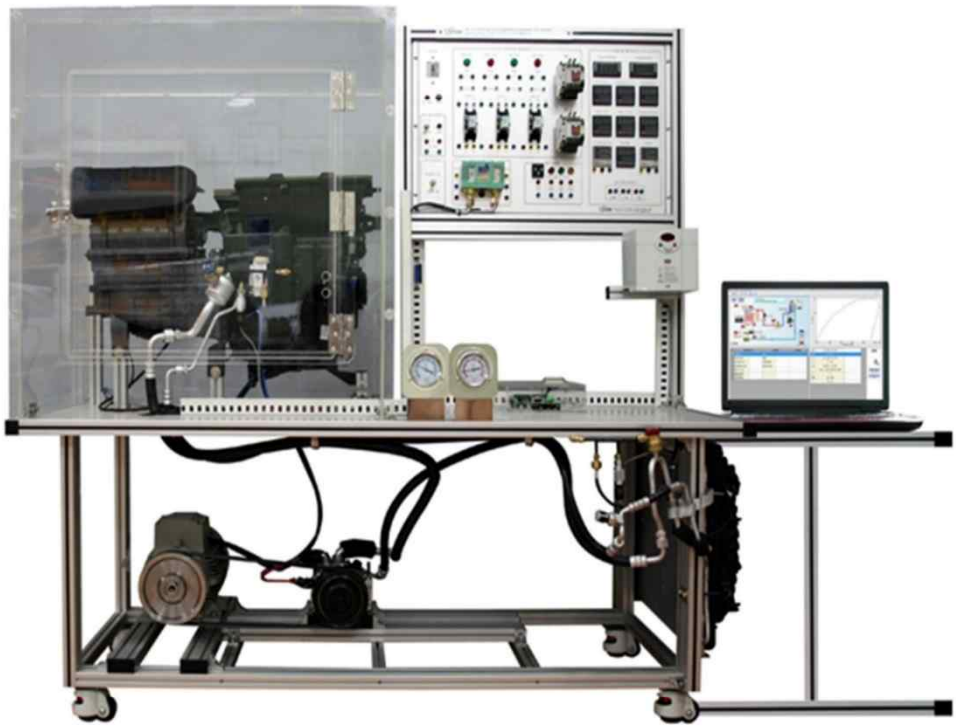
Model : KTE-9000AU

VEHICLE REFRIGERATION EXPERIMENTAL EQUIPMENT GUIDEBOOK Ver.1.1.0



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CONTENT

1. About

This experimental apparatus is designed for operation, repair and experiment of each system through cooling and heating modules applied to vehicles. The data acquisition device (DA100) applied to this apparatus allows monitoring using PC and saving experiment data on PC.

This experimental apparatus is designed to help understand car cooling and heating system parts and allow cooling and heating performance measurement according to their operating conditions.

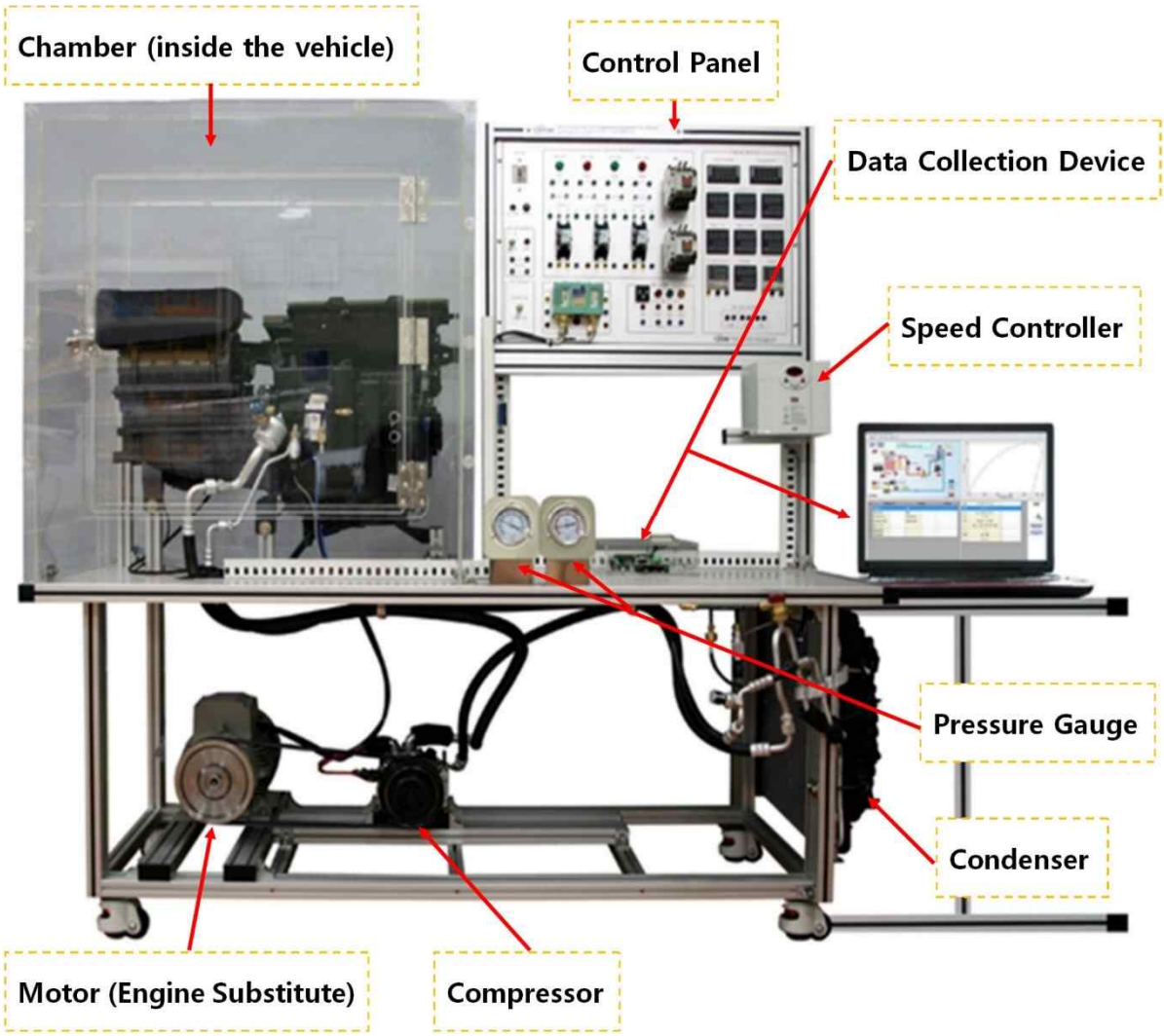
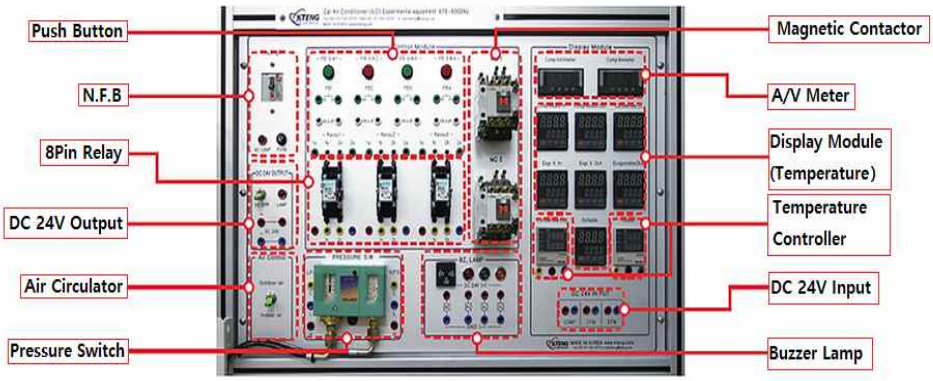


Fig. All Car Air-conditioning System

2. Applied Parts

(1) Control panel



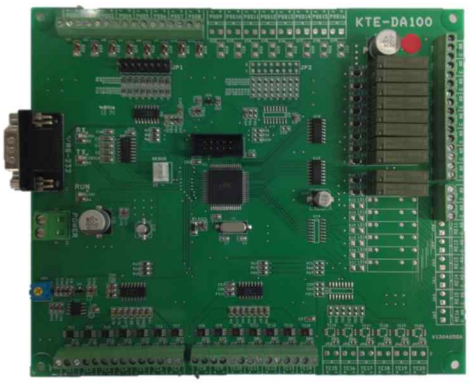
(2) Inverter

1) Start-up : Turn the MOTOR S/W “ON” then press "RUN" button of the inverter.

2) Input : 220-230V, 1 phase
50/60Hz, 21.6A

3) Output : 0-Input V, 3phase
3 HP, 2.2 KW(D)

(3) DA100 (Data acquisition module)



- Its role is to obtain the temperature and pressure of each refrigeration component of the car air-conditioner and store them on the computer.
- Program DA100 (KTE-1000BA) : Circuit Diagram, P-H Diagram

3. How to use Apparatus

3-1. Hardware

3-1-1. Cooling mode operation steps

Steps	Activity
1	Turn "ON" the NFB switch on CONTROL PANEL. Make sure that the VOLTMETER displays 12V.
2	Turn MOTOR S/W "ON" 1) Make sure that INVERTER displays the power is turned on. 2) Adjust the frequency (20~60Hz) then press "RUN" button.
3	Make sure that power is supplied to the FATC UNIT.
4	Connect DA100 MODULE to PC. 1) Make sure that the DA100 MODULE is connected to the power supply. 2) Make sure that the SERIAL and SERIAL TO USB GENDER cables are plugged in.
5	Adjust the modes, temperature, in/outdoor air according to the experimental methods for practice. 1) See the car air-conditioner performance experiment on page 9 ~ 13.

3-1-2. Heating mode operation steps

Steps	Activity
1	Fill a tank with water and operate a pump. Be careful overflow at tank.
2	Set a temperature using temperature controller.
3	Turn on heater load.
4	Operate evaporator fan take Steps1 and 4 of Cooling mode.

3-2. Software

3-2-1. Data Acquisition and System Monitoring Program

(1) Function

1) Monitoring the measured data of temperature and pressure in real time.
2) Monitoring the measured data of enthalpy on a diagram of Standard refrigeration system in real time.
3) Monitoring factors like as refrigeration effect, compressor work, condensing heat in condenser, evaporating latent heat, amount of flash gas at expansion V/V outlet, dry ratio at expansion V/V outlet, humidity at expansion V/V outlet, coefficient of performance in the abstract with temperature and pressure data which are measure in real time
4) Being saved Being saved data all of temperature, pressure and enthalpy on every minute as excel
5) Evaporation experiment: Various evaporation load, various evaporation pressure, various evaporation temperature and super heating.
6) Condensation experiment: Over condensing operation and over condensing load operation.
7) Compressing experiment: wet compressing operation, super heat compressing operation and dry saturation compressing operation.

(2) Composition

1) Main Page
2) Sector for display of temperature data
3) Sector for graph chart of temperature
4) Sector for display of pressure data
5) Sector for graph chart of pressure
6) Sector for flow diagram of Standard refrigeration system
7) Sector for display the P-H chart of Standard refrigeration system on real time.
8) Sector of setting interval for saving data.
9) Sector of starting operation

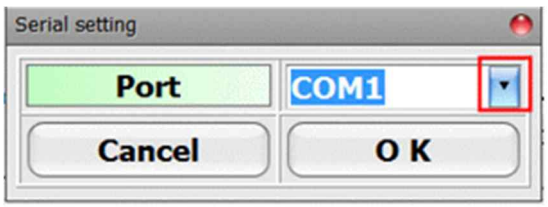
(3) Being registered with Korea Software Copyright Committee.

