WORK FLOW OF INTAKE SYSTEM

INTAKE SYSTEM LAYOUT

HFM Sensor
The HFM sensor is installed in the air intake passage between the air cleaner and the intake manifold. It measures the air volume supplied to the combustion chamber and the air temperature.

Major Functions
- It controls the EGR feedback.
- It controls the pressure control valve for the turbocharger booster.

INTAKE SYSTEM LAYOUT

1. Plug-in sensor
2. Cylinder housing
3. Protection grid
4. Hybrid cover
5. Measuring duct cover
6. Housing
7. Hybrid
8. Sensor
9. Mounting plate
10. O-ring
11. Temperature sensor
The charging efficiency may be lowered or the knocking may happen as the intake air is heated and the density of air is lowered. The intercooler is the device which cools the supercharged air.


**Layout**

- Intake manifold
- EGR valve
- EGR-LH pipe assembly
- EGR pipe assembly
- EGR pipe gasket
- EGR-RH pipe assembly
- Intake manifold
- EGR valve assembly
- EGR-LH pipe assembly
- EGR pipe gasket

**Tightening torques**

- **EGR valve gasket**
  - M8x25/30-4 EA: 10 ± 1.0 Nm
  - M8x50/133-10 EA: 25 ± 2.5 Nm

- **Intake manifold**
  - M6x25-4 EA: 10 ± 1.0 Nm

- **EGR pipe**
  - M6x16-2 EA: 10 ± 1.0 Nm

- **EGR-RH pipe assembly**
  - M6x16-2 EA: 10 ± 1.0 Nm

- **Tightening torque**
  - M8-nut: 35 ± 3.5 Nm

- **EGR pipe**
  - M6x16-2 EA: 10 ± 1.0 Nm
COMPONENTS

▶ Intake Manifold Assembly

The intake manifold assembly is built for the optimized mixture of the EGR gas in the intake chamber when the compressed air in the turbocharger is sent to the intake port. The intake port is composed of the dual port (tangential and helical port) which increases the swirl ratio in mid/low operating range, improves acceleration/fuel consumption and decreases particle materials. However, there are some differences in the form of the EGR valve and 4-cylinder engine.

⚠️ NOTICE

- The inlet port and coolant outlet port is integrated together. Therefore, be careful not to let the residual coolant in the manifold enter the inlet port when removing the intake manifold. Also, replace the gasket with a new one and tighten it to the specified torque (25 ± 2.5 Nm).

The SUS + Rubber coating is applied to the intake manifold gasket to prevent the air leakage and optimize the sealing effect.
**Turbocharger Intercooler Assembly**

The turbocharger is designed to improve the engine power by introducing more air (oxygen) into the engine. However, the intake air is heated during the compression process in the turbocharger compressor and the density is lowered.

The intercooler is the device which cools (50 ~ 60°C) the air entering the engine from high temperature (100 ~ 110°C) to maintain the turbocharging efficiency.

Thus, more air is entered the cylinder than the engine only with the turbocharger to give more power.

**Removal and Installation**

For removal and installation procedures, refer to the “Cooling system” section in DI engine service manual.
PRECAUTIONS WHEN INSTALLING INTAKE SYSTEM

**Intake (Inlet/Outlet) Hose and EGR Pipe**

The clamps of hoses and EGR pipe should be tightened to the specified tightening torque when installing the engine assembly or servicing on the air cleaner duct, the turbocharger and the intercooler.

1. Hose between air cleaner and turbocharger

   
   **Tightening torque**
   
   6 ~ 7 Nm

2. Hose between turbocharger and intercooler

   
   **Tightening torque**
   
   6 ~ 7 Nm

3. Connections of EGR pipe

   
   **Tightening torque**
   
   10 ± 1.0 Nm

4. Fixing clamps on inlet hose (intake manifold and intercooler)

   
   **Tightening torque**
   
   6 ~ 7 Nm
Precautions When Installing

: The clamps on the hoses should be tightened to the specified tightening torque when installing the engine assembly or servicing on the air cleaner duct, the turbocharger and the intercooler.

1. **Symptoms**
   : Insufficient engine power, smoke or noise when accelerating (whistle noise).

2. **Cause**
   : Clamp is out of place due to the turbocharging pressure or improper tightening torque.

