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Cascadia HVAC Operation – Part One

The new Freightliner Cascadia is equipped with a multiplexed electronic control system. Put simply, multiplexed electronic controls share information with each other. The information from input devices wired to one control module is broadcast over a databus so that information may be used by another control module. Most of the electrical systems on the truck are furnished battery power, ignition power, accessory power and ground by two Signal detection and Actuation Modules, a.k.a SAMs (see Figure 1). These two SAMs, the Cabin SAM and the Chassis SAM also control most of the electrical features of the truck. What does this have to do with the heating and air conditioning system you might ask? The answer is that these SAMs also receive inputs from switches and sensors on the truck and use that information to control outputs that are wired to the SAMS. They also transmit that information on a Controller Area Network (CAN) databus called the Cabin CAN. Some of this information is used by the air conditioning control modules, called the Front Control Unit (FCU) and the Auxiliary Control Unit (ACU), to control the air conditioning and heating system.

Cabin CAN Operation

The Cabin CAN databus connects four modules on the truck. They are the Cabin Sam, Chassis SAM, Modular Switch Field (MSF) master, and the Central Gateway Module (CGW). The Cabin Can connects all four of these modules to a Starpoint Connector. This connector is a junction box that ties all these sections of the Cabin CAN together (See Figure 2). The Central Gateway Module that is connected to the Cabin CAN translates the information on the Cabin CAN databus and routes it to other databusses that are connected to other modules such as the two air conditioning control modules (FCU and ACU). For example, the two air conditioning control modules, the FCU and ACU, communicate on the J-1939 databus. They receive information that is broadcast by the Cabin SAM after the information is translated the by Central Gateway Module and sent out over the J-1939 databus.

Cabin SAM Inputs and Outputs

Several inputs received from sensors wired to the Cabin SAM are used for HVAC control. These four inputs are: Ambient Temperature, High Side Refrigerant Pressure, Park Brake Status, and Low Air Pressure Status (see Figure 3). The Cabin SAM not only receives inputs but also controls outputs such as the AC compressor clutch. The AC compressor clutch receives power and ground from the Cabin Sam. Figure 4 illustrates the engagement rules that must be met before the AC compressor clutch will be powered. The information used to determine whether the engagement rules are met comes from several sources. The ***Blower Speed*** switch and the ***AC switch*** are mounted in the FCU. The ***Countdown Timers*** are in software programmed into the FCU. ***Air Pressure Status*** is broadcast by the Cabin Sam from information it receives from Primary and Secondary air pressure switches that are wired to the Cabin SAM. ***Engine RPM*** is broadcast over the J-1939 databus by the Engine's Common Powertrain Controller (CPC) that is mounted behind the center dash panel. The CPC receives engine RPM from the Motor Control Module (MCM) that is mounted on the left side of the engine. The CPC and MCM communicate with each other over a proprietary databus called the Engine CAN. ***Ambient Temperature*** and ***High Side Refrigerant Pressure*** are broadcast by the Cabin Sam from information received by sensors wired to the Cabin Sam. The Ambient Temperature sensor is mounted behind the front bumper at the end of the right frame rail. The High Side Refrigerant Pressure sensor is mounted in the high side refrigerant line in front of the cab frontwall in the engine compartment. ***Battery Voltage*** is sensed internally in the Cabin Sam. ***Evaporator Temperature*** is sensed by the FCU from a temperature sensor that is located next to the evaporator in the front HVAC unit. This sensor measures the temperature of the air coming off the evaporator.

Engine Fan Operation

The engine fan is controlled by the Motor Control Module (MCM). The MCM engages and releases the engine fan based on information it receives from its own sensors, but it also has to control the fan based on databus information it receives from the FCU and the Cabin Sam. When the refrigerant pressure sensed by the Cabin Sam becomes high enough that the engine fan needs to be turned on, the FCU sends a request to the CPC over the J-1939 databus. The CPC sends a command to the MCM over the Engine CAN databus and the MCM engages the engine fan. The engine fan On Time varies with vehicle speed and park brake status (see Table 1). Vehicle Speed is sensed by the Vehicle Speed Sensor that is wired to the CPC. The CPC broadcasts Vehicle Speed over the J-1939 databus and it is received by the FCU. Park Brake Status is broadcast by the Cabin Sam from information it receives from a Park Brake switch that is wired to it. Engine Fan On-Time logic is programmed into the FCU.