3-2-2. Data Acquisition and System Monitoring Program Setup and setting

1) Serial setting

-“Setting” click -> “Serial setting”

-“COM” -> OK click



2) Offset setting: Volatage’s Parameter

-Temp. setting equation: **Y=70X-150**

-Check a **Voltage** in Temp. setting

-Press. setting equationg: **Y=X**

-Check a **Press** in Press. setting

3-3. Performance Analysis

The interior temperature was maintained at 20±2℃ in the experiment to keep constant operating conditions for the air-conditioner. The pin thermal switch automatically turns OFF switching OFF the magnetic clutch of the compressor when the temperature on the evaporator's core side is 1℃ or below, in order to prevent from freezing of the air-conditioning system. KTE-9000 program (Data Acquisition & System Monitoring Program) designed to verify the equipment's reliability was applied and used together with the existing Data Logger for the simultaneous measurement. In order to identify the car air-conditioner's performance, the temperature and pressure of each refrigerant system part were measured with variations in rotational speed (1000rpm, 1500rpm, 1700rpm) according to the charge amount of the new refrigerant (R-134a) and various heat and performance factors were calculated by the automated performance measurement system software.

(1) Comparison of the Results from KTE-9000 and Data Logger Measurements

The comparison of the temperatures measured in each part of the air-conditioner appear in Figure 2 and 3 respectively. The result shows the following dispersions gained, which verifies the accuracy and reliability of the apparatus :

Compressor inlet : 0～4℃, Compressor outlet : -1～3℃, Condenser inlet : 0～4℃, Condenser outlet : 1～5℃, Expansion valve inlet : 0～4℃, Expansion valve outlet : -1～3℃, Evaporator outlet : -2～3℃.

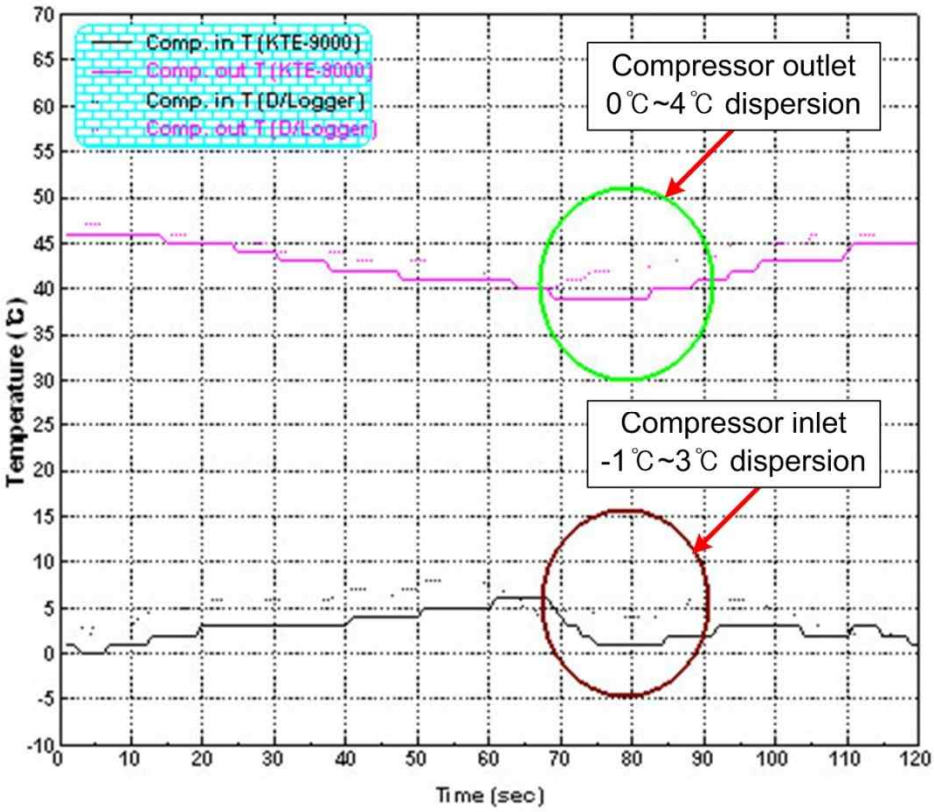


Figure 2. Comparison of compressor in-/outlet temperatures

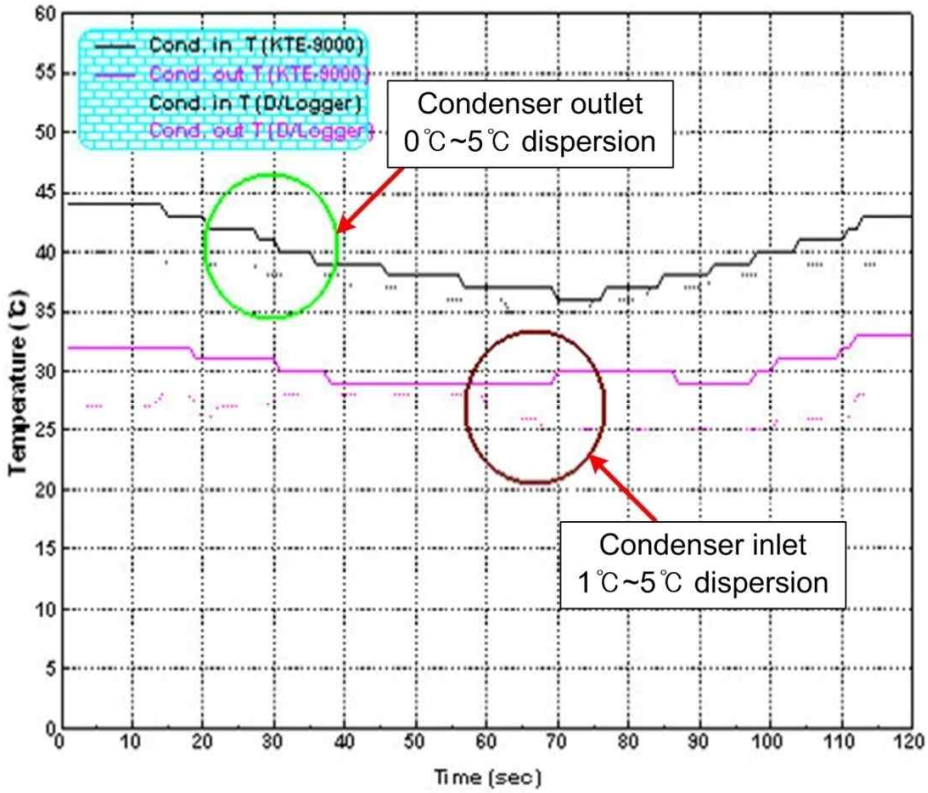


Figure 3. Comparison of condenser in-/oulet temperatures

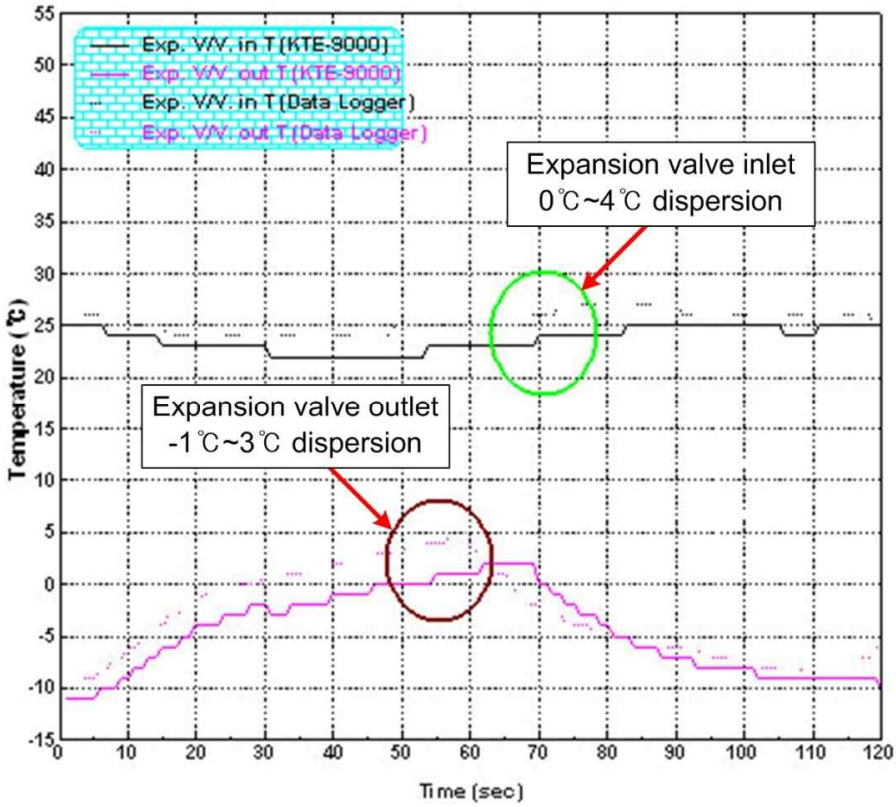


Figure 4. Comparison of expansion valve in-/outlet temperatures

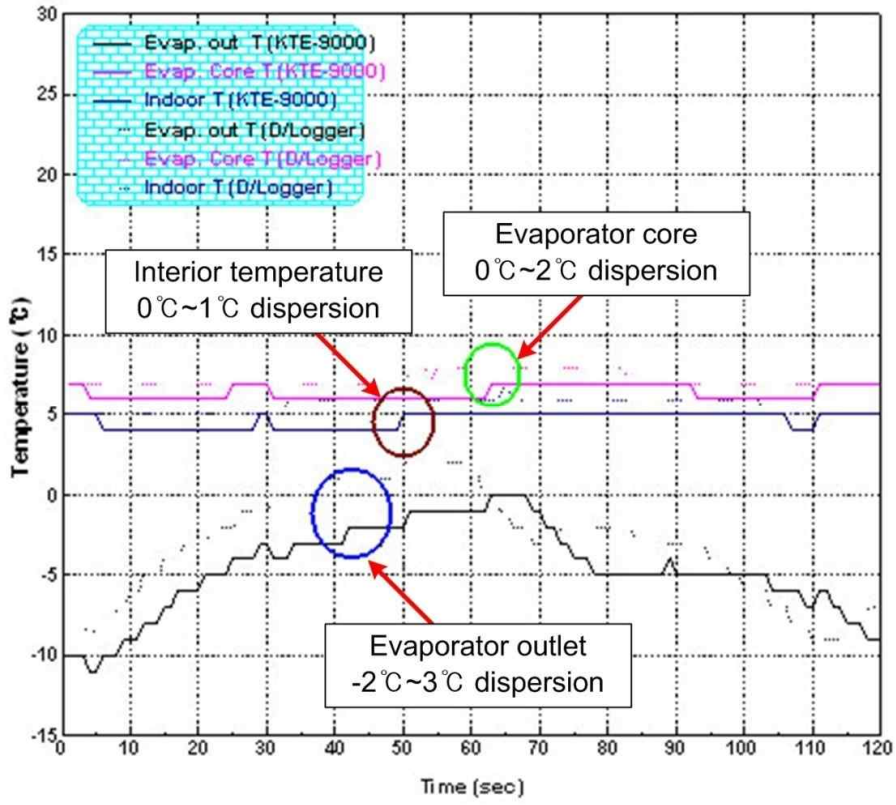


Figure 5. Comparison of evaporator, core and interior temperatures

(2) Comparison of Heat balance and Performance

Figure 6 shows the results on compressor load, refrigeration effect, condensation heat, and coefficient of performance (COP) according to the temperature and pressure calculated in data recording and system monitoring program, with 700g of refrigerant charge quantity and variations of compressor speed (1700rpm, 1500rpm, 1000rpm). The results show performance trends according to the operations of an air-conditioner, also that COP tends to decrease with increasing compressor load.

