SERVICE BULLETIN

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DATE: 6/12/03
MODEL: ASET™ AC

(Not Applicable to Mack Trucks Australia)

BEHR ELECTRONICALLY MODULATED FAN DRIVE

CH and CX model chassis equipped with ASET™ AC engines use an electronically controlled fan drive manufactured by Behr Gmbh and Company. The Behr fan drive employs a viscous fluid drive system that is electronically controlled by inputs received from the engine electronic control unit (EECU).

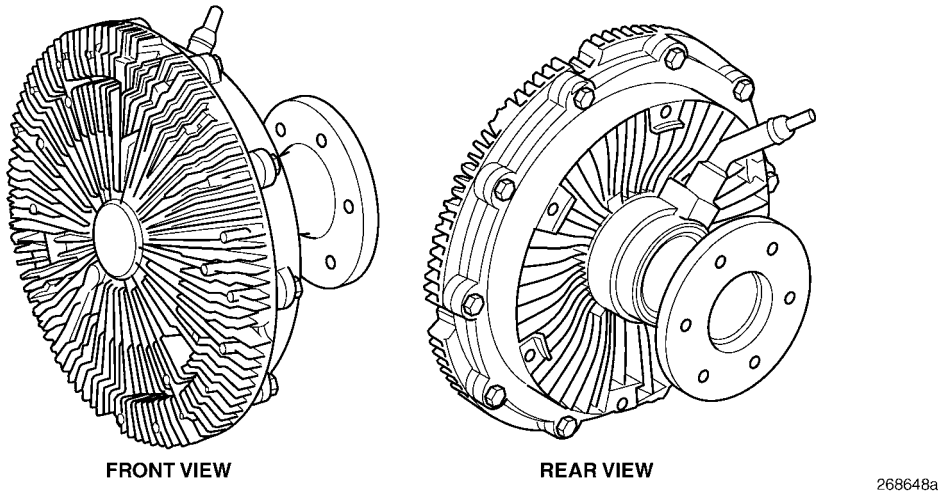

Figure 1 — Behr Electronically Controlled Fan Drive

The Behr electronically modulated fan drive features the following improvements over air sensing bi-metal viscous fan drives:

- Low idle speed
- Quick engagement
- Fan speed regulated according to cooling system requirements
- More stable coolant temperatures (less fluctuations)
- Greater life cycle
- Increased torque capacity (comparable to on/off fan clutches)
- Softer engagement (no torque-peaks at engagement)

NOTE

Unlike air-sensing viscous fan drives, there are no conditions regarding the storage of the Behr fan drive. The fan drive can be stored either horizontally or vertically.

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Operation

The main components of the fan drive are the front cover, primary disk, housing, mounting flange and solenoid.

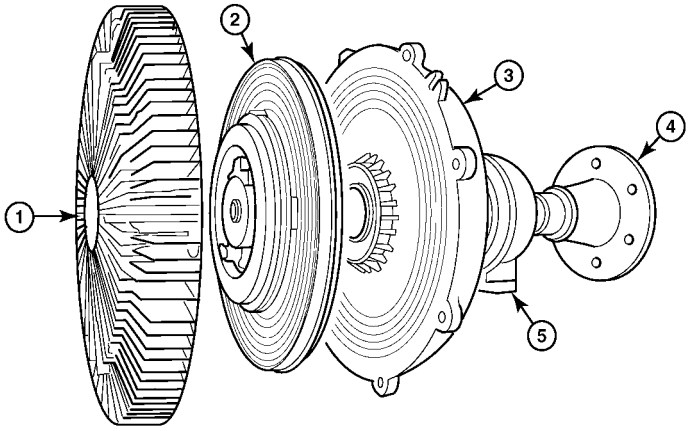

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Figure 2 — Behr Fan Main Components

1. Front Cover 2. Primary Disk 3. Housing	4. Mounting Flange 5. Solenoid

Within the fan drive is a fluid reservoir that contains a measured amount of silicone oil, and passages inside the drive that direct the flow of fluid to the “working chamber.” A valve blocks the port between the reservoir and the working chamber.

