Section 7

Automatic Temperature Control Diagnosis and Repair

Diagnosis of Automatic A/C Systems

The most common automatic A/C system malfunctions tend to be the result of basic air conditioning problems. These problems include:

- Refrigerant circuit, including leaks and inoperative components.
- Basic electrical malfunctions including open fuses, disconnected or shorted wires and inoperative switches.

Just as with a conventional A/C system, a malfunctioning compressor clutch can be caused by a number of reasons. In addition to the items listed above, check the following circuits against published specifications:

- Evaporator thermistor
- Under-and-over pressure safety switches
- Connections to the ECU
- The wiring to and inside the clutch, and the coil ground
- The clutch control circuit of the amplifier

With such a range of input signals affecting system operation, it is often easiest to test each circuit at the amplifier terminal. When the amplifier is accessed, each circuit can be back-probed with voltmeter probes at the main connector and quickly identified as “OK” or “NG” based on values in service publications.

Diagnosis of an A/C complaint, even Auto A/C malfunctions, should always begin with the “sight, sound and touch” checks of the refrigerant system. Follow with a performance check using A/C pressure gauges to determine charge level, operation of the compressor and other components.

- When the refrigerant system is fully operational and a mechanical malfunction is present, the automatic A/C circuit itself could cause variations between the desired temperature and the temperature at the outlets.
- Excess resistance in the sensor circuits will result in colder-than-desired temperatures.
- Each servo-motor provides a signal to the amplifier to confirm its position. If the internal potentiometer is inoperative, the system will be unresponsive.

Diagnosis Process

Toyota automatic A/C systems include circuits in the ECU to detect, record and display codes for faults for various sensors, actuators and circuits of the system. Operating some switches on the air-conditioning control panel reveals any stored malfunction code. The self-diagnostic codes remain stored, even when the ignition is switched OFF.

Self-Diagnosis Functions

See Vehicle Repair Manual *by model for specific procedures and DTC numbers.*

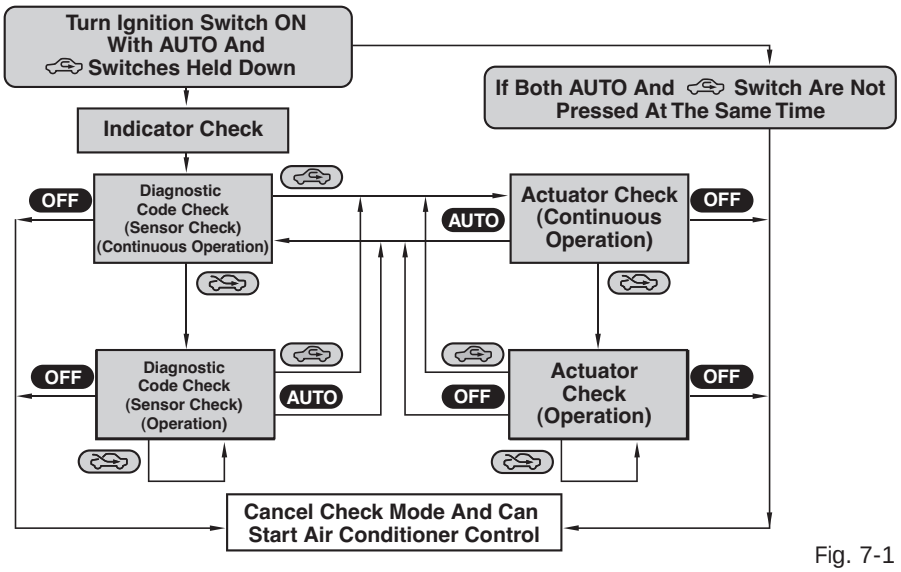

Fig. 7-1
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A self-diagnosis system can perform the following functions:

- **Compressor Lock** – If the compressor shaft locks up during A/C operation. The A/C switch indicator will blink.
- **Indicator Check** – Tests all indicator lights and buzzers of the automatic A/C control panel four times (switch the ignition ON while pressing and holding the AUTO and RECIRC switches).
- **Diagnostic Code Check** – Displays code numbers with the temperature display of the automatic A/C control panel. A chart in the *Vehicle Repair Manual* assigns a code number to a specific input (sensor) or output (actuator) circuit. In addition, the chart refers to a page to check the circuit.

  Note the following details:

  1. For **current** faults, the buzzer sounds when the code is displayed.
  2. **Past** faults that have been stored in memory, but are not currently present will display the code number without the buzzer.
  3. Faults in the solar sensor or compressor lock sensor circuit are **not** kept in memory after the ignition is switched OFF.