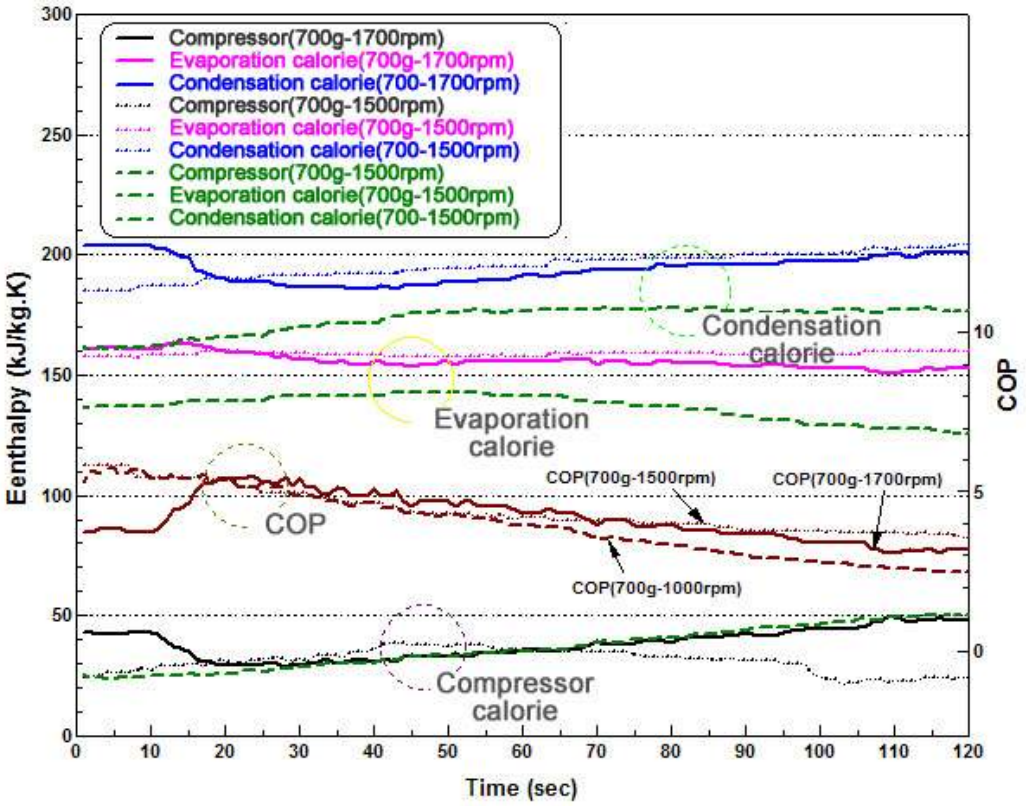


Figure 6. Comparison of Heat balance and COP

(3) Comparison in the Mollier Diagram

Figure 7 represents a P-h diagram calculated in the developed program and shows vapor-compression refrigeration cycles at 1700rpm and with variations of refrigerant charge amount (650g, 700g, 800g). It shows that compressor load decreases with increasing refrigerant charge amount, and pressure tends to fall after using a compressor, which means the performance will improve according to the improved refrigerant fluidity with increase in refrigerant charge amount.

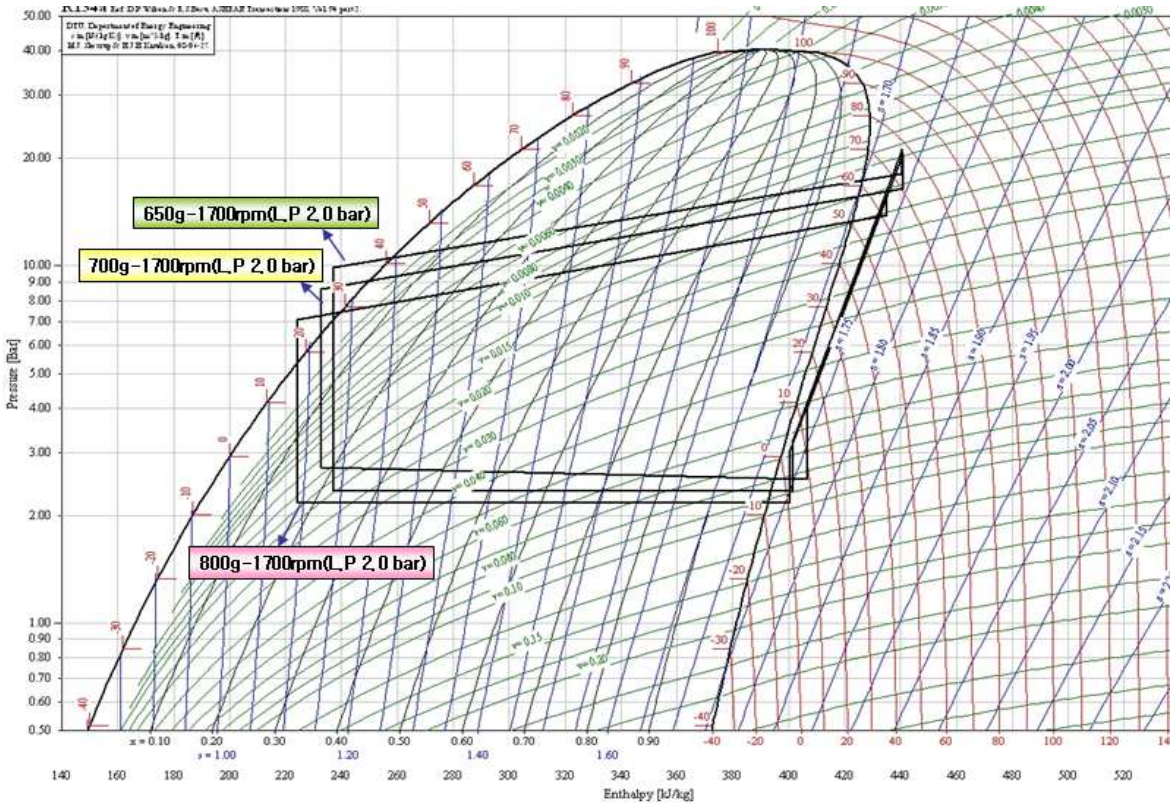


Figure 7. Characteristic Comparison in the Mollier Diagram

4. Car Air-conditioner Maintenance

4-1. Features of the Car Air-conditioning System

(1) Automatic (FATC) or manual control ECU and other safety devices

The control unit of the Full-Auto A/CON (FATC) calculates required discharge temperature according to the inputs of desired temperature set and conditions detected by various sensors (interior temperature sensor, ambient temperature sensor, photo sensor, water temperature sensor, duct sensor, vehicle speed sensor). It controls by processing the inputs through PBR, PTC, switches and sending signals to each actuator according to the results of the process.

(2) Differences between semiautomatic (SATC) and full automatic (FATC) air-conditioners

Comparison of SATC and FATC TYPE A/CON

	Semiautomatic (SATC)	Full automatic (FATC)
Set Temperature	1℃	0.5℃
Photo sensor's temperature calibration	-	O
Car speed sensor's airflow calibration	-	O
Automatic air-conditioning control	Manual control	Automatic control
Rear seat only air-conditioner	-	O (depending on the vehicle)
Humidity sensor	-	O

Comparison of SATC and FATC

	SATC	FATC
A/Con Control Unit	→	COMP' ON, OFF control
Sensor	duct, outside air, inside air, and water temperature sensors	duct, outside air, inside air, water temperature, and photo sensors
Interior Temperature Control	temperature control within set temperature range, through airflow/ COMP'/mix control using signals from each sensor	airflow/COMP' ON< OFF control, air outlet mix control, intake transfer using signals from each sensor

Airflow Control	unauthorized transmission in the Power TR (potential base change)	unauthorized transmission in the Power TR mix door's open rate control
Mode Control	Manual selection (by the driver)	automatic switching of VENT, BI-LEVEL, HEAT according to outlet temperature changes
COMP Control	→	ON/OFF according to inside/outside air temperature changes
Intake control	Manual Operation	• Automatic switching of FRESH, 1/3 FRESH, REC according to changes in ambient temperature
Heating start control	→	• The blower set on LOW with water temperature up to higher than 50℃, and the mode on DE • Water temperature rises → airflow increases • Mode switching : DEF→DEF/HEAT→HEAT

	SATC	FATC
Cooling start control	N/A	• Instantaneous prevention of warm air discharge • LOW airflow → reaches the set airflow level • LOW for 7 seconds after IG ON • 30-second delay of normal BLOWER function
Irradiance calibration	N/A	• Photo sensor
Mix door	→	• It is controlled in the automatic control unit. • It stops at the balance point of set temperature and interior temperature.
Others		• In the case of reoperation after OFF, it operates through the automatic memory of the conditions before OFF.

4-2. FATC TYPE A/CON SENSORS

(1) POWER TR (Transistor)

An NPN transistor is applied to control the blower motor speed, and for speed control, the air-conditioning ECU controls the base current of the power transistor and turns the transistor "ON" as many times as the button works, which means the change of the collector voltage is the speed control. It also controls the collector voltage using inputs from the air-conditioning ECU when it is different from the set voltage, and maintains constant speed of the blower motor, in order to prevent the phenomenon of rotation speed different from the set speed caused by various parameters.

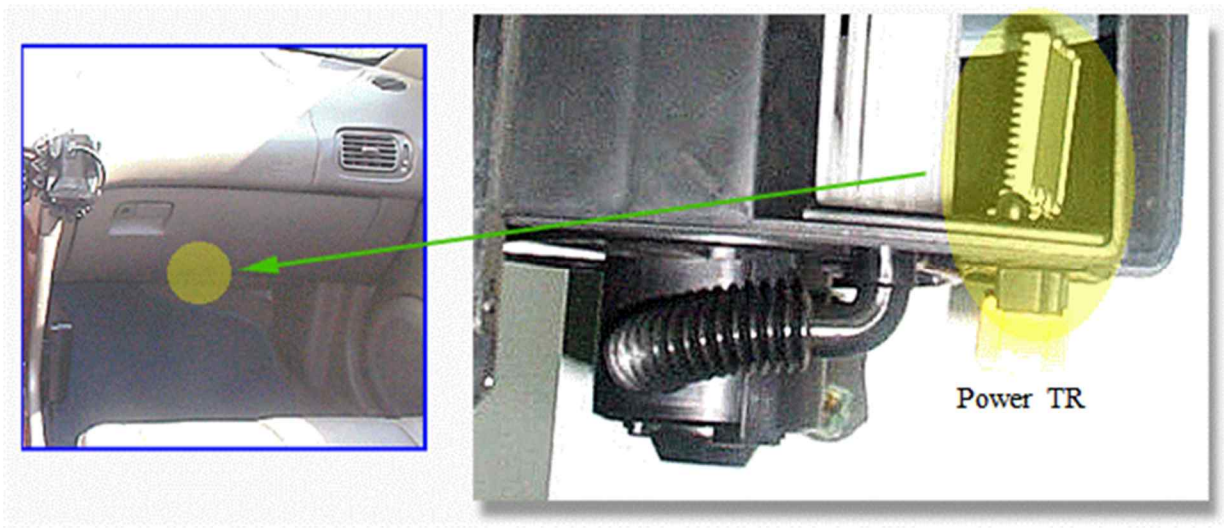


Figure 8. Mounting location of Power TR

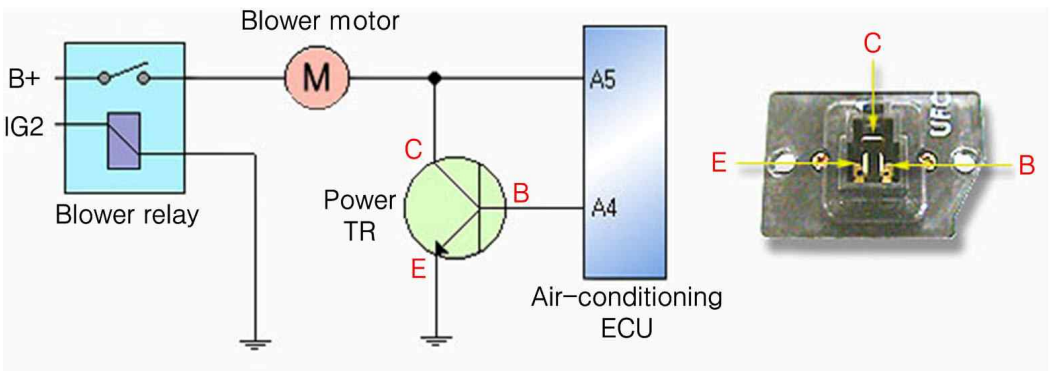


Figure 9. Power TR circuit operation

1) How to test power TR : Test fully wired power TR by checking the voltage between the base and collector terminals while rotating the blower motor. See the table below.