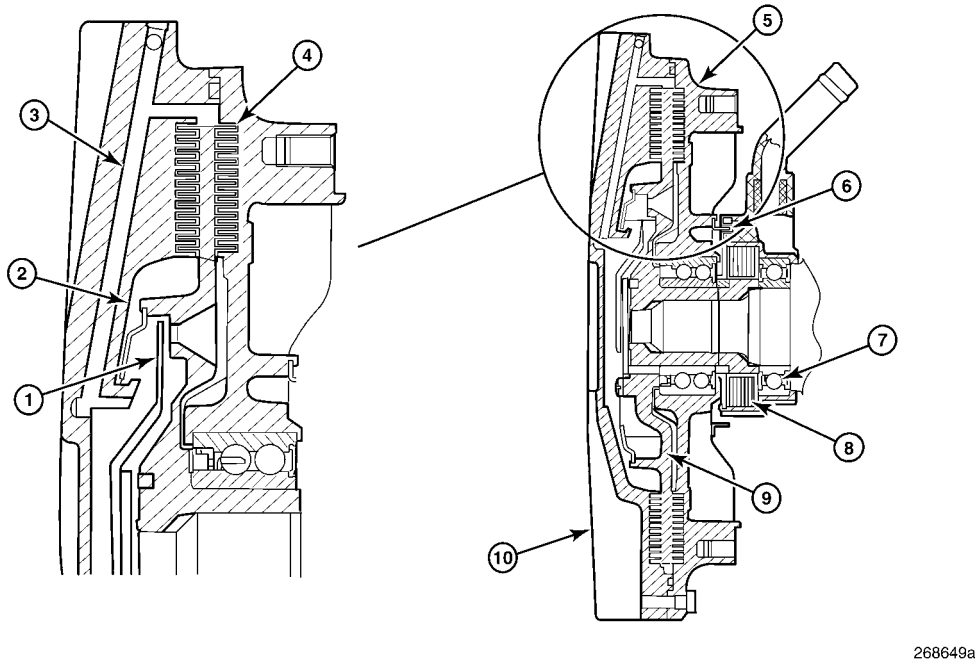

Figure 3 — Fan Drive Cut-Away

1. Valve 2. Fluid Reservoir 3. Return Passage 4. Working Chamber 5. Housing	6. Speed Sensor 7. Solenoid Bearing 8. Solenoid 9. Primary Disk 10. Front Cover

The fan drive remains engaged until a signal is received from the engine electronic control unit (EECU) to disengage. Various sensors send information concerning engine coolant temperature, boost air temperature, air conditioning system status (either off or on) and engine speed to the EECU. This information is interpreted by the EECU, and when conditions demand, the EECU sends a signal to the fan drive solenoid to disengage the fan.

