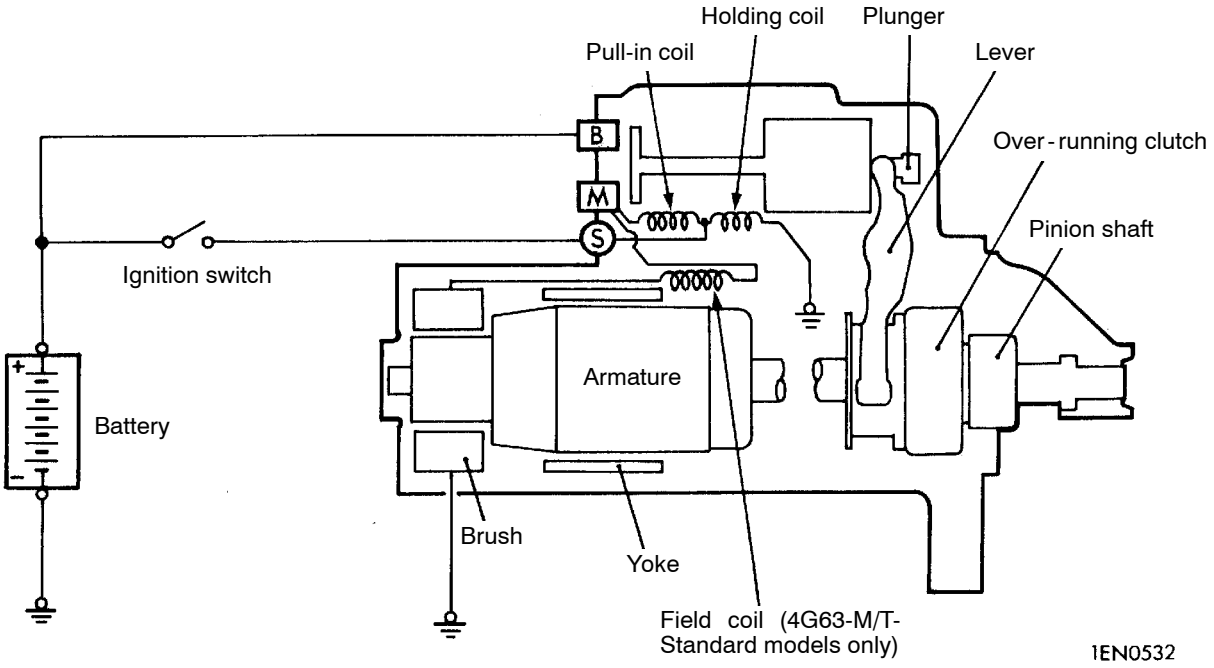
GENERAL

OUTLINE OF CHANGES

The following service procedures have been established to correspond to the addition of vehicles with 4G63-MPI engine. Items other than those given below are the same as for the 4G6-GDI engine mounted in the SPACE WAGON.

GENERAL INFORMATION

SYSTEM DIAGRAM



STARTER MOTOR SPECIFICATIONS

Items	4G63-M/T-standard models	4G63-M/T-models for cold climate, -A/T
Type	Direct drive	Reduction drive with planetary gear
Rated output kW/V	0.9/12	1.2/12
No. of pinion teeth	8	8

SERVICE SPECIFICATIONS

<Direct drive type>

Items	Standard value	Limit
Pinion gap mm	0.5-2.0	-
Commutator outer diameter mm	32.0	31.4
Commutator runout mm	0.05	0.1
Commutator undercut mm	0.5	0.2