Blower Speed	Level 2	Level 4	Level 6
voltage value (voltage between the base and collector)	5.2± 0.5V	8.1± 0.5V	10.8± 0.5V

(2) Photo Sensor

The photo sensor is located in the center of the main crash pad with built-in photovoltaic diodes. Irradiance detection allows electromotive force generated in proportion to the amount of solar irradiance accepted in photovoltaic diodes, and the force is delivered to the air-conditioning ECU to calibrate the discharge temperature and airflow to reach the temperature selected by the driver.

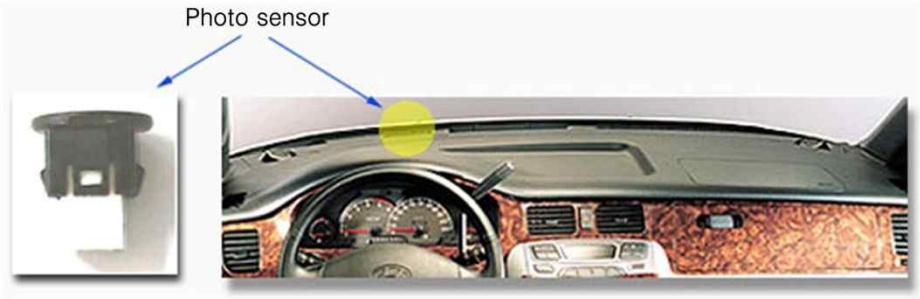


Figure 10. Photo sensor location

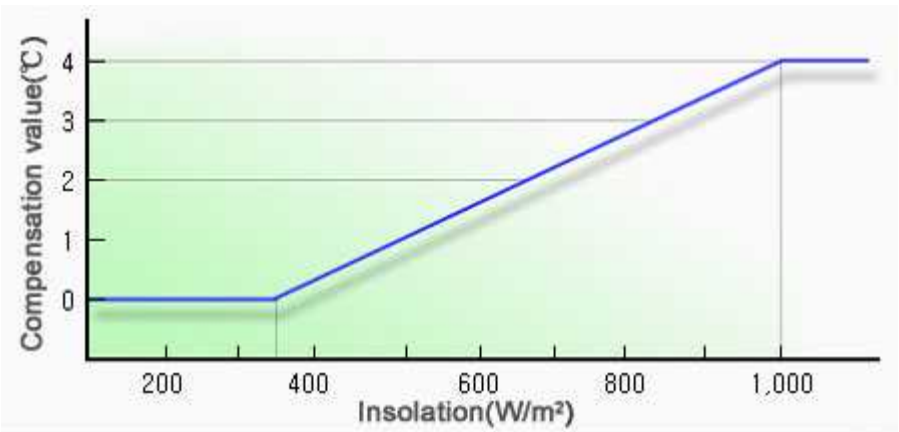


Figure 11. Compensation control graph of the photo sensor

1) If the amount of irradiance is from 0 to 350W/m2, the compensation value is 0℃.

2) From 350 to 1,000W/m2, the line goes up and the maximum compensation value is 4℃.

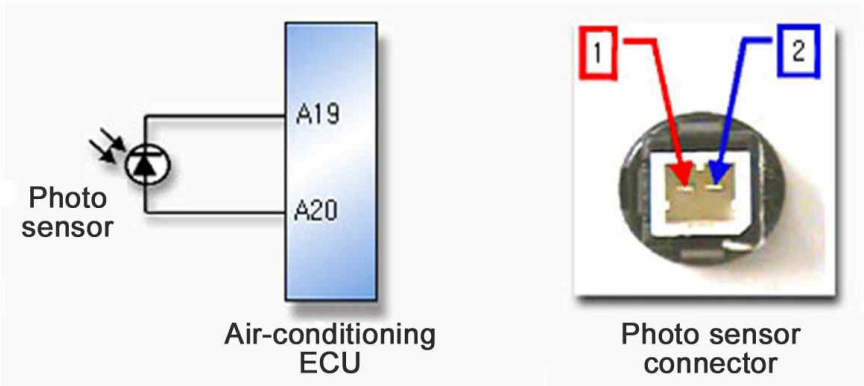


Figure 12. Photo sensor circuit and test

3) How to test photo sensor : To test the photo sensor, measure and compare the current values once covering the photo sensor's Light Receiver with hands and next without covering. If the current value measured without covering is greater, the sensor is considered normal. See the table below.

Output Voltage (mV)	Illuminance (Lux)	Output Voltage (mV)	Illuminance (Lux)
21.4	10,000	67.7	50,000
36.0	20,000	76.2	60,000
46.6	30,000	83.7	70,000
58.8	40,000		

(3) IN-CAR Sensor (Interior temperature sensor)

Figure 13. IN-CAR sensor locations in various vehicles

The IN-CAR Sensor detects the vehicle's interior temperature and inputs it into the air-conditioning ECU. The air-conditioning ECU calibrates conditions of blower motor speed, temperature control actuator and inside/outside air switching actuator in AUTO mode, according to the input values. An

NTC (negative temperature coefficient) thermistor is applied to the IN-CFAR sensor, so the resistance decreases as the temperature rises and the resistance increases with decrease in temperature.

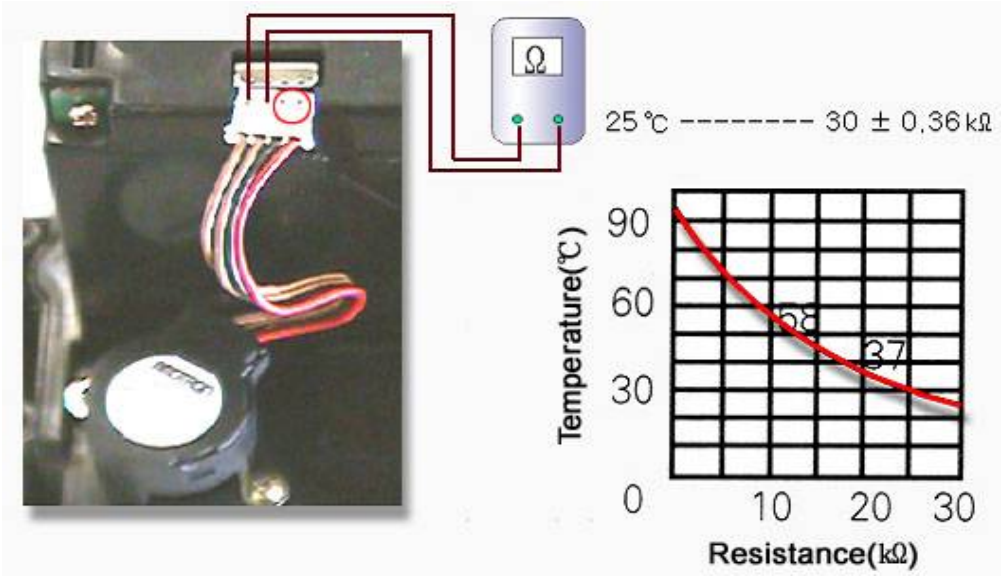


Figure 14. Temperature characteristic graph of the interior temperature sensor

1) How to test Interior Temperature Sensor : To test the interior temperature sensor, make sure if the voltage and resistance between the two terminals measured at each temperature of the following characteristic table appear normal.

Temperature (℃)	Voltage (V)	Resistance (kΩ)	Temperature (℃)	Voltage (V)	Resistance (kΩ)
30	2.24	24.26	0	3.80	94.98
25	2.50	30.00	-5	4.01	122.00
20	2.77	37.30	-10	4.20	157.84
10	3.31	58.75	-15	4.36	205.72

(4) Ambient Sensor (Ambient temperature sensor)

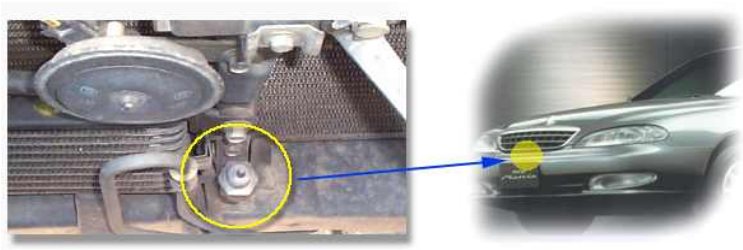


Figure 15. Ambient sensor location

The ambient sensor is mounted on the front side of the radiator. It detects outside air temperature and inputs it into the ECU, then the ECU calibrates the discharge temperature and airflow to reach the temperature selected by the driver, according to the input signals.

Same as the interior temperature sensor, an NTC thermistor is applied to the ambient sensor, so the resistance decreases as the temperature rises and the resistance increases with decrease in temperature.

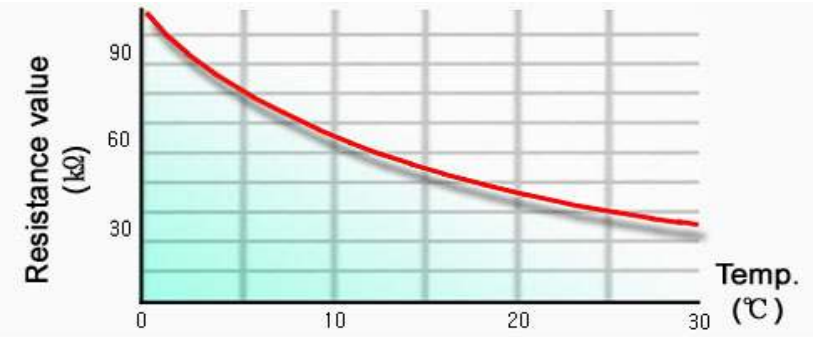


Figure 16. Temperature characteristic graph of ambient sensor

1) How to test ambient temperature sensor (same as the interior temperature)

Temperature (℃)	Voltage (V)	Resistance (kΩ)	Temperature (℃)	Voltage (V)	Resistance (kΩ)
30	2.24	24.26	0	3.80	94.98
25	2.50	30.00	-5	4.01	122.00
20	2.77	37.30	-10	4.20	157.84
10	3.31	58.75	-15	4.36	205.72