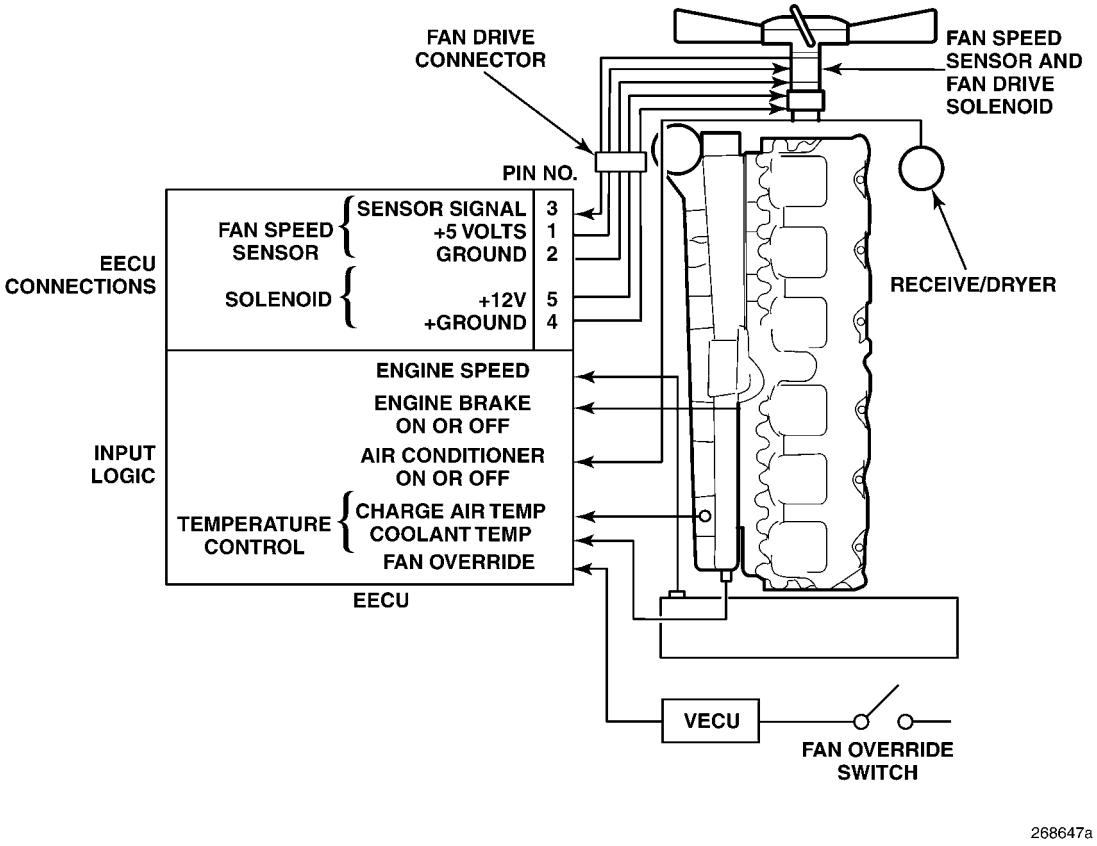

Figure 4 — Fan Drive Control Inputs/Outputs

The following is a schematic diagram of the fan drive control circuit.

