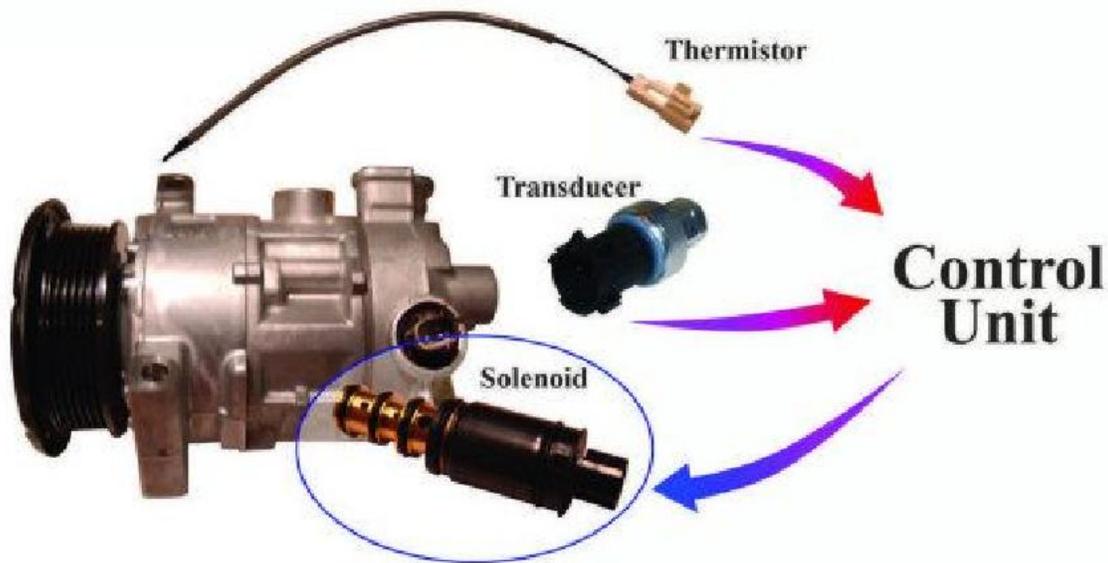




Electronically Controlled Clutchless or Variable Drive Compressors

On many new air conditioning systems, such as Lexus, Cadillac, Chrysler, and others, a new type of compressor has been fitted. There are commonly called “clutchless” compressors. If you take a look at one, they have a pulley, but most noticeably they do not have an electromagnetic clutch. There is now a thermistor, transducer and solenoid that now perform the functions electronically that used to be done mechanically by the electromagnetic clutch. These are now coordinated with the vehicle’s control unit, which may be an engine control module (ECM), a power train control module (PCM), a totally integrated power module (TIPM), or an A/C controller.



The transducer has previously been used on electromagnetic clutch systems for a few years and provides the control unit with the high side pressure information by sending a variable voltage signal of 0 volts to 5 volts which represent a pressure range of 0 psig to 500 psig. This signal replaces the high/low pressure switch circuit since the control unit expects a voltage reading of 0.025 to 0.040 volts (25 psig to 40 psig) to show that the system has adequate refrigerant to operate the compressor. If a voltage of 3.5 to 4 volts is received, the control unit will not allow the compressor to function due to the high pressure. The transducer also replaces the trinary switch since the control unit can turn on the condenser cooling fan when the high side pressure reaches 2 to 2.5 volts (200 to 250 psig). Different manufacturers may vary these typical readings, so confirm the specific reading required by the manufacturer’s specifications.

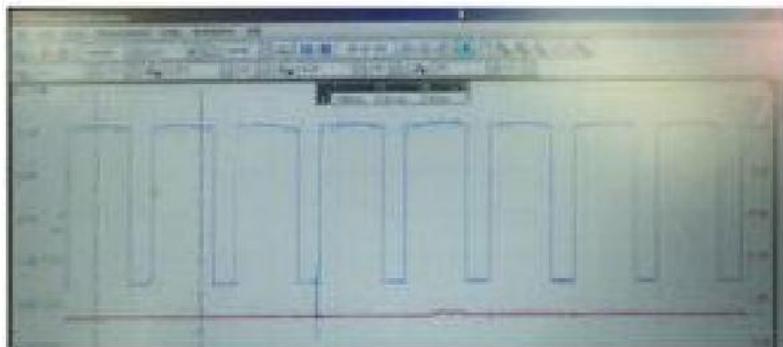
The thermistor may also be something familiar since it has replaced mechanical thermostats for several years working with amplifiers to produce a 12 volt signal to activate the clutch or a relay. In