Conclusion

Technicians who diagnose control issues on this system have to understand where the information comes from, and which control module is controlling what. Part Two of this article will illustrate ways technicians can use to determine whether the HVAC system is receiving the information it needs to operate correctly. **Stay Tuned!**

Figure 1 – SAM Modules

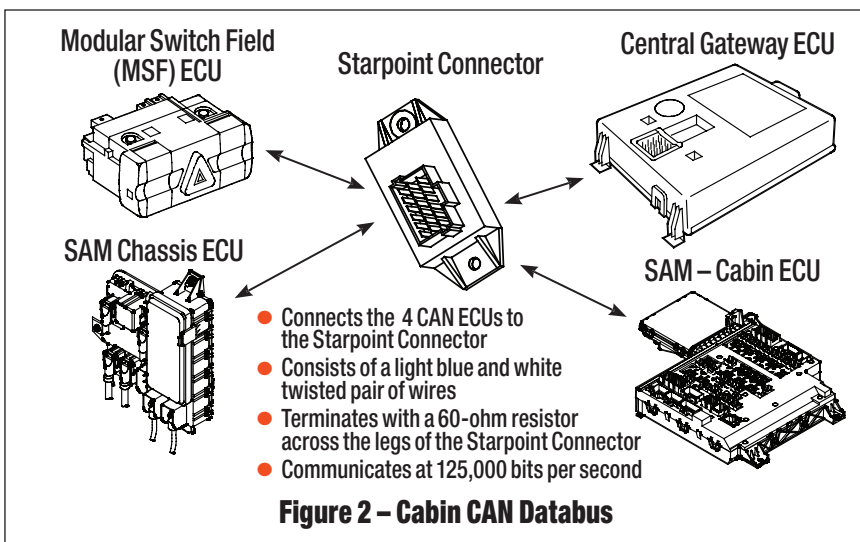

Figure 2 – Cabin CAN Databus

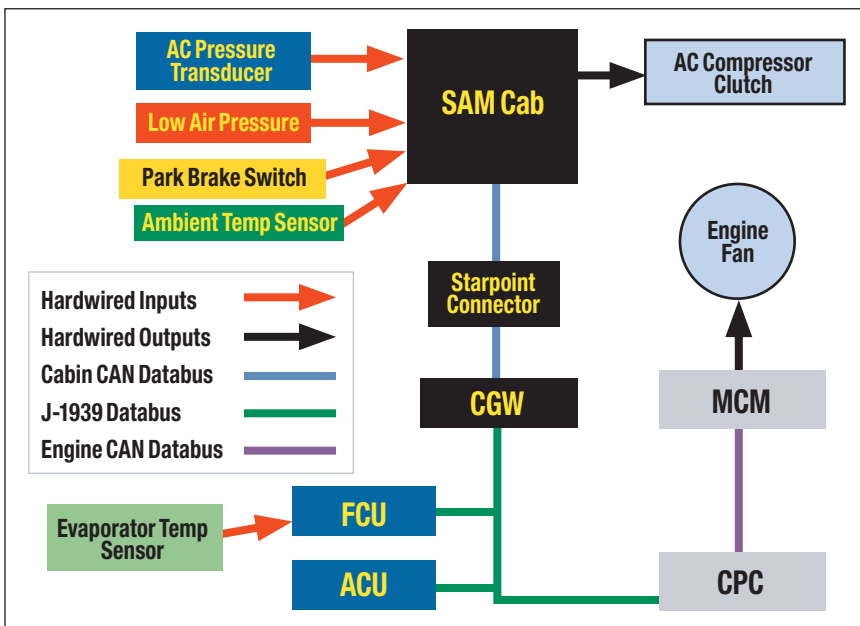

Figure 3 – HVAC Multiplexing

Input	Condition
Blower Speed Switch	any position but "OFF"
AC Switch	switch pressed or mode switch in Defrost position
Countdown Timers	must be expired-minimum cycle time equals 18 seconds
Air Pressure Status	must be greater than 60 psi
Engine RPM	450 rpm or higher for at least 5 seconds
Ambient Temperature	40°F to 200°F
Refrigerant Pressure (High Side)	above 34 psi
Battery Voltage	12.5 V or higher
Evaporator Temperature	38.5°F or higher

Figure 4 – AC Clutch Engagement Rules

Vehicle Speed (MPH)	Park Brake Status	Minimum Fan Request Time	Notes
0	On	Continuously	FCU sends fan request continuously as long as AC compressor has been iniated in the last 90 seconds with park brake applied. Note: It is normal for the engine fan to run continuously as long as the AC is on and the park brakes are set.
0-20	Off	180 sec.	Minimum Time FCU Sends Fan Request
20-40	Off	90 sec.	
Above 40	Off	30 sec.	

Table 1 – Minimum Time FCU Sends Engine Fan Request

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