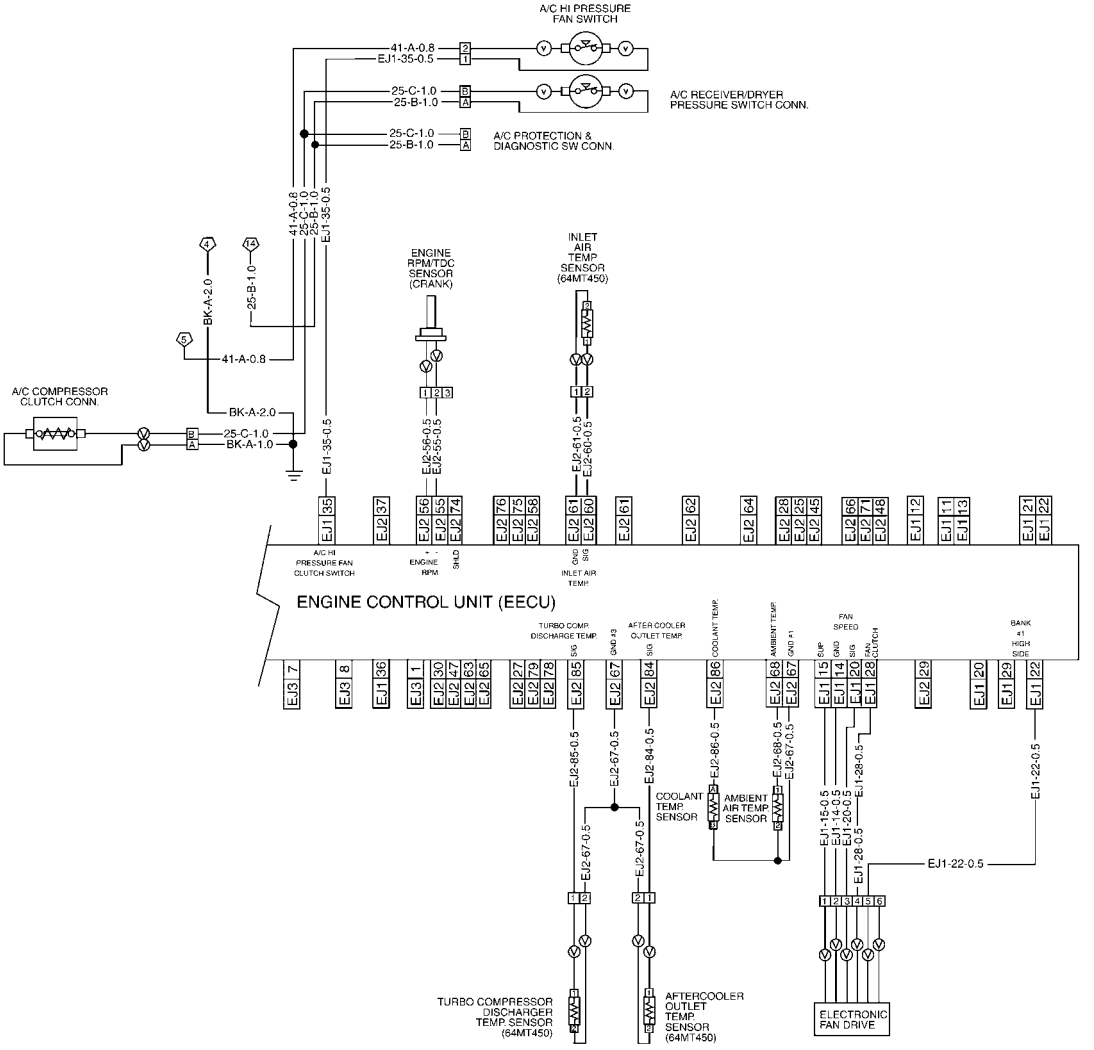

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Figure 5 — Fan Drive Control Circuit

The fan drive connector pin assignments are as follows:

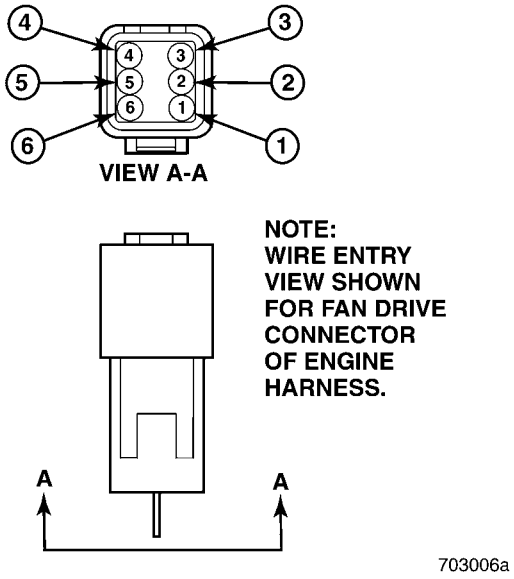

Figure 6 — Fan Drive Connector Pin Assignments

Pin No.	Wire Designation	Function
1	EJ1-15-0.5	Fan speed sensor power (+5 volts)
2	EJ1-14-0.5	Fan speed sensor ground
3	EJ1-20-0.5	Fan speed signal
4	EJ1-28-0.5	Pulse width modulated ground
5	EJ1-22-0.5	Fan drive power (+ 12 volts)
6	Blank	Not used

With the solenoid de-energized, the valve is opened, allowing oil to flow from the reservoir and into the working chamber. The primary disk, which is an integral part of the fan drive hub, is driven by the fan belt, while the housing rotates freely. As the oil flows into the working chamber, the friction generated by the shear forces of the oil couples the housing and primary disk together, thus allowing the housing and primary disk to rotate as an assembly.