STARTER MOTOR

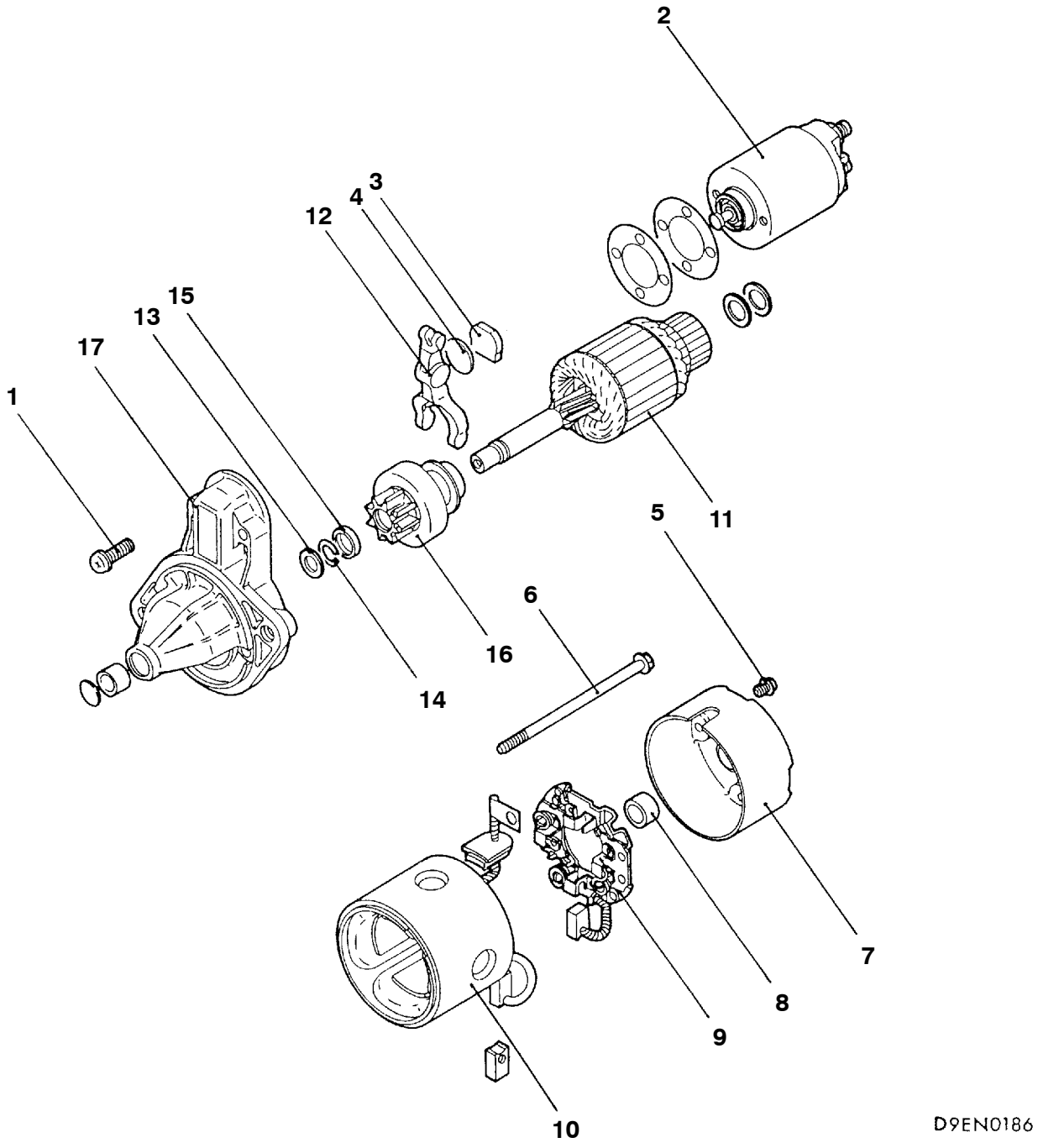
- The following service procedures have been established to correspond to the addition of a direct drive type starter motor. Items other than those given below are the same as before.

INSPECTION

FREE RUNNING TEST

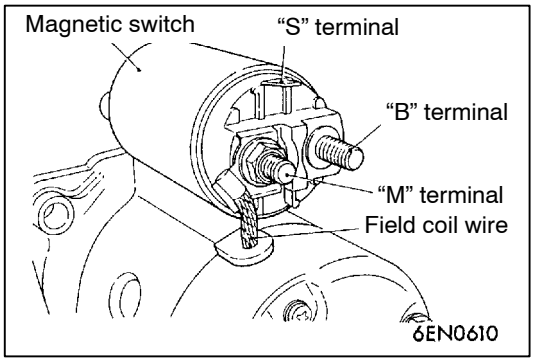
Current: max. 60 Amps (Direct drive type)

DISASSEMBLY AND REASSEMBLY <DIRECT DRIVE TYPE>



Disassembly steps

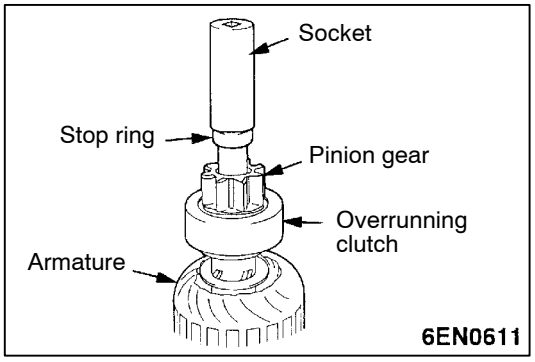
1. Screw
◀A▶ 2. Magnetic switch
3. Packing
4. Plate
5. Screw
6. Through bolt
7. Rear bracket
8. Rear bearing
9. Brush holder assembly
10. Yoke assembly
11. Armature
12. Lever
13. Washer
◀B▶ ▶A◀ 14. Snap ring
◀B▶ ▶A◀ 15. Stop ring
16. Overrunning clutch
17. Front bracket



DISASSEMBLY SERVICE POINTS

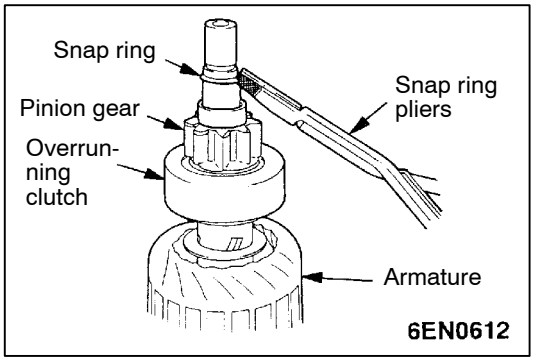
◀A▶ MAGNETIC SWITCH REMOVAL

Disconnect field coil wire from "M" terminal of magnetic switch.