3. **Correction**
   - Check if the clamp is out of place or the intercooler is leaking.
   - Always observe the tightening torque when installing the related parts.
   - Do not use a screwdriver. Always use a torque wrench when tightening the clamps.

| Tightening torque of intake hose clamp | 6 ~ 7 Nm |

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Air Cleaner Element - Replacement

※ Preceding Work: Disconnection of negative battery cable

1. Disconnect the HFM sensor connector.
2. Loosen the locking clamp and remove the intake duct.

3. Unscrew the screws and remove the air cleaner cover.

4. Remove the air cleaner element. Clean or replace the element as required.
Air Cleaner Housing
- Removal and Installation

※ Preceding Work: Removal of air cleaner cover
1. Set aside the return hose and remove the coolant reservoir bolts.

2. Remove the air cleaner housing bolts.
3. Install in the reverse order of removal.

Air Cleaner Housing/Element - Check
1. Check the air cleaner body, cover and packing for deformation, corrosion and damage.
2. Check the air duct for damage.
3. Check the air cleaner element for clogging, contamination and damage. If the element is partially clogged, remove the dust or foreign materials with the compressed air. If the contamination is severe, replace it with a new one. Also, be careful not to contaminate during the replacement.
4. Check the air cleaner housing for clogging, contamination and damage.
5. If the inside of housing is contaminated, remove the contaminants.

NOTICE
• When cleaning the air cleaner with compressed air, direct the air from inside (engine) to outside (ambient air). Otherwise, contaminants can get into the engine.
AIR FLOW SENSOR (HOT FILM AIR MASS SENSOR)

1. Plug-in sensor
2. Cylinder housing
3. Protection grid
4. Hybrid cover
5. Measuring duct cover
6. Housing
7. Hybrid
8. Sensor
9. Mounting plate
10. O-ring
11. Temperature sensor

▶ General

Application

The micro-mechanical HFM6 hot-film air mass sensor with flow direction detection by pulsating mass air flow has been conceived for load recording with internal combustion engines with petrol and diesel fuel injection.

The HFM6 installation is effected in the air intake system between the air filter and the throttle device, in the case of supercharged engines between the air cleaner and the supercharger. The HFM6 is installed either as a plug-in sensor in an existing part of the airducting, such as, e.g. the air cleaner housing, or as pre-assembled plug-in sensor module including cylinder housing.

Depending on the required air flow rate of the combustion engine, various cylinder housing sizes are provided.

The HFM6 also records, in addition to the air mass taken in by the engine, the temperature of the air taken in. The HFM6 may only be operated with a suitable control unit.

Design and Function

The hot-film air mass sensor is a thermal flowmeter. The sensor element with its temperature sensors and the heating area is exposed to the air mass flow. Through a metering channel on the plug-in sensor housing a portion of the air flow from the cylinder housing is routed past a sensor element.

A thin diaphragm is generated on the silicon-based sensor element by means of etching. A heating resistor and various temperature sensors are laid out on this diaphragm. The heating area is located in the centre of the diaphragm, which is controlled to an excess temperature using a heating resistor and a temperature sensor. The degree of this excess...
temperature depends on the temperature of the air flowing in. Without incoming air flow, the temperature at the diaphragm edges declines in an approximately linear fashion. Temperature sensors are located symmetrically in relation to the heating area upstream and downstream of the heating area. When there is no incoming flow, these sensors indicate the same temperature. With incoming flow, the part of the diaphragm upstream of the heating area is cooled down due to heat transfer in the boundary layer. The downstream temperature sensor approximately retains its temperature, due to the air heated up in the heating area.

The temperature sensors indicate a temperature difference which is dependent upon amount and direction of the incoming flow. The difference signal of the temperature sensor is evaluated as a resistance bridge.

Digital signal processing takes place after digitising the resistor bridge voltage and the intake air temperature sensor signal. This enables temperature compensation on the basis of the chip temperature and a standardization of the output characteristic curve.

The plug-in sensor housing contains the electronic module with the evaluation circuit for the sensor.

**Intake Air Temperature**

The Intake Air Temperature (IAT) sensor is a part of Hot Film Air Mass (HFM) sensor and is a thermostor, a resistor which changes value based on the temperature of the air entering the engine. Low temperature produces a high resistance, while high temperature causes a low resistance as the following table.

The ECM provides 5 volts to the IAT sensor through a resistor in the ECM and measures the change in voltage to determine the IAT. The voltage will be high when the manifold air is cold and low when the air is hot. The ECM knows the intake IAT by measuring the voltage.

The IAT sensor is also used to control spark timing when the manifold air is cold.