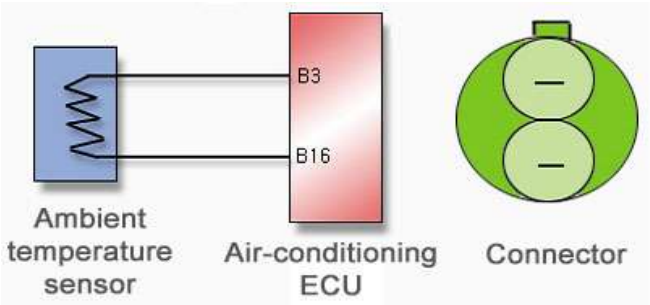


Figure 17. Ambient sensor circuit

(5) Humidity Sensor

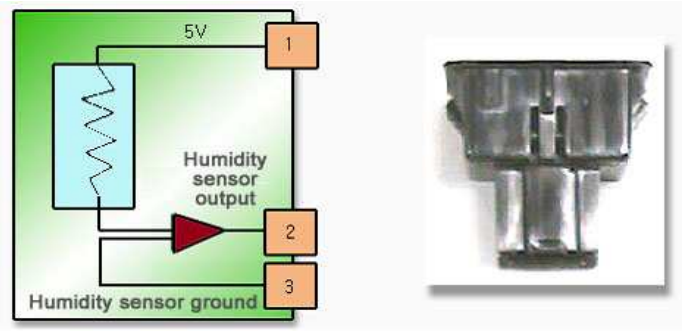


Figure 18. Humidity sensor circuit and structure

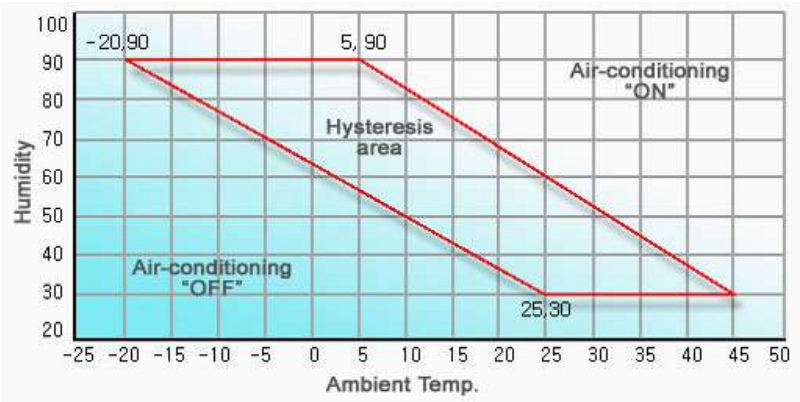
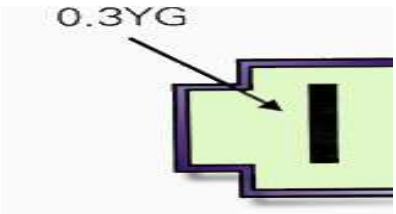


Figure 19. A/C operation according to the ambient temperature and humidity

The humidity sensor is installed on the rear shelf trim. It detects the interior humidity and sends signals to the air-conditioning ECU, then the air-conditioning ECU uses the signals and controls the interior humidity through dry operation, according to the interior humidity and temperature, ambient temperature and inside/outside air circulation mode.

(6) Water Sensor (Water temperature sensor)

The water sensor is mounted on the heater core. It detects temperature of the cooling water flowing through the heater core and sends signals to the air-conditioning ECU. The air-conditioning ECU compares the differences between the set temperature and interior/ambient temperatures and controls the heating start.



Terminal NO	Voltage
1	5V(power to sensor)
2	Changes according to resistance values

Figure 20. Water sensor terminal test

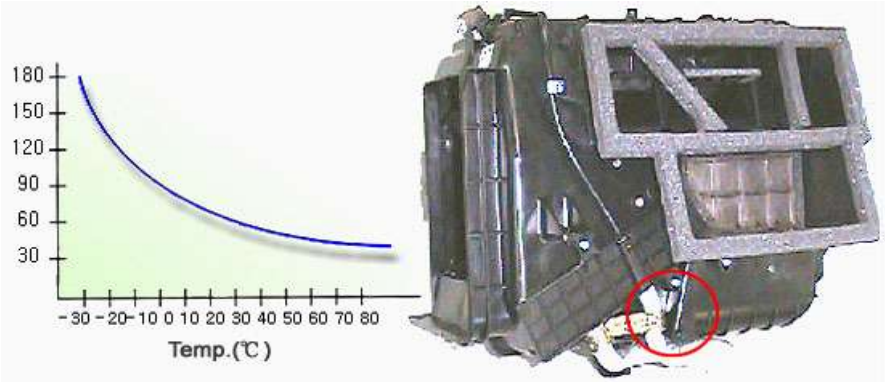


Figure 21. Location and Characteristic graph of the water sensor

1) Heating start control : If the airflow direction is on B/L, FLOOR in AUTO mode, or the difference between the set temperature in the air-conditioning ECU and the interior temperature is 3℃ or greater, or the temperature in the water sensor is 58℃ or below, the actuator starts to control the airflow direction to DEFROST Mode so that the cold air outside flowing in would not be discharged towards the passenger's feet. As the ambient/interior temperature sensors, an NTC thermistor is applied to the sensor, so the resistance decreases as the temperature rises, and the resistance increases with decrease in temperature.

2) How to test water sensor : Make sure that the resistance between the two terminals measured at each temperature of the following characteristic table appears normal.

Temperature (℃)	Voltage (V)	Resistance (kΩ)	Temperature (℃)	Voltage (V)	Resistance (kΩ)
100	0.40	0.69	25	2.78	10.00
80	0.69	1.27	15	3.33	15.89
60	1.19	2.50	0	4.02	31.61
40	2.00	5.33	-5	4.20	42.27

5. Car Air Conditioning System

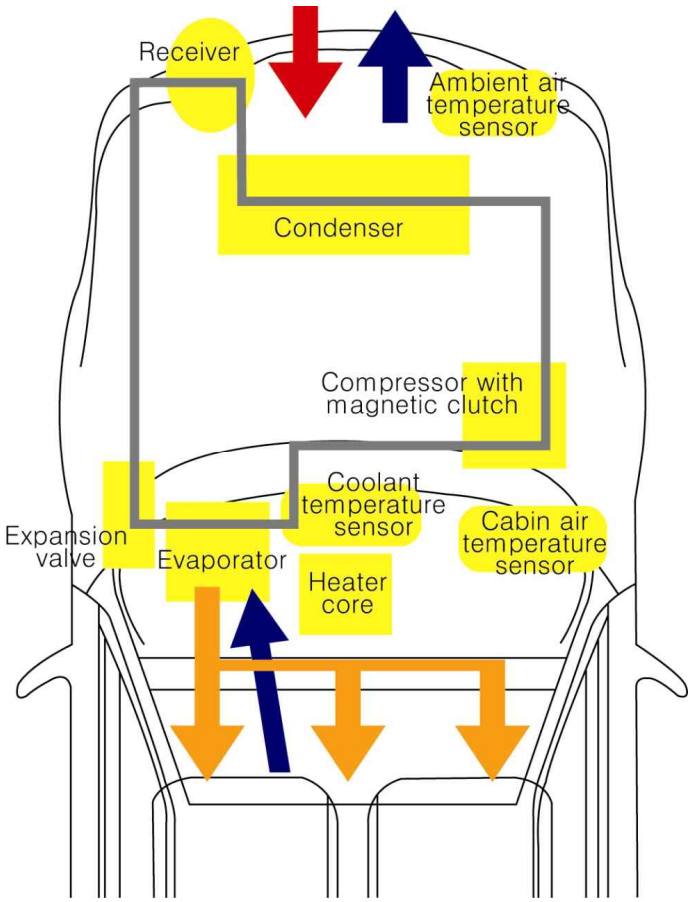


Figure 22. Vehicle Air Control System

The car air-conditioner functions through evaporation → compression → condensation → expansion in sequence, and the refrigerant circulates repeating the cycle of fluid → gas → fluid.

A lot of internal/external heat is added into the interior, which is called interior heat load.

Upon cooling, the air-conditioner functions against the interior heat load by discarding heat outward through Vehicle Air Control System (Figure 22), and upon heating, the engine coolant is sent to the heater core and the heat generated through cooling flows into the interior.

The gray lines represent the refrigerant flow, and the arrows represent the heat exchange between the inside and outside of the vehicle.

5-1. Car Air Conditioning Systems (TXV TYPE - Block Type)

※ TXV TYPE : THERMO EXPANSION VALVE TYPE

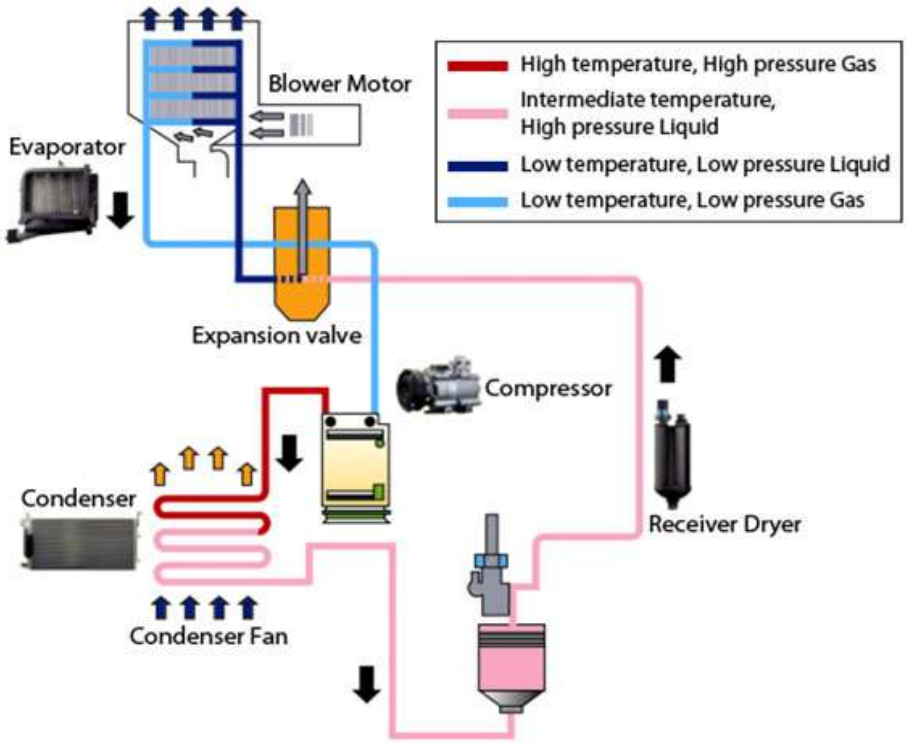


Figure 23. TYPE A/CON CYCLE

Evaporator : While the refrigerant fog turns to gas, the cooling fan functions, and the heat from the air traveling through evaporator fins is removed. (The surrounding area becomes cool.)

Blower motor : It us used to deliver inside air under negative pressure to the evaporator and supply air into the interior.

Compressor : It is a V-belt driven pump fastened to the engine. It generates low temperature/pressure refrigerant gas as well as high temperature/pressure gas and sends it to the condenser. A magnetic clutch used to control the compressor is mounted on it.

Receiver dryer : It is used to absorb moisture in the refrigerant and allows improvement in refrigerant supply by storing the refrigerant.

5-2. Structure and Principles of each Component

(1) Compressor

※ SWASH TYPE

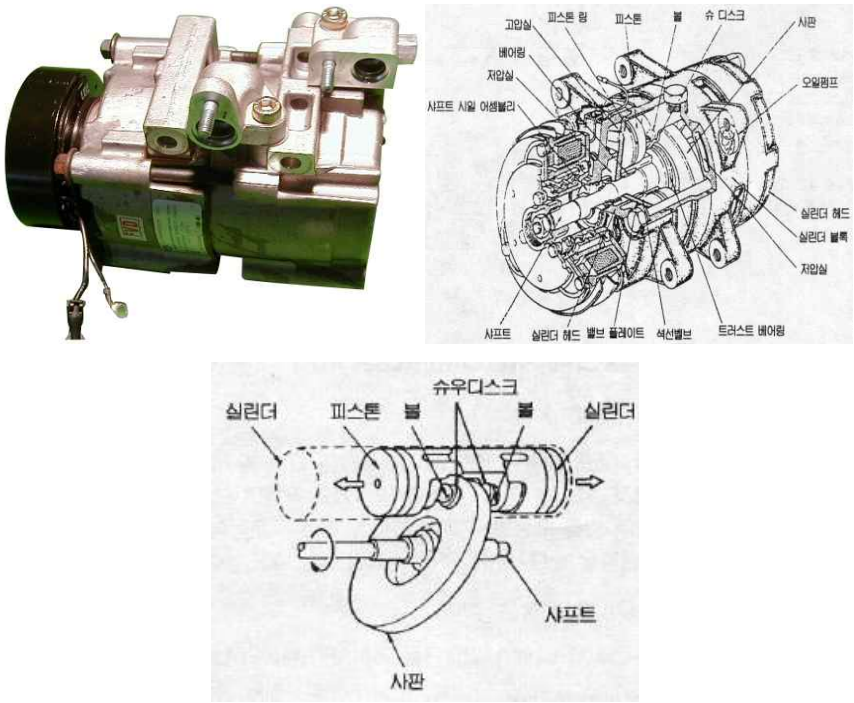
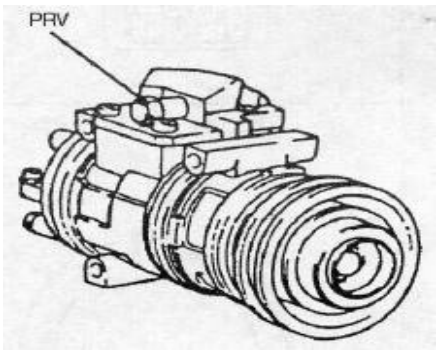
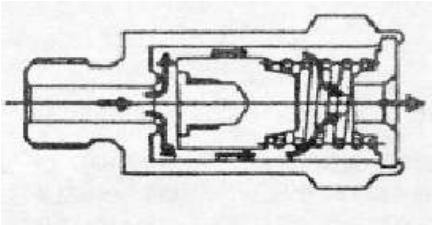


Figure 24. Swash plate-type compressor structure

The swash plate-type compressor is used to absorb and compress the refrigerant gas by rotating the shaft installed on the swash plate and converting the rotational motion of the piston to reciprocating motion. A valve plate which functions to absorb and discharge the refrigerant gas is assembled at both ends of the pistons, and a shaft seal is assembled between the shaft and the cylinder head to prevent leaks.