◀B▶ SNAP RING/STOP RING REMOVAL

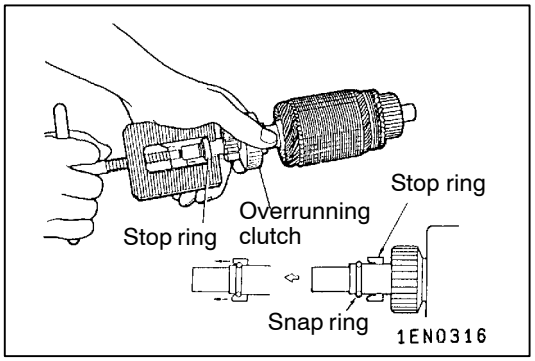
1. Press stop ring off snap ring with a suitable socket.



2. Remove snap ring with snap ring pliers and then remove stop ring and overrunning clutch.

STARTER MOTOR PARTS CLEANING

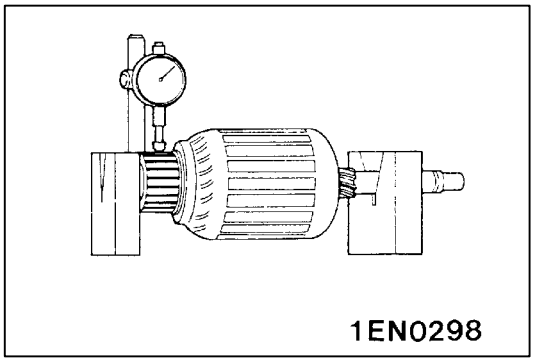
1. Do not immerse parts in cleaning solvent. Immersing the yoke and field coil assembly and/or armature will damage insulation. Wipe motor assembly with a cloth only.
2. Do not immerse drive unit in cleaning solvent. Overrunning clutch is pre-lubricated at the factory and solvent will wash lubrication from clutch.
3. The drive unit may be cleaned with a brush moistened with cleaning solvent and wiped dry with a cloth.



REASSEMBLY SERVICE POINTS

▶A◀ STOP RING/SNAP RING INSTALLATION

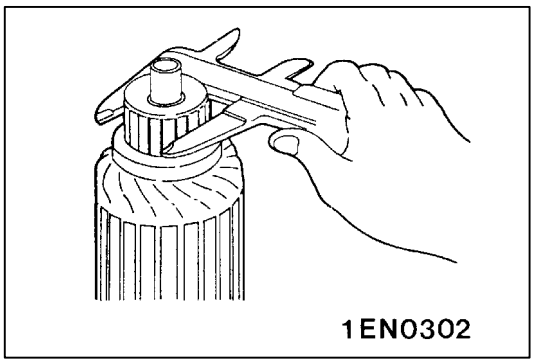
Using a suitable pulling tool, pull overrunning clutch stop ring over snap ring.



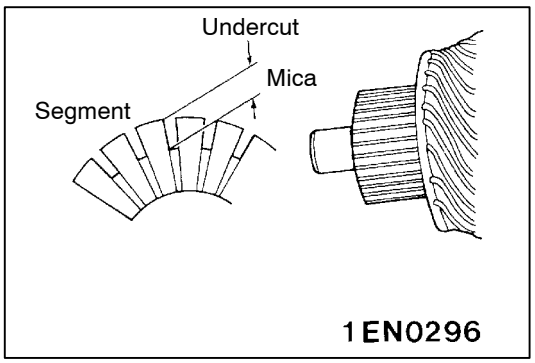
INSPECTION

COMMUTATOR CHECK

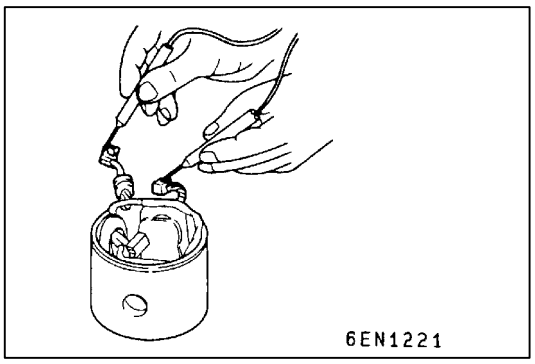
1. Place the armature in a pair of “V” blocks and check the runout with a dial indicator.
   Standard value: 0.05 mm
   Limit: 0.1 mm