<table>
<thead>
<tr>
<th>Temp. (°C)</th>
<th>R min. (Ω)</th>
<th>R nom. (Ω)</th>
<th>R max. (Ω)</th>
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<tbody>
<tr>
<td>-40</td>
<td>35,140</td>
<td>39,260</td>
<td>43,760</td>
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<td>-20</td>
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<td>5,119</td>
<td>5,499</td>
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<tr>
<td>130</td>
<td>91</td>
<td>102</td>
<td>114</td>
</tr>
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</table>

![NTC output voltage (1K Ohm Pull-Up)](image-url)
<Circuit Diagram of HFM Sensor>
HFM Sensor - Removal and Installation

✿ Preceding Work: Disconnection of negative battery cable

1. Disconnect the HFM sensor connector.
2. Loosen the clamps on the air cleaner and the turbo charger and remove the duct.

3. Unscrew the bolts and remove the HFM sensor assembly.

            **Installation Notice**

| Tightening torque | 4 ~ 5 Nm |

4. Install the reverse order of removal.
INTERCOOLER

The turbo charger is designed to improve the engine power by introducing more air (oxygen) into the engine. However, the intake air is heated (100 ~ 110°C) during the compression process in turbo charger compressor and the density is lowered.

The intercooler is the device which cools (50 ~ 60°C) the air entering the engine. Cold air has more oxygen molecules than warm air. Thus cooler air gives more power and better fuel economy.

1. Intercooler
Intercooler - Removal and Installation

1. Disconnect all wiring harnesses and related connectors from the front side of radiator assembly.

2. Remove the front end center member.
3. Remove the hood latch cable and remove the radiator support upper member.

4. Remove the intercooler inlet hose and outlet hose.

| Tightening torque | 6 ~ 7 Nm |

5. Unscrew the bolts and remove the intercooler assembly.

6. Install in the reverse order of removal.
INTAKE MANIFOLD ASSEMBLY

▶ System Characteristics

1. Shape that delivers the required capacity of compressed air from turbo charger to inlet port
2. Optimized EGR gas mixture in inlet chamber
3. Maximized intake efficiency with helical and tangential inlet port
   1) Improving the swirl ratio in low and mid operating range
   2) Improving the acceleration/fuel economy and reducing the maintenance in low and mid operating range
4. Integrated inlet port and coolant outlet port
## Special Tools and Equipment

<table>
<thead>
<tr>
<th>Name and Part Number</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y99220112B</td>
<td>Installation of intake manifold</td>
</tr>
</tbody>
</table>

Intake manifold guide pin

[Image of intake manifold guide pin]
1. Lift up the vehicle and remove the skid plate.
2. Open the coolant reservoir cap and loosen the drain cock to drain the coolant.

3. Remove the air inlet hose (1) from intake manifold.
4. Loosen the clamp and remove the coolant inlet hose (2).

5. Remove the coolant inlet port housing.
6. Remove the vacuum hose from EGR valve.
7. Remove the EGR valve mounting bolts and gasket. Remove the EGR exhaust pipe (primary) mounting bolts and gasket.

**NOTICE**

- Replace the pipes (2, 3) at both sides of EGR cooler (1) and gaskets with new ones.
- Make sure that the convex surface of gasket is facing to the pressurized direction.
8. Remove the brackets and connectors from top section of the engine.
   1) Vacuum hose bracket in turbo charger
   2) Booster pressure sensor
   3) Main wiring bracket
   4) Ground cable bracket
   5) Fuel pressure sensor connector

9. Unscrew the bolts and remove the vacuum modulator bracket.

   **Installation Notice**
   
   | Tightening torque | 9.0 Nm |

10. Remove the HP pump fuel supply line bolts.
11. Remove the HP pump fuel supply line mounting bracket.
12. Remove the HP pump fuel return line at fuel filter.

   **NOTICE**
   - Plug the openings of pipes and ports with sealing caps to keep the cleanliness of the fuel system.
   - Replace the pipes with new one once removed.

13. Remove the injector return line at HP pump.

   **NOTICE**
   - Be careful not to damage the pipes to HP pump.
   - Plug the fuel return port of the HP pump with a sealing cap.
14. Remove the intake manifold mounting bolts.

**Installation Notice**

| Tightening torque | 25 ± 2.5 Nm |

*Check the length of the bolts before installation.*

- M8 x 45: 6EA
- M8 x 130: 6EA

15. Lift up the vehicle and remove the propeller shaft joint bolts.

16. Unscrew the bolt in oil filter and remove the intake manifold and gasket.

**NOTICE**

- Replace the gasket with new one.
- Make sure that the residual coolant in intake manifold gets into the inside of inlet port.

17. Install in the reverse order of removal.

**NOTICE**

- Replace the gasket with new one.
- If replaced only gasket without any other service operation, completely remove the coolant and other contaminants from the engine before installation.