



|   |  |  |  |  |                         |  |
|---|--|--|--|--|-------------------------|--|
| <b>HYBRID VEHICLE A/C SYSTEM DIAGNOSING AND SERVICING</b> |  |  |  |  | <b>TSB #:</b> 68        |  |
|   |  |  |  |  | <b>Date:</b> 30/11/2012 |  |
| <b>PART 2</b>   |  |  |  |  |                         |  |
| Initial Once Read:  |  |  |  |  |                         |  |

### INTRODUCTION

With the introduction of Hybrid vehicles has come some changes to the A/C system. The A/C system basically remains the same in respect to the components, in other words they still use a compressor, condenser, evaporator and TXV. Modifications have been to be made to some of the A/C components to operate with Hybrid petrol / electric drive vehicles, especially in the areas of the electrically driven compressors and the high voltage power supply. We will use the Toyota Prius A/C system and components as an example for this TSB.

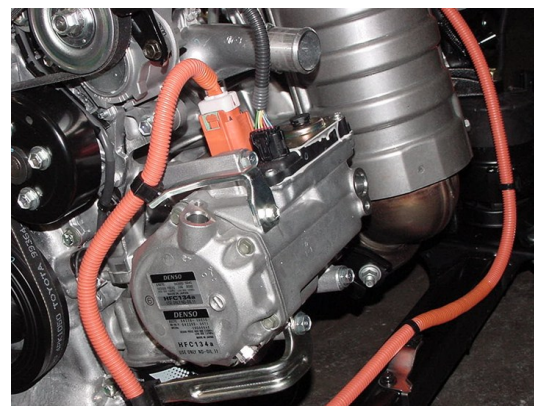
### THE COMPRESSOR

In the early days of the Toyota Hybrid vehicle (year 2001), A/C systems used a petrol engine belt-driven compressor, this conventional A/C compressor drive did not give the required fuel economy return. As Hybrid vehicle technology progressed, systems were developed that would turn the petrol engine off and the electric motor on at the traffic lights to conserve fuel, this was called "idle stop". The only problem was that once the petrol engine was turned off, the A/C compressor would also turn off and the driver would not have any A/C cooling at idle.

To get around the above situation, an electrically driven compressor was developed for the 2004 Toyota Prius. A three phase brushless electric motor was used to drive a scroll design compressor. The compressor electric motor was provided with high AC voltage of approximately 200 volts from the inverter. Using the electric compressor means that when a vehicle is in "idle stop" mode, the electric A/C compressor would be driven directly from the battery pack rather than the petrol engine. Other designs included a compressor with two internal scrolls. One scroll was connected to a clutch pulley and driven via a belt from the crankshaft pulley of the petrol engine. The other scroll section was connected to an electric motor for when the vehicle was stopped at the traffic lights (idle stop).



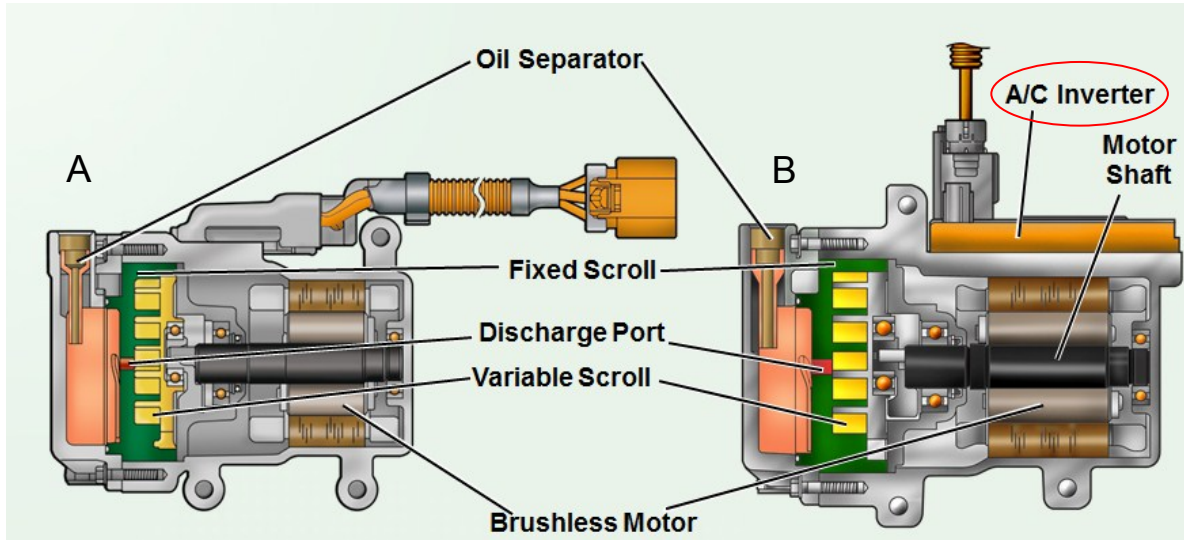
2001-2003 GENERATION 1 TOYOTA PRIUS  
BELT DRIVEN COMPRESSOR.



2004-2010 GENERATION 2/3 TOYOTA PRIUS  
HIGH VOLTAGE COMPRESSOR.



NOTE THE HIGH VOLTAGE ORANGE  
WIRING HARNESS TO THE COMPRESSOR



There are two different designs of Toyota Prius (Denso) electric compressors. A is a high voltage 3 phase with AC voltage provided by the inverter. B has an inbuilt inverter which converts DC high to AC high voltage AC.