2. Measure the commutator outer diameter.
   Standard value: 32.0 mm
   Limit: 31.4 mm

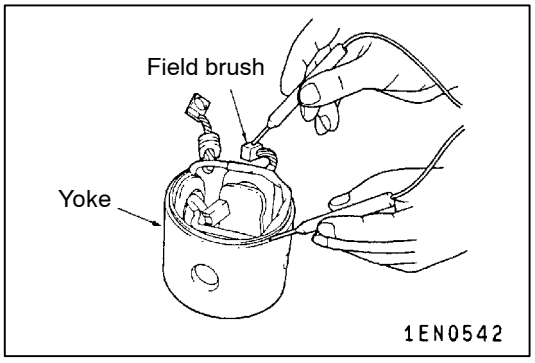


3. Check the undercut depth between segments.
   Standard value: 0.5 mm
   Limit: 0.2 mm



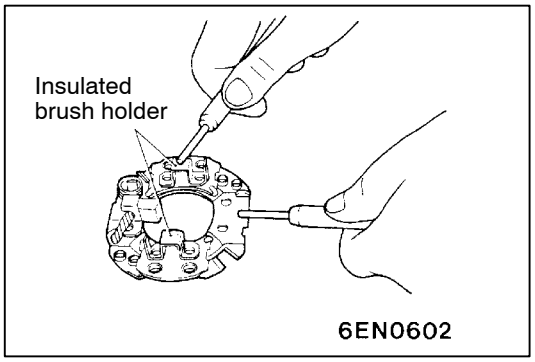
FIELD COIL OPEN-CIRCUIT TEST

Check the continuity between field brushes. If there is continuity, the field coil is in order.



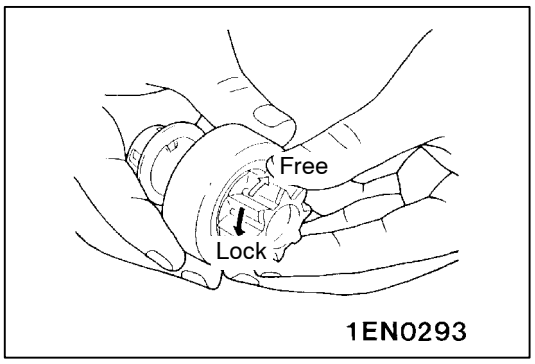
FIELD COIL GROUND TEST

Check the continuity between field coil brush and yoke. If there is no continuity, the field coil is free from earth.



BRUSH HOLDER CHECK

Check the continuity between brush holder plate and brush holder.
If there is no continuity, the brush holder is in order.

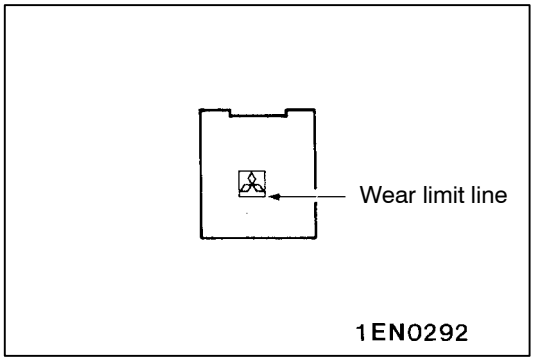


OVERRUNNING CLUTCH CHECK

1. While holding clutch housing, rotate the pinion. Drive pinion should rotate smoothly in one direction, but should not rotate in opposite direction. If clutch does not function properly, replace overrunning clutch assembly.
2. Inspect pinion for wear or burrs. If pinion is worn or burred, replace overrunning clutch assembly. If pinion is damaged, also inspect ring gear for wear or burrs.

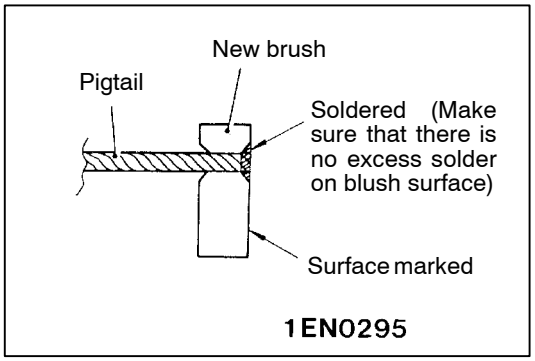
FRONT AND REAR BRACKET BUSHING CHECK

Inspect bushing for wear or burrs. If bushing is worn or burred, replace front bracket assembly or rear bracket assembly.

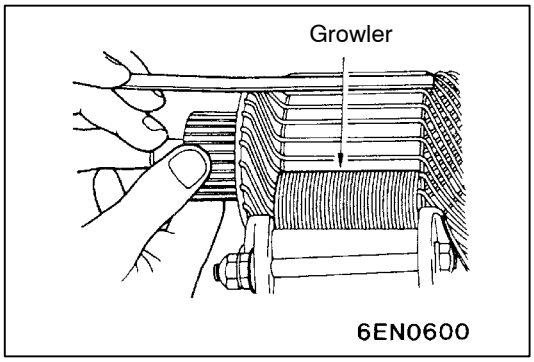


BRUSH AND SPRING REPLACEMENT

1. Brushes that are worn beyond wear limit line, or are oil-soaked, should be replaced.
2. When replacing field coil brushes, crush worn brush with pliers, taking care not to damage pigtail.



