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## Cascadia HVAC Operation – Part Two

Last month's Tech Talk article provided information about how the HVAC system in the Cascadia model Freightliner is controlled. Please refer to that article. Much of the input information that the Front Control Unit (FCU) and the Auxiliary Control Unit (ACU) need to do their jobs comes to them over the J-1939 datalink. Some of this input information comes from the engine's control unit, and some comes from the SAM Cabin. Much of this information is required by the FCU before it will engage the AC compressor clutch. Technicians who diagnose AC clutch engagement issues must know where these inputs come from and how to determine whether the FCU is receiving the necessary input information.

### Fault Code Diagnostics

Both the FCU and the ACU broadcast fault codes on the J-1939 datalink. Some of these fault codes are triggered when the FCU does not receive the information it needs from the J-1939 datalink. These fault codes will display on the message center on the dash when they are "active", but the only way to read them as "inactive" or "stored" codes is by using the ServiceLink diagnostic software that is available to Freightliner dealerships. **Refer to the Operator's Manual in the vehicle for instructions on how to read fault codes on the dash message display.** Table 1 lists fault codes that are stored when the FCU doesn't receive necessary information from the J-1939 datalink. This is not a complete list of all the fault codes that the FCU and ACU broadcast, but these are the codes that are related to the FCU and ACU failing to receive information that they need from the J-1939 datalink. If one of these codes is active the FCU will not engage the AC compressor clutch.

### Blower Motor Diagnostics

The Cascadia uses a brushless direct current (BLDC) blower motor in both the front and rear HVAC units. Both have four circuits connected to them. Pin locations in the 6-pin blower motor connectors are as follows:

- Pin 1 – Feedback / Diagnostic Signal – connected to FCU or ACU
- Pin 2 – Not Used
- Pin 3 – Ground – connected back to the SAM Cab
- Pin 4 – 12V Battery – powered by the SAM Cab
- Pin 5 – PWM Command – connected to FCU or ACU
- Pin 6 – Not Used

Blower speed is controlled by Pulse Width Modulated (PWM) signal from the FCU or ACU. Each controller sends a 2000 Hz pulse width signal to its respective blower motor at Pin 5 of the blower motor connector. The pulse width of the signal varies with the fan speed switch speed selection. The blower motor operates between 400 and 3850 rpm.

Under normal operation, the feedback signal to the FCU and ACU, at Pin 1 of the blower motor connector, indicates blower motor speed by varying the frequency, **rpm = 20X Frequency**. The blower motor has a protection mode built into it that will cause it to operate at a reduced speed or shutdown to prevent damage. Any of the following conditions will cause the blower motor to enter "protection mode".

**Over/Under Voltage** – if the voltage supply to the blower motor is less than 8.5V or more than 17V, the blower motor will enter protection mode and shut down. The blower feedback circuit will indicate a fault and a fault will be logged in the FCU or ACU.

**Reverse Voltage Protection** – the motor will not operate if the polarity of the power and ground wires is reversed.

**Current Protection** – if the motor exceeds the maximum current, the speed will be reduced until the current is within the normal range (under 23.5A). The blower feedback circuit will indicate a fault, and a fault code will be logged in the FCU or ACU.

**Temperature Protection** – if the blower's internal temperature sensor indicates that the temperature inside the motor is too high, the blower speed will be reduced to 1000rpm to reduce the load on the motor. A second comparison is made between the temperature and the maximum limit. If the temperature is still too high the blower speed is further reduced to 500 rpm and another comparison is made between the temperature and the maximum limit. If the temperature is still too high the motor will shut down until it has cooled. The blower feedback circuit will indicate a fault and a fault code will be logged in the FCU or ACU.

If the blower motor has entered protection mode, the blower speed feedback signal becomes a diagnostic signal to the FCU and ACU by setting its frequency to 10 Hz and varying the duty cycle of the signal to indicate the cause of the protection mode. Table 2 illustrates the various duty cycles of the diagnostic signal and the fault conditions they represent. The frequency and duty cycle of this signal may be measured with a digital multimeter that has the capability to measure frequency and duty cycle. Table 3 illustrates the fault codes that may be logged in the FCU or ACU when the blower motor enters one of the protection modes.