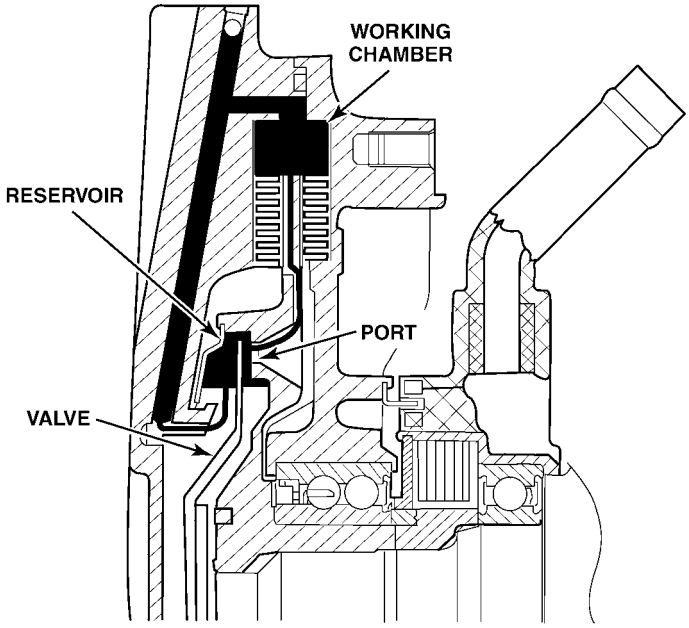

Figure 7 — Fan Drive Fluid Flow

The fan drive spins faster as the quantity of oil entering the working chamber increases. Centrifugal force pushes the fluid toward the outer circumference of the working chamber, then the fluid is pumped back to the reservoir through the return passage by a “ramming” effect. Fluid flow out of the working chamber is restricted due to the size of the return passage.

Fluid flow from the working chamber back to the reservoir is influenced mainly by the differential speed between the primary disk and the housing. At low speeds (idle) when the differential speed is low and the working chamber is completely filled with fluid, fan disengagement could take several minutes.

To keep engine coolant at a constant temperature range, the EECU regulates the amount of oil entering the working chamber by energizing and de-energizing the fan drive solenoid as required. A fan speed sensor mounted on the back of the fan drive assembly measures fan speed by counting the teeth on the fan drive tone wheel. The information is then sent to the fan speed control circuit in the EECU. When the EECU detects that the fan is approaching maximum speed, the fan speed control circuit energizes the fan drive solenoid.

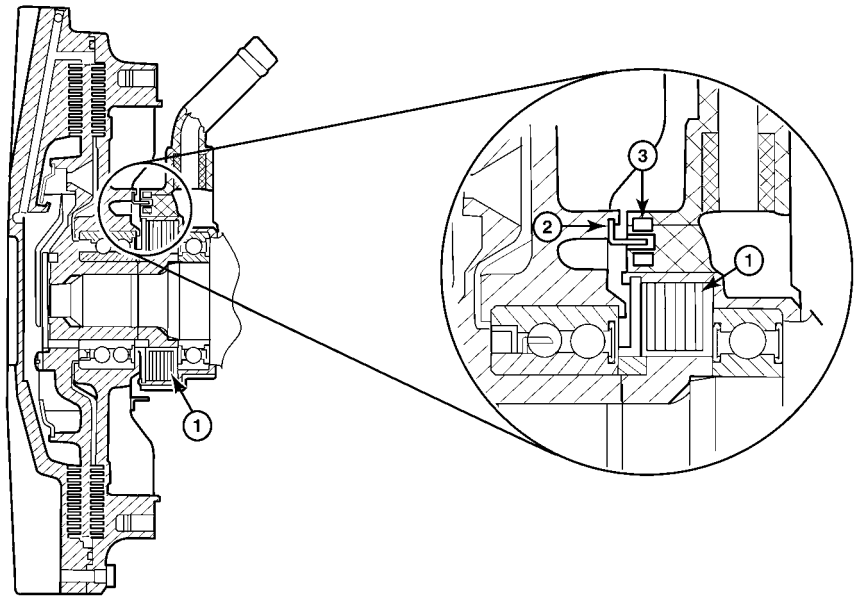

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Figure 8 — Fan Speed Sensor and Solenoid