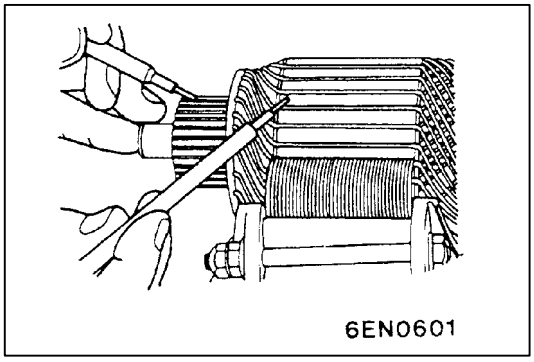
3. Sand pigtail end with sandpaper to ensure good soldering.
4. Insert pigtail into hole provided in new brush and solder it.
   Make sure that pigtail and excess solder do not come out onto brush surface.
5. When replacing ground brush, slide the brush from brush holder by prying retainer spring back.



ARMATURE TEST

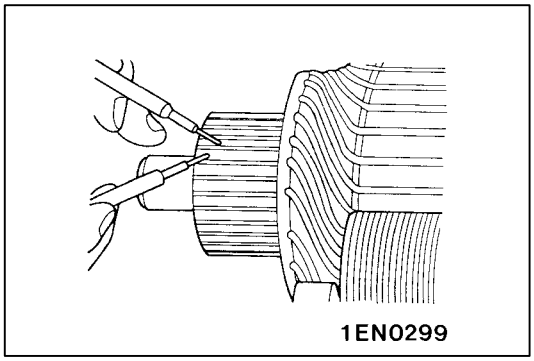
ARMATURE SHORT-CIRCUIT TEST

1. Place armature in a growler.
2. Hold a thin steel blade parallel and just above while rotating armature slowly in growler. A shorted armature will cause blade to vibrate and be attracted to the core. Replace shorted armature.



ARMATURE COIL EARTH TEST

Check the insulation between each commutator segment and armature coil core.
If there is no continuity, the insulation is in order.



ARMATURE COIL OPEN-CIRCUIT INSPECTION

Check the continuity between segments. If there is continuity, the coil is in order.

IGNITION SYSTEM

GENERAL

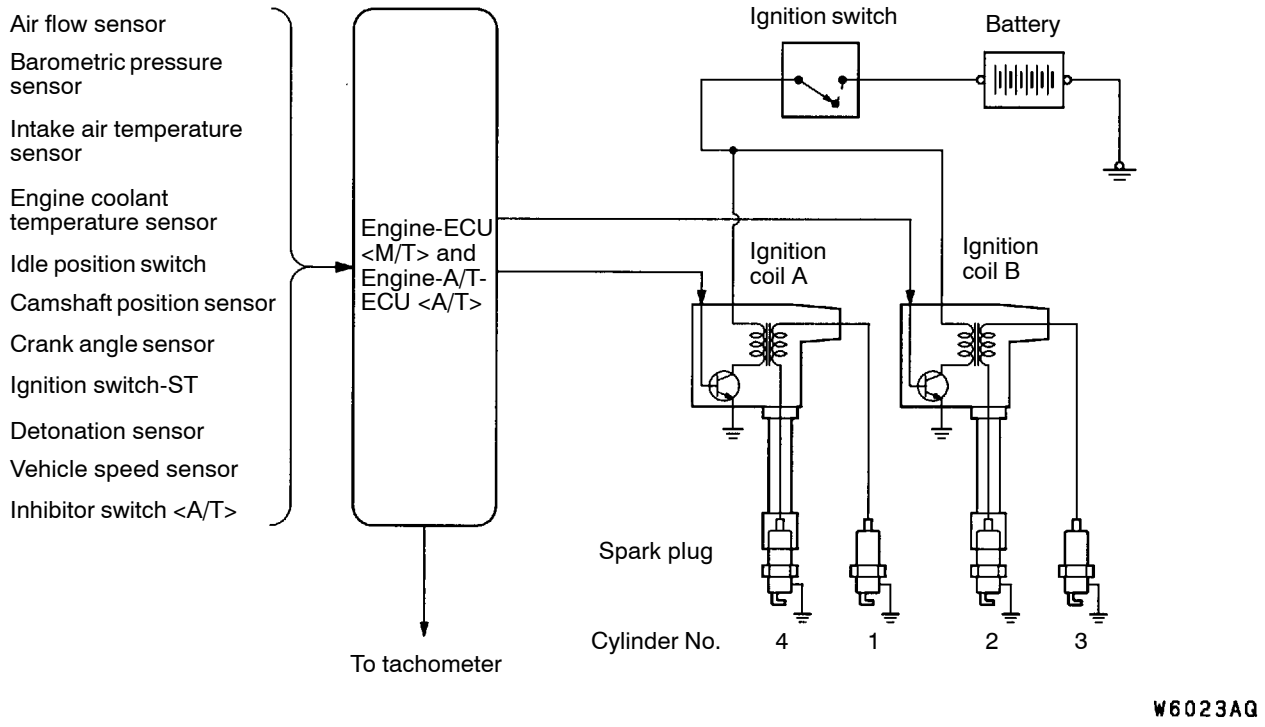
OUTLINE OF CHANGES

The following service procedures have been established to correspond to the addition of vehicles with 4G63-MPI engine. Items other than those given below are the same as for the 4G6-GDI engine mounted in the SPACE WAGON.