A/C Sensor Check Chart

See Vehicle Repair Manual *for DTC numbers.*

Display	Diagnosis
00	All sensors are normal
11	Open or short circuit in room temperature sensor circuit
12	Open or short in ambient temperature sensor circuit
13	Open or short circuit in evaporator temperature sensor circuit
14	Open or short circuit in water temperature sensor circuit
21*	Open or short in solar sensor circuit
22*	Compressor lock detected
23*	Refrigerant pressure is either too high or too low
31	Abnormal air mix servo-motor potentiometer output voltage
32	Abnormal air servo-motor potentiometer output voltage
33	Abnormal air outlet servo-motor potentiometer output voltage
41	Abnormal air mix servo-motor operation
42	Abnormal air inlet servo-motor operation
43	Abnormal air [illegible] operation

Fig. 7-2
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- **Actuator Check – Test Recirc Control.** Press the **REC** switch to begin the test sequence for actuators. This process causes the system to engage eight or 10 different combinations of fan speed, distribution, temperature and intake modes in a preset sequence. The steps can be advanced manually by repeatedly pressing the **UP** (S) switch. The *Vehicle Repair Manual* includes a chart showing the conditions for each of the steps.

A/C Actuator Test Function Chart

• *See* Vehicle Repair Manual *by model for specific conditions.*

Step No.	Display Code	Conditions					
		Blower Speed	Airflow Vent	Air Inlet	Air Mix Damper Position	Magnetic Clutch	Water Valve VSV**
1	0	OFF	Face	Fresh	Cool Side (0% open)	OFF	OFF
2	1	1	↑	Fresh/Recirc.*	↑	↑	↑
3	2	↑	↑	Recirc.	↑	ON	↑
4	3	3	Bi-level	Fresh	Cool/Hot (50% open)	↑	ON
5	4	↑	Foot II	↑	↑	↑	↑
6	5	4	Foot I	↑	Hot side (100% open)	↑	↑
7	6	↑	Foot/Def.	↑	↑	↑	↑
8	7	5	Def	↑	↑	↑	↑

*Indicator light for "fresh ( )" mode goes on.
**Servo-motor controlled, some vehicles.

Fig. 7-3
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Testing Sensor Inputs

To review, the in-car ambient, coolant and evaporator temperature sensors are all **Negative Temperature Coefficient (NTC) thermistors,** so their resistance rises as the temperature decreases.

Test procedures and specifications for each circuit are in the *Vehicle Repair Manual.* Many automatic A/C sensors are tested while **unplugged** using an ohmmeter. Some circuits can be tested at the connector nearest the sensor. In other cases, you can remove the A/C control panel to access the multipin connectors on the back of the panel.

The test values for thermistors are described in a chart or a graph that shows the resistance values at different temperatures. As a rule of thumb, almost all **NTC thermistors** have a room temperature value of 1,500 – 2,000 ohms (1.5K – 2KΩ). Compare the conditions and the ohmmeter display with the table or graph.

Thermistor Test With Ohmmeter

Resistance increases as temperature decreases.

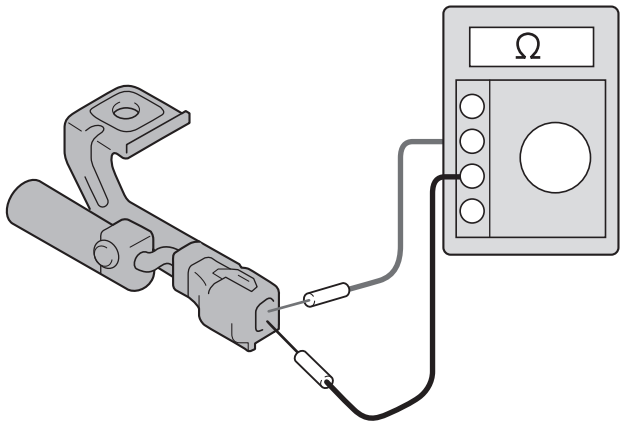

Fig. 7-4
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This system contains a “fail-safe” mode that allows it to operate even when a primary sensor circuit has malfunctioned. In the following illustration, consider how the system might respond to an open circuit in one of the temperature sensor circuits:

- An open circuit has a resistance of infinite ohms (∞Ω).
- Very high resistance from an NTC might indicate an extremely cold temperature. The system might be expected to respond by producing maximum heat until the interior temperature equals the preset temperature. However, this countermeasure will never happen.

To avoid this, the A/C ECU may substitute a fixed value for an out-of-range sensor circuit. This would allow the system to continue operation with reduced responsiveness.

Open in Auto A/C Sensor Circuit

ECM defaults to fixed value in open circuit.