1. Solenoid Coils 2. Tone Wheel	3. Fan Speed Sensor

Maintenance and Troubleshooting

The Behr electronically modulated fan drive is a highly reliable, maintenance free system. Diagnostics for the electronically modulated fan drive are generally electrical in nature as follows:

- The fan drive may be shorted high or low
- An input to the fan drive control circuit is commanding the fan drive to be engaged — Inputs such as air conditioning ON or OFF, coolant temperature, charge air cooler outlet temperature and customer options such as the fan override switch may cause the fan drive to remain engaged. The air conditioning ON or OFF signal or the charge air cooler outlet temperature are the most likely causes for a failure of the fan drive to disengage. A failure of either of these two sensors would not be evident to the operator of the vehicle.
- Failure of the fan speed sensor

There are causes other than electrical that would cause the fan drive to remain engaged. These causes are as follows:

- The correct fan type was not electronically installed in Customer Data Programming — The ASET™ AC EECU contains settings for several fan options; standard ON/OFF fan drive, electronically modulated viscous fan drive and air-sensing viscous fan drive. If the incorrect fan type is selected, the fan will not function properly and can remain engaged at all times.
- A fan drive failure that has caused over-heated fluid — Over-heating will cause the viscous fluid to breakdown. In the early stages, viscous fluid breakdown will result in excessive fan drive slippage, whereas in the later stages, the fan drive will remain engaged.

The following charts provide troubleshooting information for problems that might arise with the fan drive. The fan drive assembly is not repairable. Any problems diagnosed as being the fault of the fan drive require that the fan drive assembly be replaced.

NOTE

When diagnosing a faulty fan drive, note that when differential speed between the primary disk and the housing is low (engine at an idle) and the working chamber is completely filled with oil, fan drive disengagement may take several minutes.

⚠ WARNING

Always service the fan drive assembly with the engine NOT running. Keep clear of the fan when the engine is running. The fan may start to rotate at high speed without warning. DO NOT attempt to restrict fan rotation while the engine is running.

Symptom	Possible Causes	Diagnostic Procedures
Fan does not disengage (no blink code), engage properly or poor fuel economy due to fan drive remaining engaged.	1. Damaged bearings or fluid leaking from fan drive.	1. With the engine NOT running, rotate the fan drive by hand with the fan belt installed. This will require moderate force due to the resistance of the fluid inside the fan drive. Any evidence of internal noise, roughness, binding or leaking fluid indicates that the fan drive is damaged and must be replaced.
	2. Malfunction of valve or solenoid, or defective fan drive.	2. Shut off the engine and allow the coolant to cool. After the engine has sufficiently cooled, start the engine and make sure the air conditioner is turned OFF. The fan should disengage after a short time (after approximately 10 minutes of operation at moderate engine speed [1100–1500 rpm]). If the fan remains engaged, disconnect the electronic fan drive connector and on the fan drive side of the harness connector, supply 12 volts to pin No. 5 (+12 volts) and connect pin No. 4 to a good chassis ground. Doing this applies 12 volts directly to the fan drive solenoid. If the fan remains engaged with 12 volts applied to the solenoid in this manner, a problem exists with the fan drive solenoid, valve, or the fan drive could have failed mechanically, requiring that the fan drive be replaced. If the fan drive disengages with 12 volts applied directly to the solenoid in this manner, inspect the engine wire harness for rubbing or chafing that may result in a short (high or low), and check all pin connections in the engine harness between the fan drive and the EECU.
	3. Fan speed sensor error.	3. A fan speed sensor error will log a 1-8 blink code. Refer to the *V-MAC® III Service Manual,* 8-211, for diagnostic procedures.
	4. Incorrect fan type selected in EECU Customer Data Programming.	4. Access customer data programming and verify that “Electronic Viscous Fan Installed?” is selected YES. Refer to the *V-MAC® III Service Support Software User Guide,* 8-341, for information on customer data programming.