Gas emissions at pressures greater than certain value

Figure 25. High pressure safety valve

1) High pressure safety valve

① In the case of abnormally high pressure, the oil and refrigerants are emitted (system stabilization). Operating pressure : 35.3~42.2kg/㎠

※ Once the PRV operated, oil and refrigerants should be injected to fill the shortages in the SYSTEM.

2) Belt lock controller

① Belt lock protection

② In the case of slipping clutch fixed in the air-conditioning system, the belt lock controller starts functioning (thermal cut-off fuse : It detects the heat caused by the slipping clutch (184℃ OFF) then the thermal cut-off fuse results in blocking coil power supply to protect the belt and engine.)

3) Compressor circuit operation

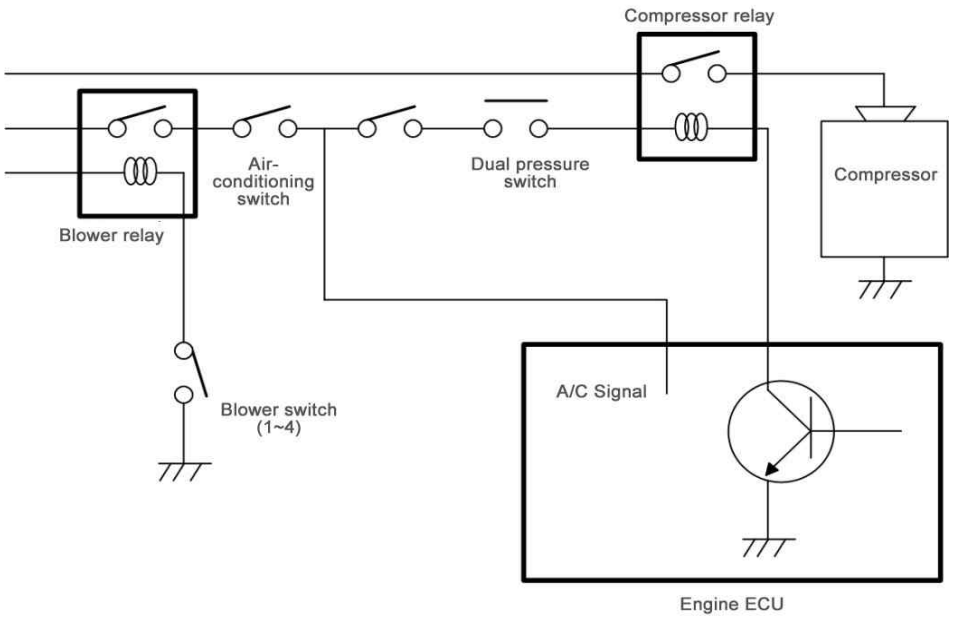


Figure 26. Compressor circuit operation

(2) Receiver - Dryer

It consists of a cylindrical steel or aluminum body, filters, desiccant, pipe, etc. The liquid refrigerant entering into the inlet pipe passes through the filter and desiccant where the dirt and moisture is removed, and it is discharged towards the expansion valve through the outlet pipe down near the bottom.

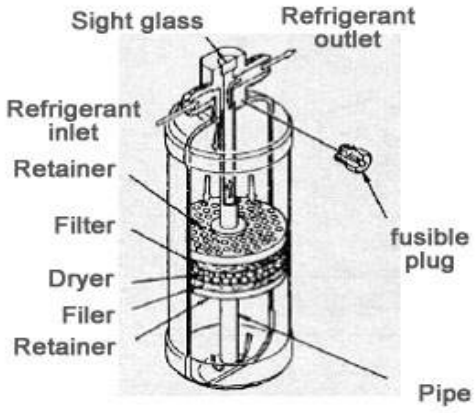
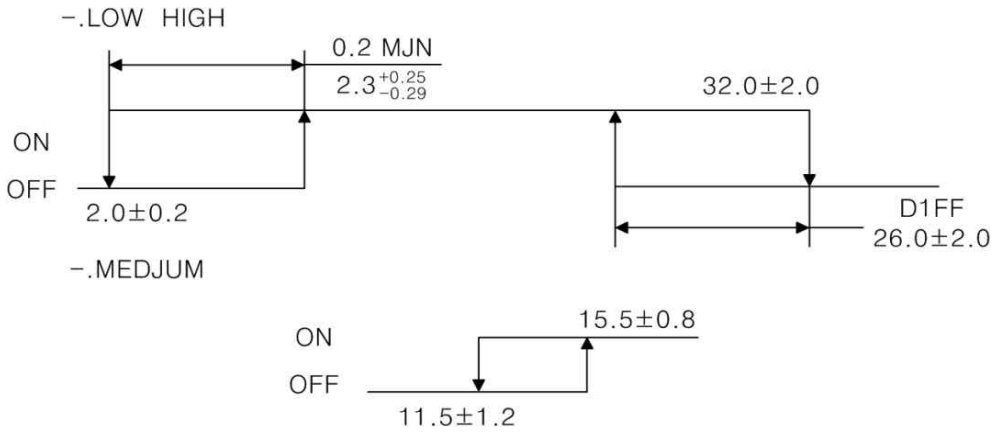


Figure 27. Receiver dryer structure

(3) TRIPLE SWITCH

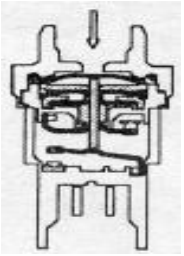
1) Structure and function : It is positioned on the top of the receiver dryer. It has three set pressure values and combines the DUAL S/W, a FAN SPEED control HIGH PRESS, and the S/W features. It detects the pressure on the high pressure side and if the pressure rises more than defined value, the S/W contact point turned ON and the FAN starts high-speed function.

2) Triple switch operating pressure



(4) Functions of COMP ‘ & COND’ FAN according to the pressure

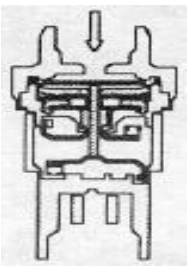
Pressure	COMPRESSOR	CONDENSER FAN	Note
2.3 - 15.5	ON	OFF	Pressure rise
15.5 - 32.0	ON	ON	Pressure rise
32.0 or above	OFF	ON	Abnormally high pressure
26.0 - 11.5	ON	ON	Pressure down
11.5 - 2.0	ON	OFF	Pressure down



• Pressure rise section (2.3~15.5kgf/㎠)

• COMP ON and COND FAN OFF state

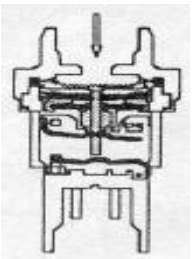
• While the pressure pushes the overall parts related to middle/high pressure downward and the low pressure DIAPHRAGM becomes reversed. The shaft goes up as much as the low pressure DIAPHRAGM is reversed, and also the LEAK SPRING(H,L) goes up to reach the contact point switched ON.



• Pressure rise section (15.5~32.0kgf/㎠)

• COMP ON and COND FAN ON state

• If the pressure continues and reaches 15.5k, middle/high pressure DIAPHRAGM becomes reversed. The shaft goes down as much as the middle pressure DIA is reversed, pushing the LEAK SPRING(M) to reach the contact point switched ON. (COND FAN : HIGH operation)



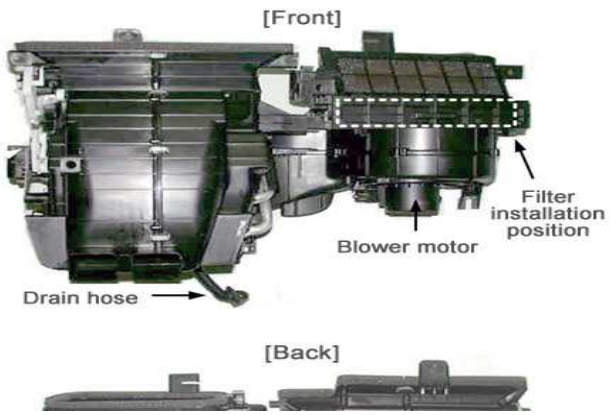
• Abnormally high pressure section (32.0kgf/㎠ or above)

• COMP OFF and COND FAN ON state

• If the pressure abnormally rises to 32k or above, the middle/high pressure DIAPHRAGM becomes reversed once again, and the high pressure DIA pushes the GUIDE to reach the COMP contact point switched OFF, but the COND FAN contact point remains ON.

Figure 28. How a triple switch works

(4) Heater, evaporator and blower unit



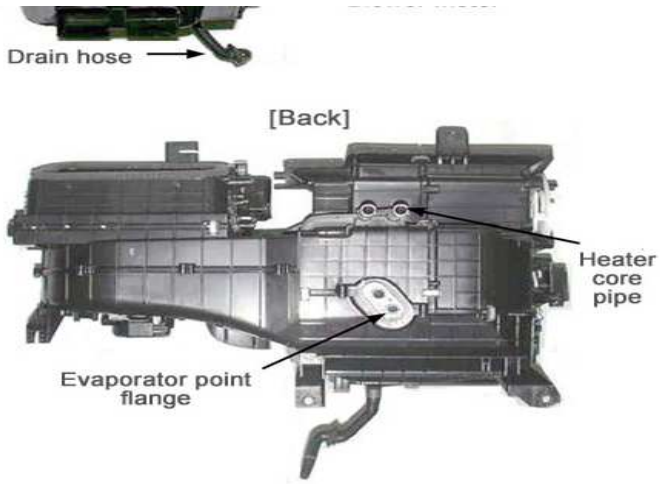


Figure 29. Front and back side of INSTRUMENT TYPE air-conditioner

1) EVAPORATOR

The evaporator functions to convert the low temperature/pressure refrigerant steam coming in through expansion process to superheated steam, through heat exchange between the refrigerant and inside/outside air.

If heat is removed from the air, it changes to be under low temperature/humidity conditions and is discharged to the interior of a vehicle by the blower, which allows keeping the interior environment comfortable.

If humidity is condensed generating water by cooling effect, the condensed water remains on the outer surface of the evaporator core, then the space which the air can pass through will be reduced, so the drainage of water should be facilitated.

Figure 30. EVAP'-CORE

2) EXPANSION VALVE

① Features : The expansion valve is attached to the evaporator inlet. It helps the evaporator to facilitate the evaporation by converting the high temperature/pressure liquid refrigerant from the condenser into low temperature/pressure steam through throttling.