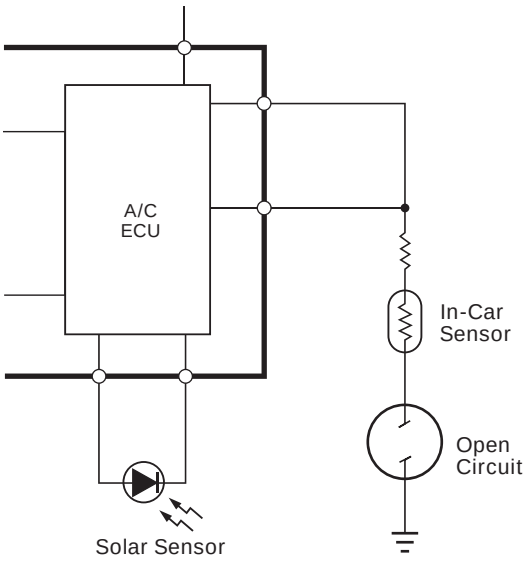

Fig. 7-5
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Testing the Solar Sensor

Alternately cover, then illuminate the sensor while the system is in the **AUTO** mode. When illuminated (not covered), the fan speed should increase noticeably and the outlet temperature should decrease slightly.

With a multimeter, test the solar sensor with a bright light. This decreases its resistance and increases the voltage when checked at the harness connector.

Solar Sensor Test With Ohmmeter

- *Some solar sensors are dual action (driver/passenger).*
- *Two DTC (21/24) numbers for dual type.*

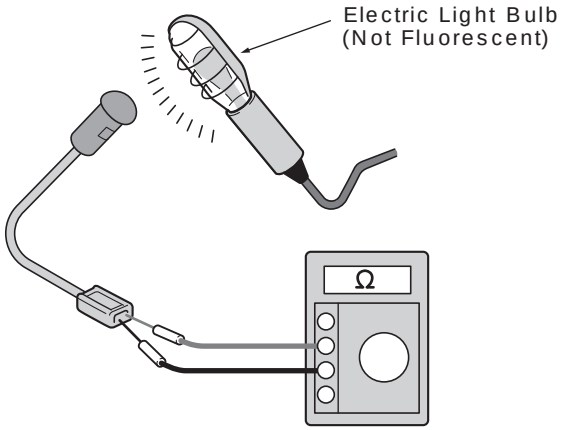

Fig. 7-6
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Testing Servo-Motors

During a diagnostic test of system actuators, one or more operational modes may not respond correctly. The diagnostic test will direct you to test specific actuators. The test will be one of two types: Functional and Circuit.

A Functional Test consists of applying battery voltage across the motor terminals of the servo-motor harness connector. The arm motion should be smooth to the end of its travel. With reverse polarity, the arm should move smoothly in the opposite direction.

Servo-Motor Test

• Position changes with power applied and change of polarity.

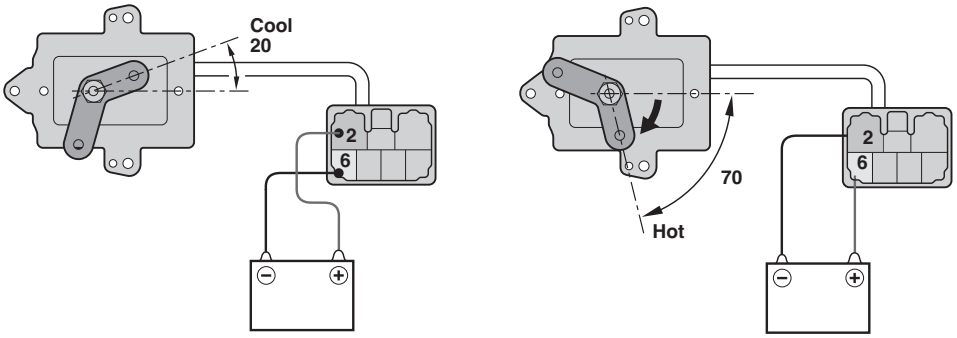

Fig. 7-7
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A potentiometer is built into some servo-motors so the ECU can determine the arm position of each one. These circuits are important for proper system operation. The variable resistor can be measured with an ohmmeter as the servo-motor is energized during the Functional Test described above.

Servo-Motor Test

• Feedback signal to ECU that door has moved.

• Pin locations vary by model.

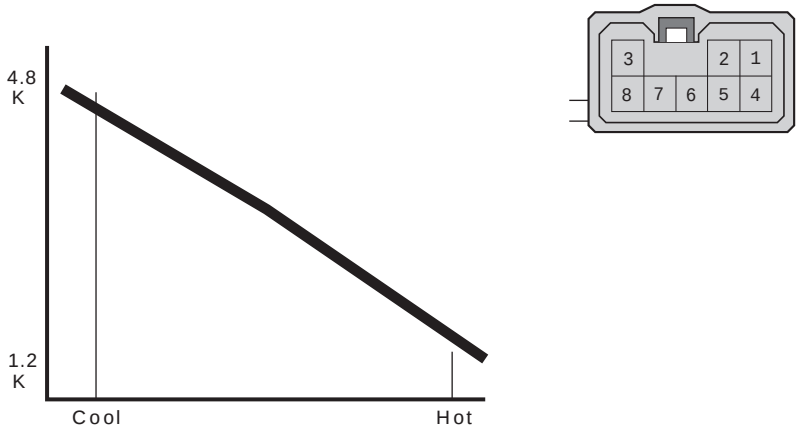

Fig. 7-8
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Automatic A/C System Repair Techniques

Due to similarities between the refrigerant and control systems among different automatic A/C systems, most complaints can be diagnosed using standard A/C system tools and techniques. Take all appropriate measures in regard to personal safety around pressurized gases and electrical devices. Observe standard procedures for refrigerant recovery, recycling, evacuation and charging.