Symptom	Possible Causes	Diagnostic Procedures
Fan does not disengage (no blink code), engage properly or poor fuel economy due to fan drive remaining engaged.	5. Defective charge air cooler outlet temperature sensor (part No. 64MT450) or coolant temperature sensor (part No. 64MT2103).	5. Verify that the charge air cooler outlet temperature is below 150°F (66°C) and that the coolant temperature is less than 200°F (93°C). Refer to the *V-MAC® III Service Support Software User Guide,* 8-314, for information on checking temperature sensor output.
	6. Incorrect signal from air conditioning system.	6. Access EECU Customer Data Programming. Deselect the option “Air Conditioning Installed.” Doing this causes the fan control circuit to ignore any inputs from the air conditioning system. If the fan drive functions properly after five minutes of engine operation, the problem causing the fan drive to remain engaged is with the air conditioning signal to the EECU. Repair the air conditioning system, then reset the option “Air Conditioning Installed” to yes.
	7. Customer option set to YES, causing fan drive to remain engaged.	7. Access the “Cab Fan Controls” section of the VECU Customer Data programming and verify that for any option set to YES, the particular input for that option is turned OFF and not signaling the fan to remain engaged.
Fan does not engage.	1. Fluid leakage from fan drive.	1. Inspect the fan drive for evidence of oil leakage around the outer circumference of the housing.
	2. Internal damage to fan drive.	2. Rotate the fan drive by hand with the fan belt installed. This will require moderate force due to the resistance of the fluid inside the drive. Any evidence of internal noise, roughness or binding as the fan drive is being rotated requires that the fan drive be replaced.
	3 Electrical or electronic problem with fan drive control.	3. If there are no mechanical problems with the fan drive, the fan drive solenoid may be defective, or a problem with the electronic control system may exist.
	4. Incorrect fan type selected in EECU Customer Data Programming.	4. Access customer data programming and verify that “Electronic Viscous Fan Installed?” is selected YES. Refer to the *V-MAC® III Service Support Software User Guide*, 8-341, for information on customer data programming.

Symptom	Possible Causes	Diagnostic Procedures
Noise during operation.	1. Damaged bearings.	1. Rotate the fan drive by hand with the fan belt installed. This will require moderate force due to the fluid inside the drive. Note any noise or roughness as the drive is being rotated. Also, pull the fan drive back and forth and note any axial movement of the drive. Any noise, roughness or axial movement of the drive indicates damaged bearings, requiring that the fan drive be replaced.
	2. Fan blades striking fan ring.	2. Rotate the fan and note if the fan contacts the fan ring at any point during rotation. Additionally, look for evidence of damage to the tips of the fan blades caused by the blades striking the fan ring.

⚠ CAUTION

Fan blades striking the fan ring can cause internal damage to the fan drive that could go unnoticed. The fan drive should be replaced if evidence of the fan blades contacting the fan ring is noticed. Refer to the information given under the heading "Fan Drive Replacement Due to Fan Collision" in this bulletin.

In addition to the information provided in the above troubleshooting table, other conditions, such as damaged wire harnesses, poor cooling system performance, faulty thermostats, faulty sensors, etc., will affect operation of the fan drive. Those areas should also be investigated when diagnosing fan drive problems.