② BLOCK TYPE EXPANSION VALVE : The block type expansion valve applied to New EF-Sonata is located in the engine room, which helps reduce the noise of the expansion valve and facilitate replacement of the expansion valve. Low charge of the refrigerant in the system or air mix caused by improper vacuum level can result in noise, so if the noise occurs, the amount of refrigerant or vacuum level should be adjusted.

【Caution】

If the plastic cap of the expansion valve is not in correct position, the heat in the engine room may be delivered to the sensing bulb, then the pressure on the expansion valve diaphragm increases and excessive amount of refrigerant is supplied to the evaporator. The rest liquid refrigerant not evaporated in the evaporator may come into the compressor and cause damages to the compressor.

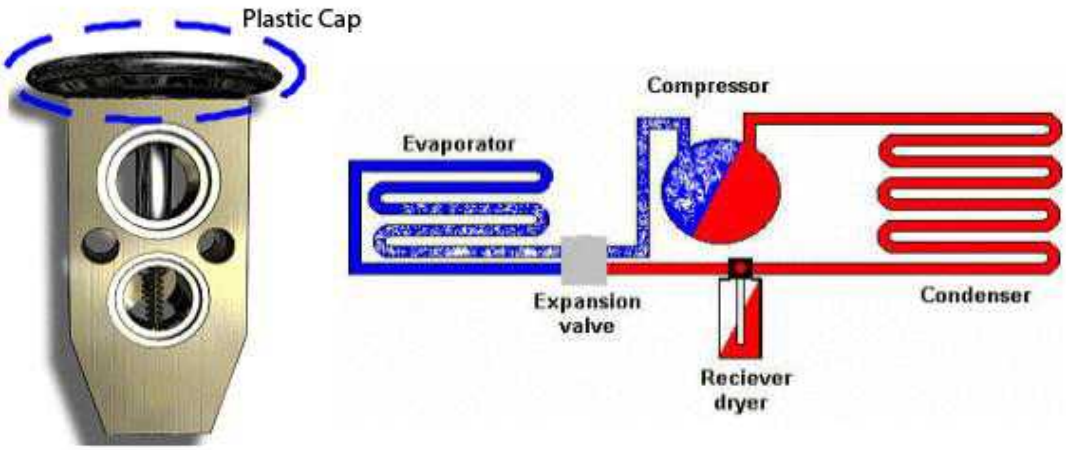


Figure 31. BLOCK TYPE EXPANSION VALVE

3) Evaporator Temperature Sensor

① THERMISTOR : FATC specifications

② Features : As the specifications shown in the manual, it is used in order to prevent freezing. It detects temperature at the evaporator core and blocks the compressor operation relay outputs into the engine ECU. An NTC thermistor characterized by increase in resistance value with decreasing temperature and decrease in resistance value with increasing temperature, is applied

to the sensor. It detects the evaporator core temperature and if the temperature is 0.5℃ or below, the air-conditioning ECU controls the output power of the triple switch from 12V to 0V. (How air-conditioning compressor works : When 12V is applied to the engine ECU C13 terminal, the A21 terminal becomes grounded then the air-conditioning relay is switched ON.)

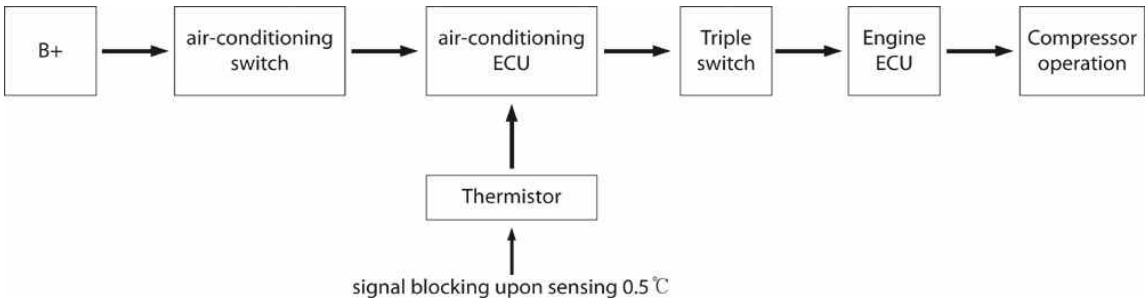
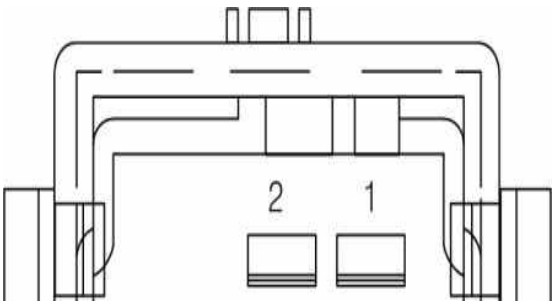


Figure 32. Signal Detection in the Thermistor

③ Terminal & Temperature vs. Resistance Characteristic Table

Temperature (℃)	Maximum resistance (kΩ)	Resistance (kΩ)	Minimum resistance (kΩ)
-10	17.50	18.20	19.00
0	11.00	11.36	11.70
0.5	10.75	11.14	11.44
3	9.59	9.95	10.25
10	7.04	7.32	7.61
20	4.63	4.86	5.09
30	3.14	3.31	3.50
40	2.18	2.32	2.46



** The location and shape of the terminal is the same as the manual specification **

Figure 33. Terminal Shape

4) A/CON FILTER

① Features : The air-conditioner filter is used to remove the dirt and odor in the interior and keep comfortable interior environment. The filter is optional, so if it is not provided to the vehicle, it can be purchased and installed.

② Replacement Cycle : If the filter has not been replaced for a long time, it is blocked by debris increasing the blower motor noise, and discharge air volume is extremely reduced. The regular life cycle of the filter is 5,000-12,000 Km, however, it needs more frequent attention and replacement upon operation in areas with a lot of dust and smoke caused by severe air pollution or bad road conditions.

Figure 34. A/CON FILTER

③ How to change : Remove the glove box, then pull out the locking part at the bottom of the air-conditioner filter cover and take out the filter. Upon replacement, make sure to see the directions of the arrows so the airflow direction indicator on the filter should be installed to the blower motor side.

Figure 35. A/CON FILTER Change

5) BLOWER MOTOR

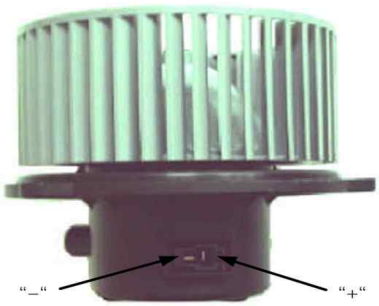


Figure 36. Shape of Blower Motor

① Specifications

- Type : DC FERRITE
- Applied voltage : DC 12 VOLTS
- Rotation direction : clockwise

② How to test : Apply random voltage to "+" terminal, and GROUND "-" terminal to test.

③ Terminal and circuit

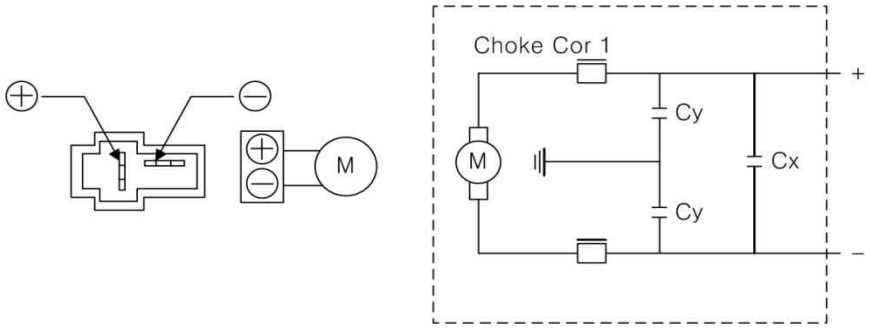


Figure 37. Shape and Circuit of Blower Motor Terminal

6) BLOWER SPEED control device

① BLOWER RESISTOR : MANUAL Specification

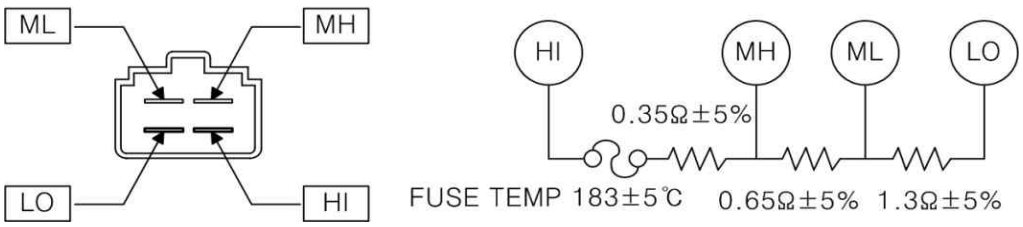


Figure 38. Shape and Circuit of Terminal

② Location : It is mounted on the side of the EVAP & BLOWER UNIT. Replacing is available by removing the glove box.

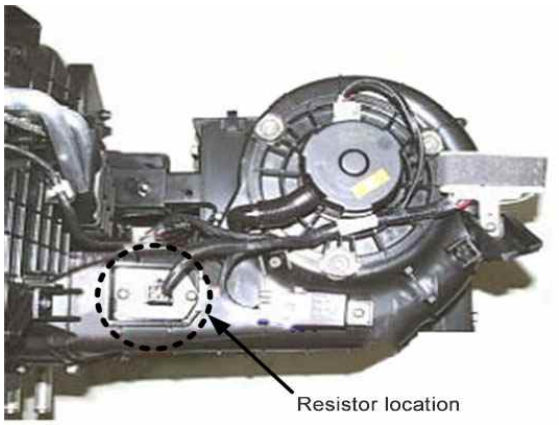


Figure 39. BLOWER RESISTOR

③ How to test

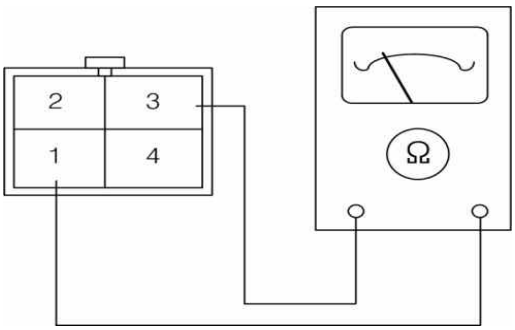


Figure 40. How to test using Multi-Tester

As shown in Figure 40, measure the resistance between terminals and make sure it displays standard values.

Measured terminals	Measure (Ω)
Terminals 3 - 1	0.35± 5%
Terminals 3 - 2	1± 5%
Terminals 3 - 4	2.3± 5%

7) POWER TR : FATC Specification

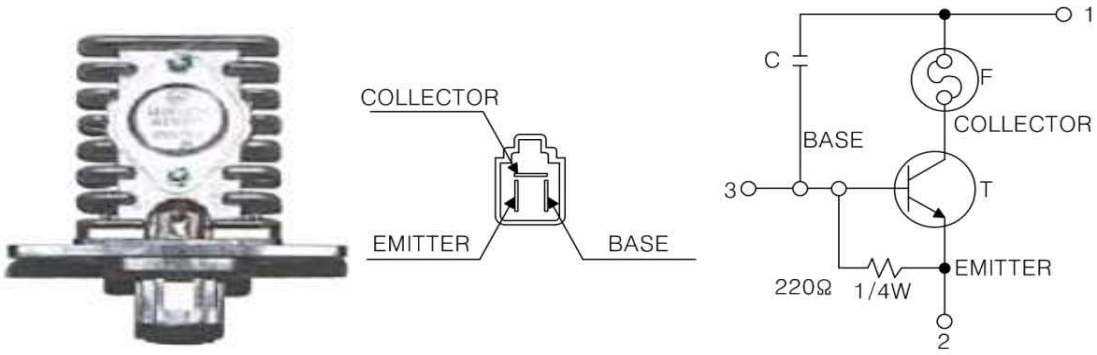


Figure 41. Shape and Circuit of POWER TR

① Location : It is mounted on the side of the EVAP' & BLOWER UNIT. Replacing is available by removing the glove box. (The mounting location for AUTO specification POWER T/R is the same as for the RESISTOR.)