Automatic A/C systems may require wiring harness repairs, particularly following a collision. Since these systems sense temperature conditions by looking at electrical resistance, proper wiring repairs are very important to system operation. Be sure to use the components and procedures of the Toyota Wiring Harness Repair Kit to avoid adding excess resistance to the automatic A/C circuit.

A/C System Odors

A/C system odors are a common complaint among users, especially after start-up. Odors are primarily caused by one of two things:

1. Dirt or microscopic particles which are trapped in the evaporator, then later blown into the vents. This results in a “musty” or “stale” odor.
2. **Microbes** growing on the evaporator surfaces. These are later blown into the vent ducts. Microbes are small living bacteria which are carried into the evaporator case, then grow in the warm, moist environment. The Xenon tube in some rear A/C systems helps reduce these microbes.
3. Change the clean air filter when odor is detected.

There is no permanent mechanical repair for either type of odor. Replacing the evaporator or cleaning it with a strong chemical is only a temporary fix. The driver must change how the system is used.

To avoid evaporator odor, operate the system in the **FRESH** mode rather than in **RECIRC.** This allows a flow of clean, fresh air over the evaporator. The compressor should be switched **OFF** with the A/C switch while the fan runs for several minutes before shutting off the engine. In addition, park the vehicle with the windows slightly open with the system in the **FRESH** mode to allow the evaporator to dry out.

Clean Air Filter

- *Located behind Glove Box.*

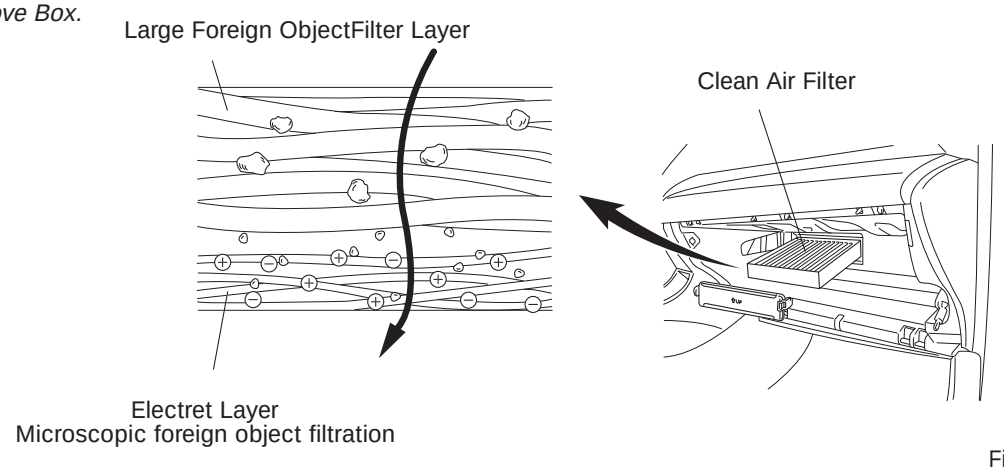

Fig. 7-9
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Late model Toyota vehicles are equipped with a replaceable polyester filter to prevent the entry of micro dust and pollen. Positioned before the evaporator, the filter fibers have a static charge to attract small particles to the filter surface.

If air volume is low, the air filter could be clogged. Replace the filter. Do not attempt to clean it.

Diagnosing the Automatic A/C System

The A/C ECU has a self-diagnosis feature that stores operation failures in memory. DTCs can be displayed by operating switches on the A/C control panel. DTCs remain in memory even when the ignition is OFF.

As described in Section 8, a Fuzzy Logic system in some vehicles attempts to simulate human control of the HVAC system using input sensors, a sophisticated A/C ECU and output actuators. Vehicles with such systems also contain a self-diagnosis feature.

Function	Description
Indicator Check	Checks indicator lights and temperature setting display.
Sensor Check	Checks the past and present malfunctions of the sensors and clears past malfunction data.
Actuator Check	Checks against actuator check pattern to make sure if blower motor, servo-motors and magnetic clutch are operating correctly according to signals from the ECU. Checks sequence of modes and fan speeds to check airflow from each outlet. Compare with air outlet and airflow chart.

Notes