Fan Drive Replacement Due to Fan Collision

Internal damage to the fan drive can occur if the drive is subjected to shock loads generated by the fan assembly striking or colliding with the fan shroud, fan ring or other associated components. Shock loads of this type can lead to flaking and break-out of the bearing material, resulting in complete failure of the bearings shortly after the fan collision has occurred.

Even though there is no obvious or visible physical damage to the fan drive, the drive MUST be replaced anytime a fan assembly has been replaced due to damage caused by a collision with the fan ring, shroud, etc. Failure to replace the fan drive following a fan collision will adversely affect warranty coverage should the fan drive fail at a later time.

If fan drive replacement is necessary and the existing fan has not been damaged in any way, the fan can be reinstalled on the new drive. A fan-to-fan drive mounting hardware kit (part No. 3543-C0415), consisting of six hex-bolts (fan-to-fan drive mounting) and four self-tapping screws (cover-to-fan mounting), is available through the MACK Parts System. When installing the fan to the drive, tighten the mounting bolts to 19 lb-ft (26 N·m).

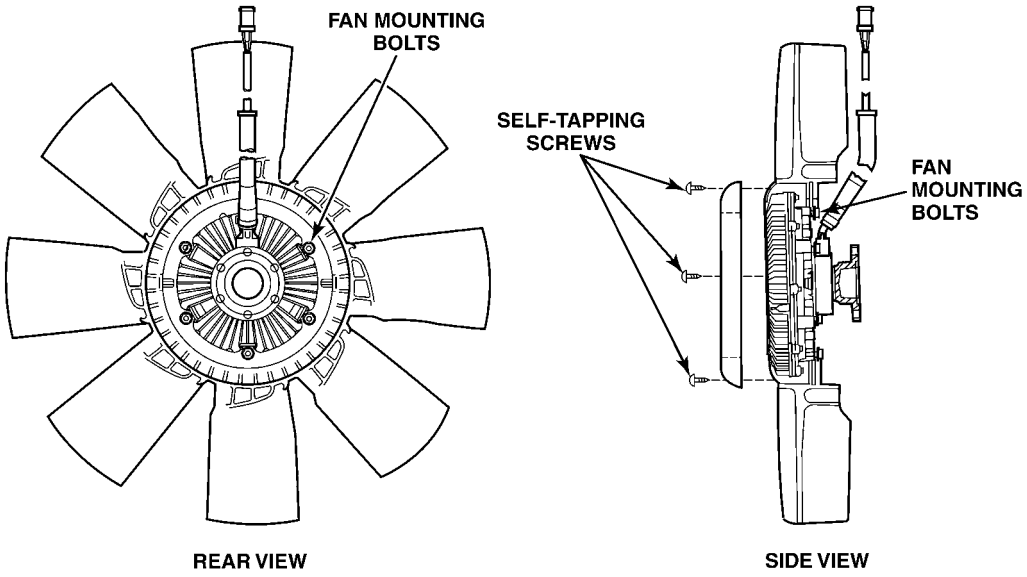

Figure 9 — Fan-to-Fan Drive Mounting Hardware

Slip-Heat Protection

If rotating speed of the fan is different from fan drive speed, damage to the drive can occur due to the heat generated by the friction of the moving parts. Slip-heat protection is controlled by the EECU software and datafile which uses data from the engine and fan speed sensors, and prevents intermediate fan speeds at high input speeds. Without slip-heat protection, the fan drive will overheat at high input speeds. For current production chassis equipped with the Behr electronically modulated fan drive having a 680 mm diameter fan, slip-heat protection limits fan drive operation as follows:

- Fan drive input speed of 2850 rpm (approximate engine speed of 1650 rpm) — no limitations.
- Fan drive input speed between 2850–3200 rpm (approximate engine speed between 1650–1860 rpm) — functions similar to an on/off fan drive, with a small modulation zone.
- Fan drive input speed above 3200 rpm (approximate engine speed above 1860 rpm) — fan drive disengaged.