GENERAL INFORMATION

This system is equipped with two ignition coils (A and B) with built-in power transistors for the No. 1 and No. 4 cylinders and the No. 2 and No. 3 cylinders respectively.
Interruption of the primary current flowing in the primary side of ignition coil A generates a high voltage in the secondary side of ignition coil A.
The high voltage thus generated is applied to the spark plugs of No. 1 and No. 4 cylinders to generate sparks. At the time that the sparks are generated at both spark plugs, if one cylinder is at the compression stroke, the other cylinder is at the exhaust stroke, so that ignition of the compressed air/fuel mixture occurs only for the cylinder which is at the compression stroke.
In the same way, when the primary current flowing in ignition coil B is interrupted, the high voltage thus generated is applied to the spark plugs of No. 2 and No. 3 cylinders.
The engine-ECU <M/T> and engine-A/T-ECU <A/T> turns the two power transistors.
Inside the ignition coils alternately on and off. This causes the primary currents in the ignition coils to be alternately interrupted and allowed to flow to fire the cylinders in the order 1-3-4-2.
The engine-ECU <M/T> and engine-A/T-ECU <A/T> determines which ignition coil should be controlled by means of the signals from the camshaft position sensor which is incorporated in the camshaft and from the crank angle sensor which is incorporated in the crankshaft. It also detects the crankshaft position in order to provide ignition at the most appropriate timing in response to the engine operation conditions. It also detects the crankshaft position in order to provide ignition at the most appropriate timing in response to the engine operation conditions.
When the engine is cold or operated at high altitudes, the ignition timing is slightly advanced to provide optimum performance.
Furthermore, if knockking occurs, the ignition timing is gradually retarded until knocking ceases.

SYSTEM DIAGRAM



IGNITION COIL SPECIFICATIONS

Items	Specifications
Type	Molded 2-coil

SPARK PLUG SPECIFICATIONS

Items	Specifications
NGK	BKR6E-11
DENSO	K20PR-U11

SERVICE SPECIFICATIONS

IGNITION COIL

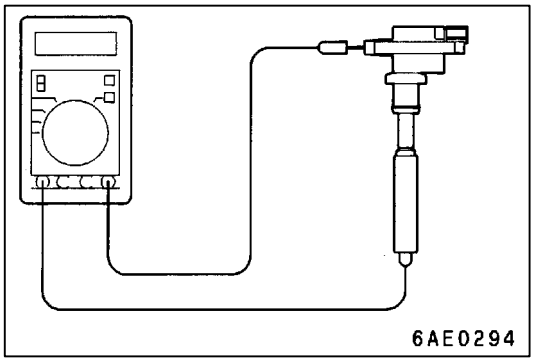
Items	Specifications
Secondary coil resistance kΩ	8.5 - 11.5

SPARK PLUG

Items	Specifications
Spark plug gap mm	1.0 - 1.1

RESISTIVE CODE

Items	Specifications
Resistance kΩ	max. 22



ON-VEHICLE SERVICE

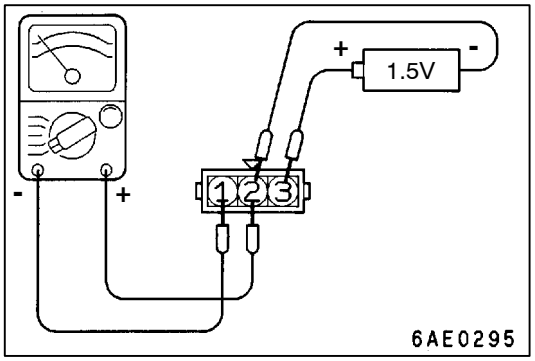
IGNITION COIL (WITH BUILT-IN POWER TRANSISTOR) CHECK

Check by the following procedure, and replace if there is a malfunction.

SECONDARY COIL RESISTANCE CHECK

Measure the resistance between the high-voltage terminals of the ignition coil.

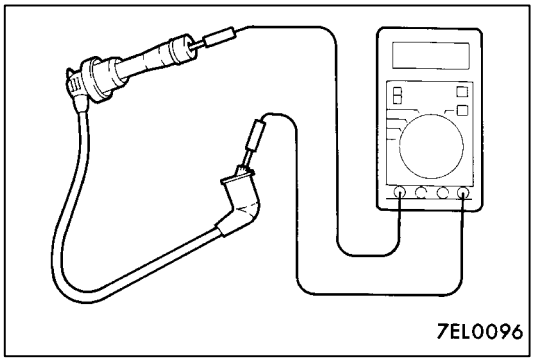
Standard value: 8.5 - 11.5 kΩ



PRIMARY COIL AND POWER TRANSISTOR CONTINUITY CHECK

NOTE
An analog-type circuit tester should be used.

Voltage: 1.5V	Terminal No.		
	1	2	3
When current is flowing	○	⊖ ——— ○	⊕
When current is not flowing			



RESISTIVE CORD CHECK

Measure the resistance of the all spark plug cables.