these new systems the thermistor produces a variable resistance as the probe tip changes temperature. The thermistor produces a voltage signal that is sent directly to the control unit. This keeps the evaporator from freezing but also provides a variable signal that can be used along with other engine management information to vary the output of the compressor. This allows the A/C system to match engine load/energy consumption to the cooling needs of the passenger compartment. The relationship between the probe tip temperature to resistance value ranges from 5 k ohm (32 deg F) to 1 k ohm (90 deg F).

The control unit interaction is a major change in compressor control. The control unit uses a PWM (pulse width modulated) signal to the compressor control solenoid to vary the output level of the compressor. We have had mechanical control valves in the V-5 and V-7 compressors that ramped up or ramped down the compressor function based solely on suction line pressures. The ability of the control unit to consider evaporator temperature, engine rpm, high side pressure, accelerator pedal position, and ambient temperature when deciding to increase or decrease refrigerant flow from the compressor makes this system completely interactive.

The clutchless compressor when seen on a running engine gives the appearance of a regular clutch type unit with the clutch engaged, because the front hub plate is always spinning when the engine is running. The clutchless compressor will reduce swash plate angle to 2% when not activated by the control unit showing almost equal suction and discharge pressures. With the compressor shaft turning and pressures almost equal, many technicians assume the compressor is defective and will mistakenly want to replace it.

This constant rotation of the compressor shaft created a need to perform different diagnostic tests before replacing the compressor. The PWM signal to the electronic control valve in the rear of the compressor can be read with a lab scope. The pattern observed will be a digital wave pattern that appears narrow when the compressor is operated at a moderate rate and wider when the compressor operation increases.



Electronic control valves utilize a solenoid and by pass channel in the rear of the compressor to balance the refrigerant pressure between the discharge chamber and crankcase to provide a swash plate angle from 3% to 100%. The compressor can be externally activated to perform diagnostic tests because the control valve is electronically operated. A testing unit provides the variable PWM signal that would normally come from the control unit, activating the compressor while it is still connected to a

charged system. This will allow the technician to operate the compressor at different performance levels to evaluate condenser, accumulator/drier, expansion device and evaporator functions.

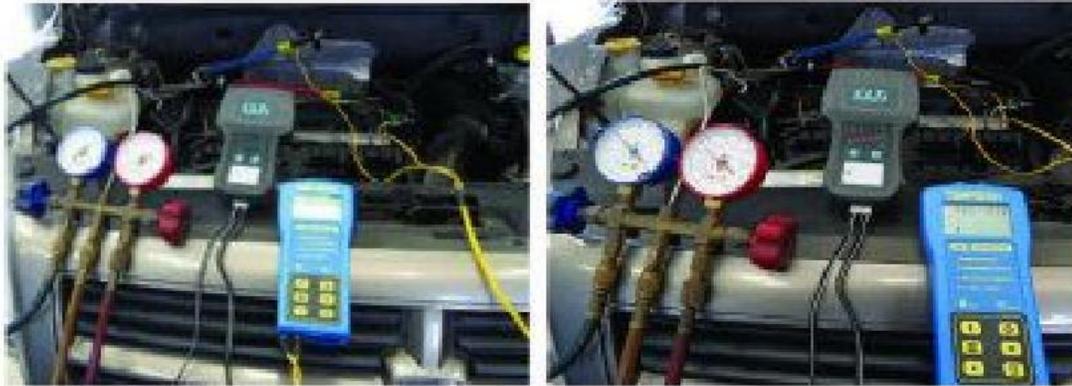
These types of systems can be divided into three sections for diagnosis. The refrigerant system which most shops repair; the control system that incorporates control head, actuators and vent doors (dash removal) and the engine management system which some shops may require specific scan tools to perform. A shop that may concentrate only on the refrigerant system repair can determine if there are problems in that section of the system and decide if it is a repair job that fits their shop operation.