8) Blower & POWER TR Circuit Diagram

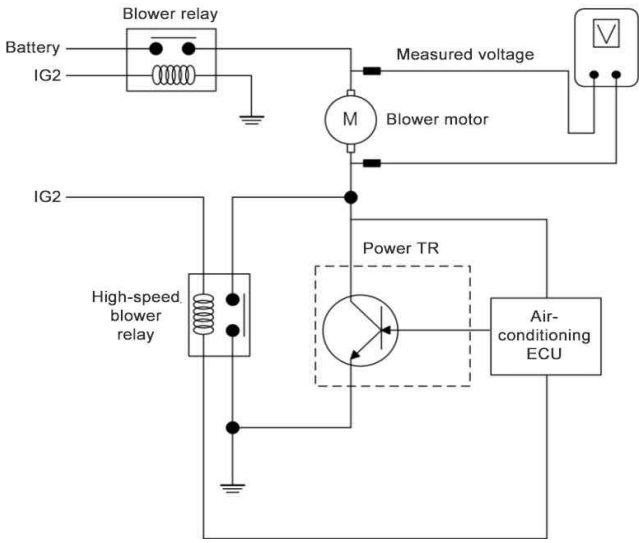


Figure 42. Blower and Power TR Circuit Diagram

Voltage values measured between both BLWR terminals (Vehicle voltage : 12V)

Level	Voltage value (V)
Level 2	5.2 ± 0.5
Level 4	7.9 ± 0.5
Level 6	10.6 ± 0.5

9) HEATER UNIT

The heater unit consists of a heater core through which the engine coolant flows in the case, a mode door for airflow direction control, an air-mix door for temperature control, etc.

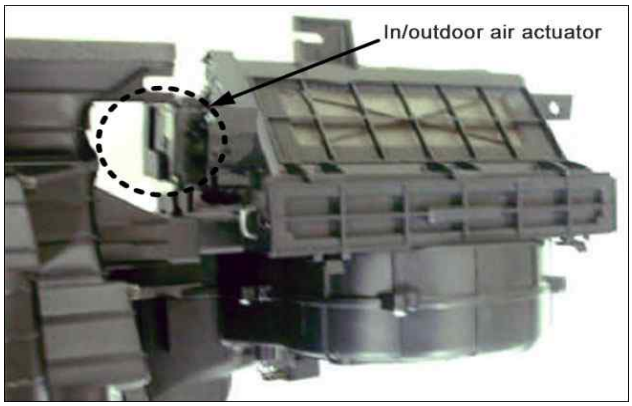
10) HEATER CORE

Figure 43. HEATER-CORE

It is a heat exchanger which supplies warm air to the interior. While the high-temperature coolant that has absorbed heat circulating through engine is passing through the heater core, the tube-fin heat exchanger allows the air supplied from outside to pass through.

11) In/outdoor air actuator

① Features : It is attached to the in/outdoor air inlet duct of the EVAP ‘ & BLOWER UNIT, and used to drive internal/external air switching door through In/outdoor Air switch control.



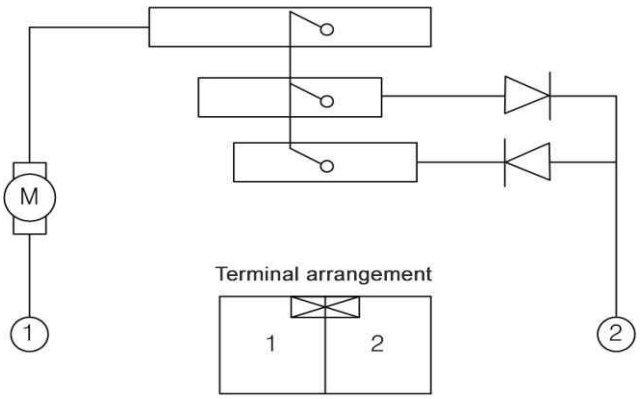
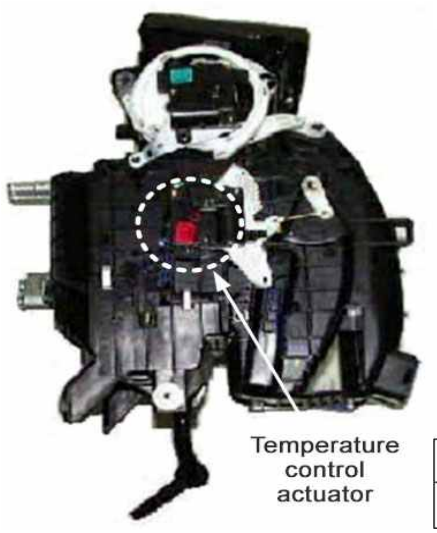


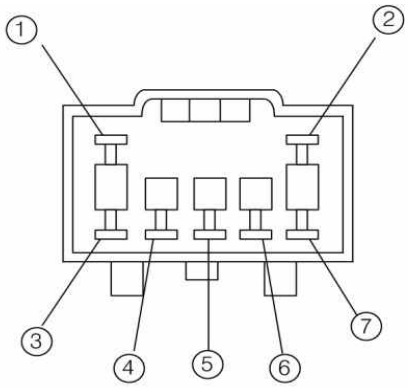
Figure 44. Location and Circuit of In/outdoor air Actuator

② How it works : Clockwise, viewed from the output side when a voltage applied to Terminal 2

12) Temperature control actuator

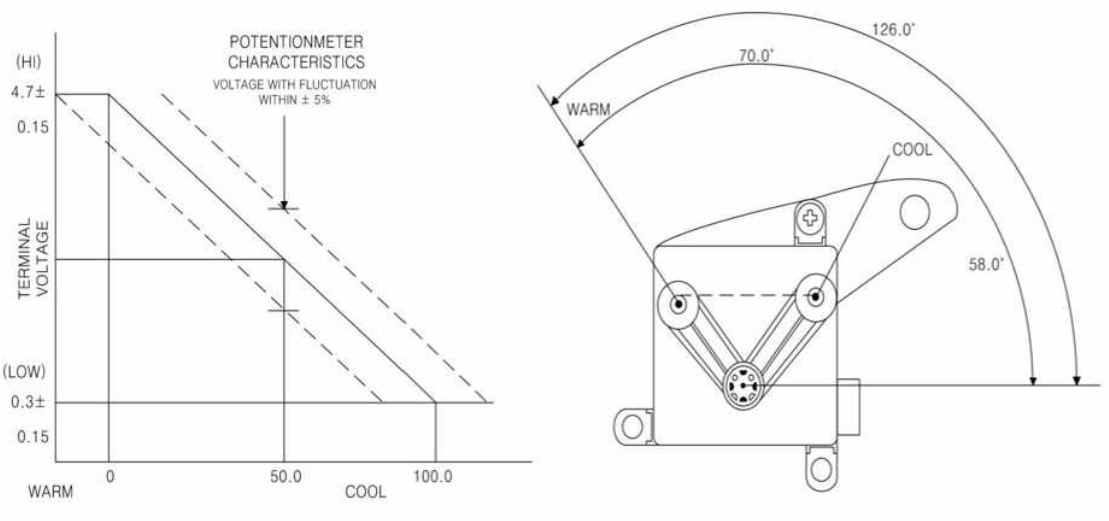
① Features : It is located on the side of the heater unit case. It receives control signals and controls TEMP' door position using a small DC MOTOR. The potentiometer in the actuator allows feedback control signals on current TEMP' door position, so if it reaches the requested position, outgoing control signals will be switched OFF to stop the DC MOTOR of the actuator.





TE NO	1	2	3	4	5	6	7
MODE	x	x	VENT	OEF	VENT	VENT	VENT

Figure 45. Location and Circuit of Temperature control actuator



WARM in the case a (+) terminal applied to Terminal 3

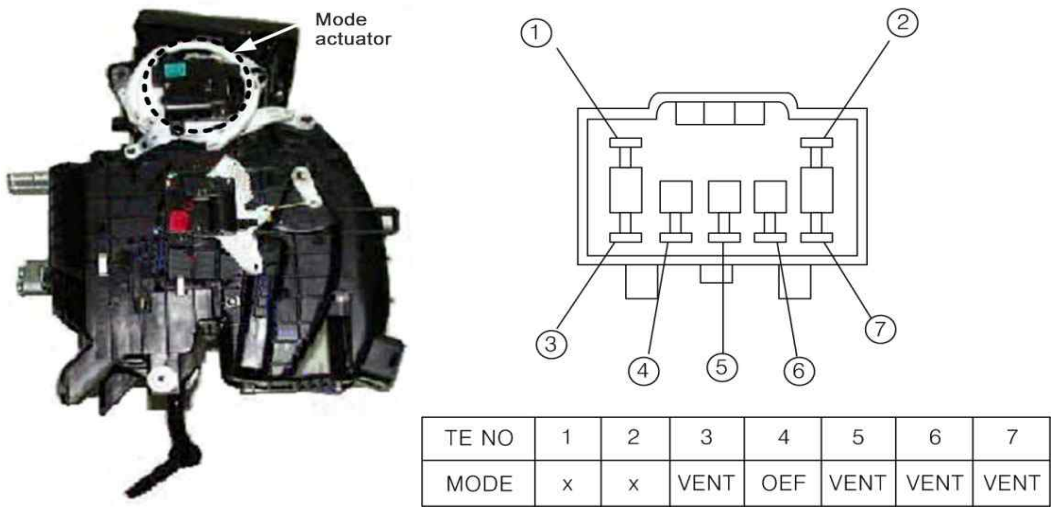
Figure 46. Potentiometer Characteristics and Operating Area

If a 5 VOLT FEEDBACK signal is applied to Terminal 3, output voltage at Terminal 6 appears according to the characteristics as shown in the figure above. In the case that a "+" voltage is applied to Terminal 3, rotate anticlockwise, i.e. towards WARM.

② Wiring color codes

Terminal NO.	NO. 3	NO. 4	NO. 5	NO. 6	NO. 7
COLOR	LgB	LgW	LW	LB	P

13) Mode actuator



TE NO	1	2	3	4	5	6	7
MODE	x	x	VENT	OEF	VENT	VENT	VENT

Figure 47. Location and Circuit of Mode actuator

① How to test : It is located on the side of the heater unit case. It receives control signals and controls mode door position using a small DC MOTOR. The potentiometer in the actuator allows feedback control signals on current mode door position, so if it reaches the requested position, outgoing control signals will be switched OFF to stop the DC MOTOR of the actuator.

② Wiring color codes

Terminal NO.	NO. 3	NO. 4	NO. 5	NO. 6	NO. 7
C O L O R	0	RB	LW	W	P

(5) Heater airflow distribution

Unit : % (Tolerance omitted)

Set Mode Discharge direction	Inside air	Outside air			
	COOL	1/2 COOL	WARM		
	VENT	BI-LEVEL	FLOOR	MIX	DEFROST
VENT	100	60	-	-	-
FLOOR	-	40	65	45	-
DEFROST	-	-	20	40	80
SIDE-VENT	-	-	15	15	20

◎ Warrantee and A/S application sheet

Product Warrantee Certification

Fill out this sheet, and send by Fax or E-mail..

MODEL		
WARRENTEE TERM	1 YEAR	
PURCHASING DATE	(M/D/Y)	
ORGANIZATION	**SCHOOL**	
	DEPARTMENT	

Headquarters :679-7 2Fl Sinhyun-Li, Opo-Eup, Gwangju-City, Gyonggi-Do, KOREA (zip : 464-895)
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