### FCU Calibration

If the FCU is replaced or any of the door actuators on the front HVAC unit are removed or replaced the FCU must be manually calibrated. To perform the calibration routine:

1. Turn the ignition ON but do not start the engine.
2. Set the blower speed control to full left or "OFF".
3. Set the temperature control to full right or "HOT".
4. Set the mode control knob to full left or "FACE".
5. Press the A/C and RECIRC buttons simultaneously until the A/C and RECIRC indicators begin flashing simultaneously.
6. The calibration process will begin and continue until the A/C and RECIRC indicators stop flashing.

**Future Tech Talk articles on the Cascadia HVAC system will cover performance testing and refrigerant system pressure diagnostics.**

**Table 1 - HVAC Fault Codes Table**

J-1939 FCU Fault Codes: FCU [J-1939 Source Address (SA) 25]				
SA	SPN	FMI	Fault Description	Fault Trigger
25	70	9	Parking Brake Switch Status Message-abnormal update rate	FCU does not receive J-1939 parking brake switch status from SAM Cab.
25	84	9	Vehicle Speed-abnormal update rate	FCU does not receive J-1939 vehicle speed message from engine ECM / CPC.
25	110	9	Engine Coolant Temperature message-abnormal update rate	FCU does not receive J-1939 engine coolant temperature message from engine ECM / CPC.
25	158	3	FCU-Voltage Above Normal	FCU Voltage is too high or voltage is applied when it should not be.
		4	FCU-Voltage Below Normal	FCU Voltage is too low.
25	168	9	SAM Cab Battery Voltage Message-abnormal update rate	FCU does not receive J-1939 battery voltage message from SAM Cab.
25	171	9	Ambient Air Temperature-abnormal update rate	FCU does not receive ambient air temperature message from SAM Cab.
25	190	9	Engine Speed Message-abnormal update rate	FCU does not receive J-1939 engine speed message from Engine ECM / CPC
25	629	12	FCU-bad intelligent device or component	Internal FCU failure
25	639	2	J-1939 Datalink-incorrect or intermittent data	FCU attempts to broadcast this fault if all J-1939 received messages are corrupt continuously for a period of 1.5 seconds.
25	522510	9	High Pressure Sensor-abnormal update rate	FCU does not receive high pressure sensor information from SAM Cab.
25	523307	9	Low Air Pressure Switch Status Message-abnormal update rate	FCU does not receive J-1939 low air pressure switch status message from SAM Cab
J-1939 ACU Fault Codes: ACU [J-1939 Source Address (SA) 58]				
58	158	3	ACU-voltage above normal	ACU voltage is too high.
		4	ACU-voltage below normal	ACU voltage is too low.
58	609	12	ACU-bad intelligent device or component	Internal ACU Failure
58	639	2	J-1939 Datalink-incorrect or intermittent data	ACU attempts to broadcast this fault if all J-1939 received messages are corrupt continuously for a period of 1.5 seconds

**Table 2 - Blower Motor Protection Mode Table (as indicated on feedback / diagnostic circuit)**

Protection Mode	Frequency	Duty Cycle	Notes
Voltage too low	10hz	50%	If the blower is in protection mode, it communicates via the feedback-diagnostic circuit to the FCU or ACU. The duty cycle will correspond to the protection mode entered.
Voltage too high	10hz	50%	
Locked rotor	10hz	75%	
Overcurrent or thermal protection	10hz	25%	

**Table 3 - J-1939 Fault Codes from FCU (SA-25) and ACU (SA-58) for Blower Protection Modes**

SA	SPN	FMI	Fault Description	Fault Trigger
25	523318	2	Blower protection mode-voltage out of range (front unit)	Voltage supply to motor is below 8.5V or higher than 17V.
		6	Blower protection mode-overcurrent or thermal protection (front unit)	Current to motor is above 23.5A or motor is overheated internally.
		7	Blower protection-speed mismatch or blocked rotor (front unit)	Speed signal from motor indicates the speed is not matching requested speed.
58	523318	2	Blower protection mode-voltage out of range (rear unit)	Voltage supply to motor is below 8.5V or higher than 17V.
		6	Blower protection mode-overcurrent or thermal protection (rear unit)	Current to motor is above 23.5A or motor is overheated internally.
		7	Blower protection-speed mismatch or blocked rotor (rear unit)	Speed signal from motor indicates the speed is not matching requested speed.



Visit the Freightliner booth #11117 at this year's Great American Trucking Show, August 20-22, in Dallas, Texas. As part of the show we will have special guests Kurt Grote, Henry Albert, and Dick McCorkle with us in the booth. These drivers are currently testing the new Freightliner Cascadia and are "blogging" about their travels at <http://www.SliceofTruckerLife.com>.



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