1. Check cap and coating for cracks.
2. Measure resistance.

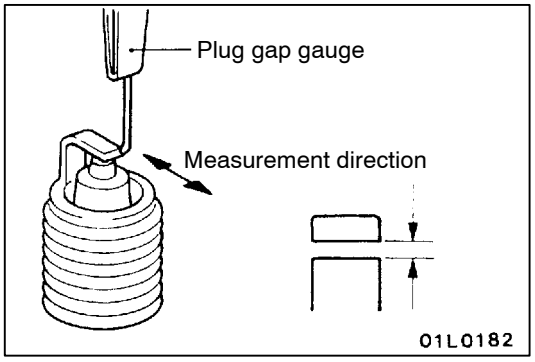
Limit: Max. 22 kΩ

SPARK PLUG CHECK AND CLEANING

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: 1.0 - 1.1 mm

   If the plug gap is not within the standard value range, adjust by bending the earth electrode.
6. Clean the engine plug holes.

   Caution
   Be careful not to allow foreign matter in cylinders.

7. Install the spark plugs.

CAMSHAFT POSITION SENSOR CHECK

Refer to GROUP 13A - Troubleshooting.

CRANK ANGLE SENSOR CHECK

Refer to GROUP 13A - Troubleshooting.

DETONATION SENSOR CHECK

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

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

WAVEFORM CHECK USING AN ANALYZER

Ignition Secondary Voltage Check

MEASUREMENT METHOD

1. Clamp the SECONDARY PICKUP around the spark plug cable.

   NOTE
   1. The peak ignition voltage will be reversed when the spark cables No. 2 and No. 4, or No. 1 and No. 3 cylinders are clamped.
   2. Because of the two-cylinder simultaneous ignition system, the waveforms for two cylinders in each group appear during waveform observation (No. 1 cylinder - No. 4 cylinder, No. 2 cylinder - No. 3 cylinder). However, waveform observation is only applicable for the cylinder with the spark plug cable clamped by the secondary pickup.
   3. Identifying which cylinder waveform is displayed can be difficult. For reference, remember that the waveform of the cylinder attached to the secondary pickup will be displayed as stable.

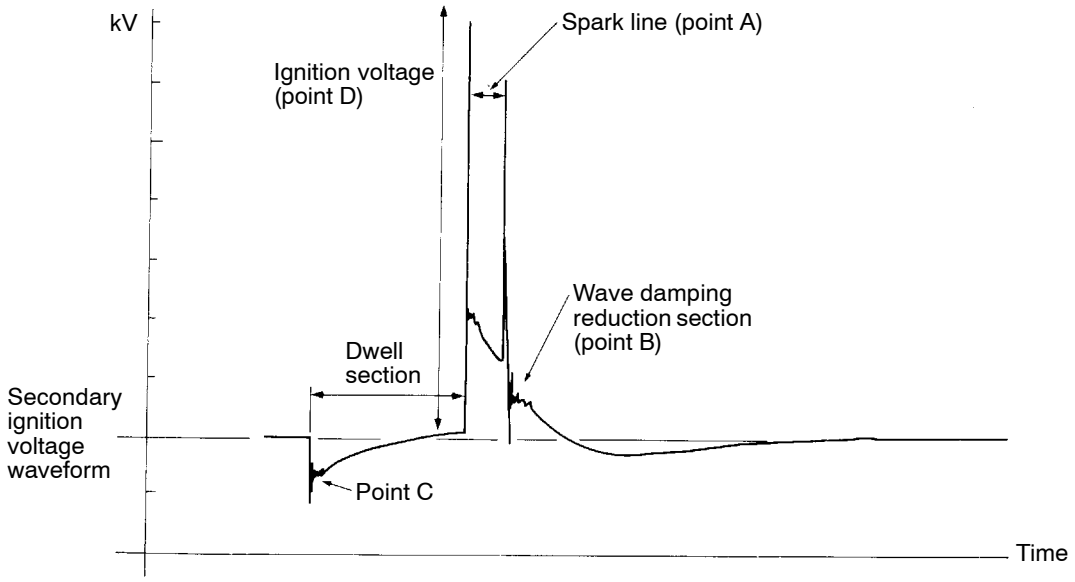
2. Clamp the spark plug cable with the trigger pickup.

   NOTE
   - Clamp the trigger pickup to the same spark plug cable clamped by the secondary pickup.