Electronically Control Clutchless System Testing

Electronically controlled systems can be intimidating since they are the most interactive system on vehicles today. They combine the refrigerant circuit with engine management and dash vent control to provide a comfortable environment for the vehicle passengers with minimum compressor function.

The majority of the customers are concerned about no cooling or poor cooling efficiency. The first challenge is to determine the potential capacity of the refrigerant circuit since customer satisfaction will be based on cooling performance.

A shop may elect not to get involved in engine management or dash controls but can still repair the refrigerant circuit. Since the electronic control valve which activates and controls the compressor output can be disconnected from the vehicles harness and controlled externally with the CLT control unit, the shop technician can signal the electronic control valve to change the internal swash plate angle from 3% (A/C off) to 100% to determine if the compressor can pump refrigerant through the system. This test would produce the same benefit for the technician that placing a jumper wire from the battery to the clutch wire on a clutch equipped compressor would. A connected manifold set would be used to view high and low side pressures for circuit evaluation. Refrigerant could be added if necessary, normal temperature testing could be performed and with the evaporator cold, the dash controls could be checked for proper temperature control and mode function. If the refrigerant circuit performed normally when activated by the CLT control unit, the technician could eliminate replacing the compressor as a source of the customer's problem.



In the left picture above, the compressor is not activated (although the front drive plate of the compressor is turning) and the pressures are almost equal. In the right picture, the CLT control unit has the compressor swash plate at the full angle. Unfortunately, many technicians see the left picture results and assume the compressor is bad causing them to replace the compressor unnecessarily. This often results in a failed repair and a compressor returned to the supplier.

The CLT control unit will also indicate if the solenoid has a direct short preventing compressor operation. In cases when the CLT control unit demonstrates that the refrigerant circuit is good, the next decision for the technician is whether to continue with the evaluation. The next challenge would be to determine why the vehicle's control unit was not providing signals to the electronic control valve. If there were engine management issues with the vehicle, there would likely be a check engine light on. If there is no check engine light on, or if the technician wanted to evaluate the rest of the system, the next step would be to verify the function of the transducer and thermistor.

The transducer is mounted to the discharge line and communicates line pressure to the vehicle's control unit. It has a three wire connector which receives 5 volt input signal and a ground signal. It then sends out a variable signal to the vehicle's control unit reflecting the discharge line pressure. Like most clutch systems this system requires a pressure above the low pressure threshold of 25 to 40 psig or 0.025 to 0.040 volts and below the high pressure threshold of 350 to 400 psig or 3.5 to 4.0 volts to operate. The reference signal can be read with a DVOM (digital volt ohm metre) or power probe by probing the connector or by using a tester/simulator (shown below) that inserts between the transducer and its connector.



This device can read the reference voltage put out by the transducer but more importantly it allows the technician to manually dial the voltage down below the low voltage threshold and above the high voltage threshold to test the system's reaction. On vehicles with electronic fans, the technician can dial the voltage up to the specified range to activate the fans for evaluation. The pressure reporting benefit can also be useful to evaluate condensers where high side pressure reading is downstream of the condenser. The voltage reference from the transducer indicates true discharge line pressure and a restricted condenser may cause downstream high pressure readings to be lower than it really is. The ability to test the electronic fan on these systems adds to its value.

The thermistor probe is normally inserted into the evaporator fins to read temperature accurately and may require the removal of the evaporator to replace it. Testing the thermistor can be accomplished without removing the evaporator since the connector is on the outside of the evaporator case. Reading the resistance of the thermistor and the surrounding temperature and comparing it to the vehicle specification will let the technician know if it is faulty. Using a thermistor tester (shown below) will provide a view of the activity of the thermistor with temperature changes and the technician can substitute a signal to the control unit to verify proper system operation when the correct values are available. Demonstrating that a thermistor is good solves the problem before removing the evaporator and replacing it and can save unnecessary labour.



These compressors also have a constant circulation of filtered lubricant whenever the engine is running. This places an increased importance on having a proper level of clean, quality lubricant in the system at all times.

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