Diagnosing of the A/C system remains the same as for non-Hybrid vehicles. The A/C system remains divided into a High and Low side and the charging ports used suit the R134a coupler. Standard R134a pressure gauges are used when diagnosing for faults in the A/C system.

**THE MAIN ISSUE WHEN WORKING ON A HYBRID VEHICLE IS SAFETY PROCEDURES. Please refer to the safety procedures introduction as described in TSB 67 "Hybrid Vehicle Description Part 1".**

- ⇒ **REPLACING THE ELECTRIC COMPRESSOR** - Ensure that the main battery pack is disconnected from the vehicle electric system. Turn the battery isolating switch or device to the OFF position and allow 15-20 minutes for the inverter capacitors to power down (discharge). If in doubt as to where the isolating switch is, go to the vehicle manufacturers website to obtain the information, consult the owners handbook or contact your local dealership. Disconnect the 12 volt auxiliary battery. Place a suitable warning sign near the vehicle to indicate "this vehicle contains high voltage components and is currently being worked on, **DO NOT TOUCH** any electrical components, wiring or electrical terminals". Always wear PPE (personal protective equipment) linesman insulated rubber gloves class 0 rated to 1000 volts, leather gloves over the insulated rubber gloves to protect the insulated gloves from damage, rubber soled work boots, eye protection and remove any loose tools from your overalls top pockets.
- ⇒ **REPLACING OTHER A/C SYSTEM COMPONENTS** - Not connected to the electrical system and with no insulated coloured wiring harness particularly orange. Components such as the condenser or TXV. It is still advisable to isolate the main battery pack and remove the ignition key or proximity pad key to an area 5m away from the vehicle. Place a suitable warning sign on or near the vehicle to indicate that the vehicle contains high voltage and is currently being worked on **DO NOT TOUCH** any electrical components contained in this vehicle. (example provided at end of this bulletin).
- ⇒ **DIAGNOSING WITH PRESSURE GAUGES** - It is good practice to always wear the correct PPE. Connect your R134a pressure gauges as you would normally on a non-Hybrid vehicle, but use extreme care that you do not touch or "brush against" any electrical terminals or wiring harnesses. Insert your thermometer into the dashboard centre face vent. Have a look at what type of compressor is on the vehicle as you may have either a petrol driven type or an electric driven type. You will have to either start the petrol engine or the electric motor (or in the case of the dual drive compressor with 2 internal scrolls activate both) for diagnosing an issue. When starting the electric drive to check pressures, always check the instrument panel "ready" lamp to see if it is illuminated, this means the vehicle is ready to be driven away. Ensure the transmission is in Park and do not touch the accelerator pedal - otherwise the vehicle could move.



⇒ **A/C SYSTEM SERVICING** - This is the same as for a non-Hybrid vehicle but with a change to the equipment used. Because oil contamination is critical, it is recommended that you do not fill oil into the A/C system through an automated charging machine. If you use an automated machine for evacuation and charging, ensure that the charging hoses are flushed to remove any residual PAG oil that may remain from a previous non-Hybrid PAG system before using the machine on a Hybrid system. Refer section below on “compressor lubricating oil”. The way to remove the risk of lubricating oil cross contamination is to use service equipment that is dedicated for the Hybrid A/C systems. This will ensure that no residual PAG oil remaining in hoses or gauge manifolds will enter a Hybrid A/C system.

⇒ **COMPRESSOR LUBRICATING OIL** - Denso Hybrid compressors use a dedicated oil which is ND-11. Other A/C system manufacturers use their own dedicated oil. Consult the charge label or compressor label to confirm type. Substitute aftermarket non-conductive synthetic oils such as the ADAIR (Rock oil) ISO Grade 68 are available and suitable as a replacement or will mix readily with the existing OEM Hybrid electric compressor PAG oils. Most A/C compressors used in Hybrid vehicles are driven by a high voltage electric motor. **Only the specified non-conductive lubricating oil MUST can be used** as the windings in these electric motors are exposed to the A/C system lubricating oil. Testing has confirmed that just 1% oil contamination can result in dramatic issues including electrocution. The insulation and windings may become damaged and this could cause a high voltage leak to the compressor case. Anyone touching the compressor could receive a high voltage electric shock. Sensors in the compressor case may sense the fault (voltage leak) and disengage the compressor.



ADAIR Synthetic Oil

Denso ND11

⇒ **TESTING FOR AN A/C ELECTRICAL ISSUE** - The Hybrid electrical DC and AC high voltage do not use a chassis ground or common neutral circuit like a non-Hybrid vehicle. All circuits are isolated from the vehicle chassis. Your multimeter must be suitable for the Hybrid high voltage circuit and also have provision for insulation leakage testing. **Extreme care must be taken.** Observe all the high voltage handling procedures and wear the correct PPE. Use the appropriate scan tools for the vehicle make and type.



Multimeter and probes must be rated to a minimum of 1,000 volts



**PLEASE USE THIS INFORMATION CONTAINED IN THIS TSB AS A “GUIDE ONLY”. YOU MAY STILL BE REQUIRED TO SOURCE INFORMATION FROM THE VEHICLE MANUFACTURERS WEBSITE.**



THIS SIGN IS PROVIDED AS A TEMPORARY MEASURE IF YOU DO NOT HAVE ONE AVAILABLE.