STANDARD WAVEFORM

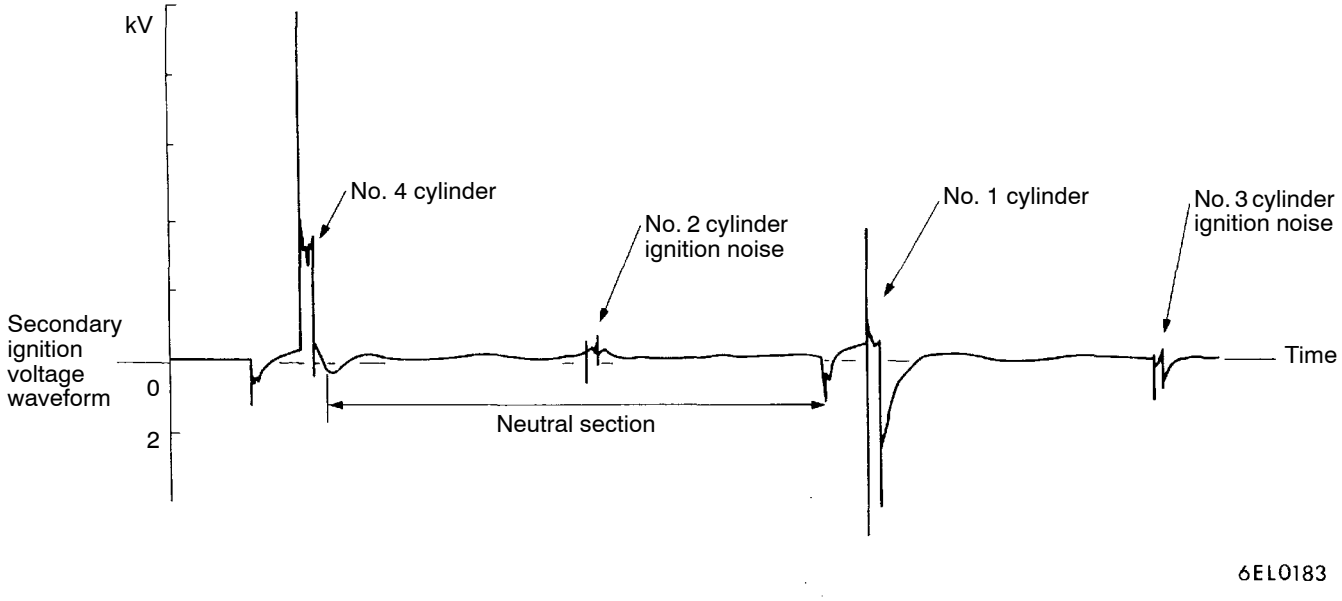
Observation Conditions

Function	Secondary
Pattern height	High (or Low)
Pattern selector	Raster
Engine revolutions	Curb idle speed



Observation Condition (The only change from above condition is the pattern selector.)

Pattern selector	Display



WAVEFORM OBSERVATION POINTS

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

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 vibration in reduction vibration section (Refer to abnormal waveform example 5)

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

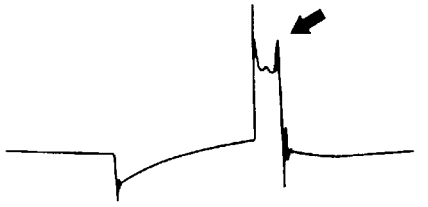
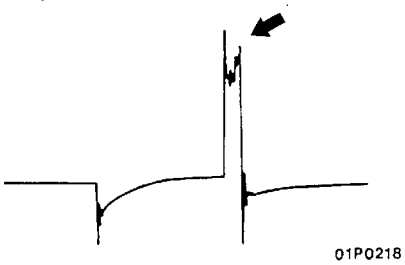
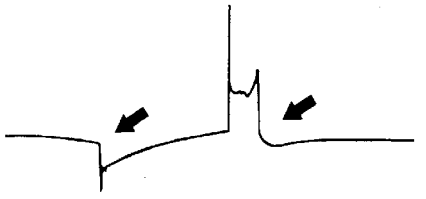
Point C: Number of vibrations at beginning of dwell section (Refer to abnormal waveform example 5)

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

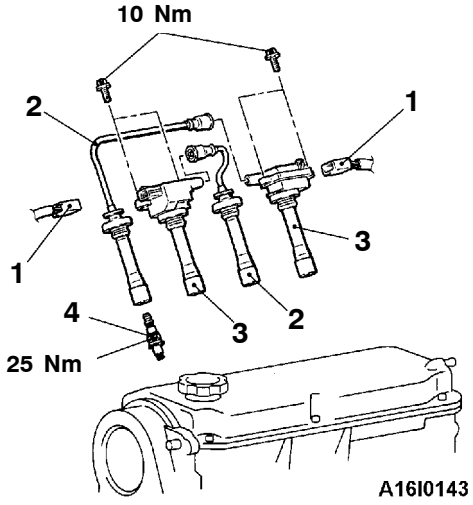
Abnormal waveform	Wave characteristics	Cause of problem
Example 1  01P0215	Spark line is high and short.	Spark plug gap is too large.
Example 2  01P0216	Spark line is low and long, and is sloping. Also, the second half of the spark line is distorted. This could be a result of misfiring.	Spark plug gap 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 waveform 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 COIL

REMOVAL AND INSTALLATION

Pre-removal and Post-installation Operation
Engine Cover Removal and Installation

<4G6-MPI>



Removal steps

1. Ignition coil connector
2. Spark plug cable
3. Ignition coil
4. Spark plug

CAMSHAFT POSITION SENSOR

REMOVAL AND INSTALLATION

Pre-removal and Post-installation Operation
Engine Cover Removal and Installation

<4G6-MPI>