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Title: **Horton Stratis Fan Hub Diagnostics**

Applies To: **Prostar, LoneStar, TranStar, WorkStar, IBB**

DESCRIPTION

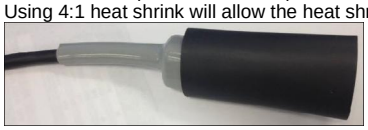
Horton VMaster Ultra (Stratis) Viscous Fan Drive Troubleshooting Guide
Engine feature code 12THX

GENERAL OPERATION (ALL ENGINES)

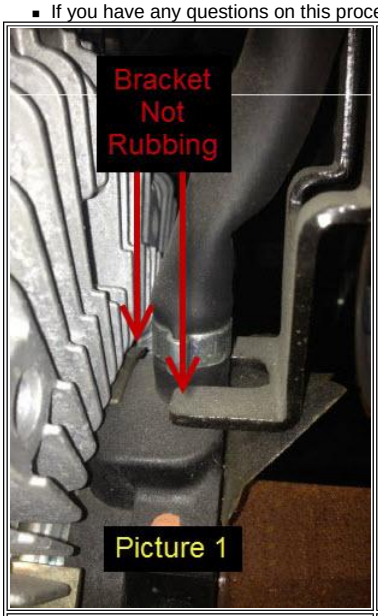
- Horton VMaster is a variable speed drive. It does not function like an on/off drive. Even when the drive is off the fan will spin between 50-300 rpm.
- When drive is commanded off by ECU, fan speed should be 50 to 300 rpm.
- When drive is commanded on by ECU, fan speed should be approximately 125% of the engine speed.
  - Example: At 2100 engine rpm x 1.25 fan drive ratio, the fully engaged fan speed should be approximately between 2490 and 2600 rpm
- The default state of the fan is ON. The ECM or EIM uses a pulse width modulated (PWM) signal to turn the fan OFF. This is described in more detail in the information provided for each engine platform.
- After first start of the day (A/C in off position) Time for fan to disengage
  - At high idle (2100 engine rpm), disengagement may take up to 2 minutes after disengagement command, depending on the ambient temperature
  - At low idle (600 engine rpm), disengagement occurs approximately 25 to 30 minutes after disengagement command.
- Warm truck (A/C in off position) Time for fan to disengage
  - At high idle (2100 engine rpm), disengagement occurs approximately 20 seconds after disengagement command.
  - At low idle (600 engine rpm), disengagement occurs approximately 25 to 30 minutes after disengagement command.
- Caution: This fan clutch has left hand threads.

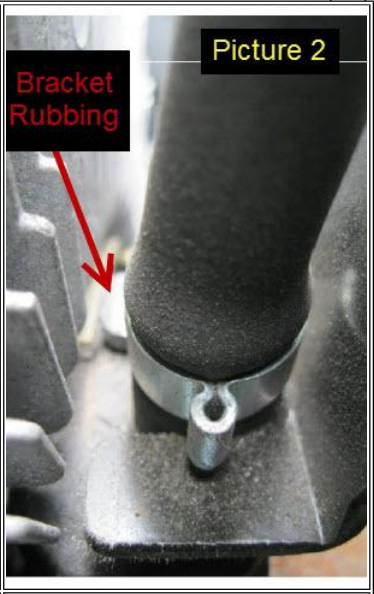
N13 and EPA10 MaxxForce 11 / 13

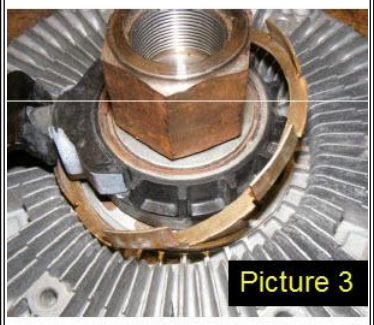
TROUBLESHOOTING

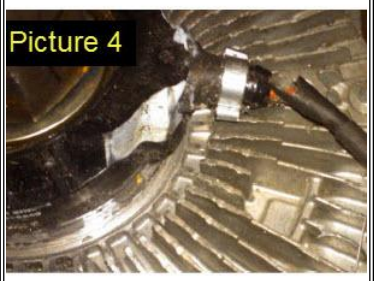
1. Visual Inspection
   - Check for rubbing on wire.
   - 
     - If rubbing is present and inside wires are visible, but no copper is visible apply heat shrink over the harness.
     - If copper can be seen, check to see if it is only one single wire, or multiple wires.
       - If it is one wire, place electrical tape over the wire.
       - Using 4:1 heat shrink will allow the heat shrink tubing to pass over the connector as shown. P/N: ZBJE849565 or equivalent
       - 
       - If multiple wires are showing copper, remove and replace the fan hub assembly.
     - Reroute the wiring harness at outlined in the "Harness Re-Route Procedure" in this iKNow article.
   - Check to see if ARB is touching the target wheel. Refer to Picture 1 and Picture 2.

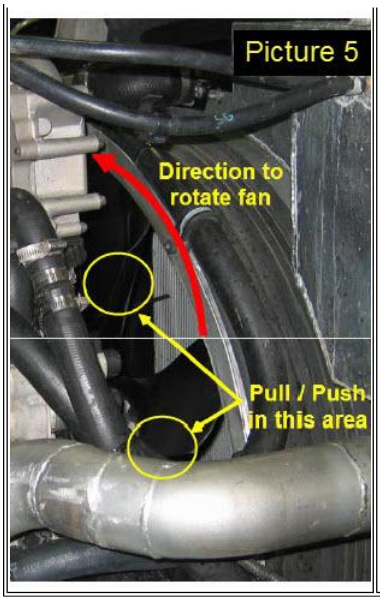
- If it is touching, reposition ARB to clear the target wheel as shown in Picture 1.
- Check to see if the target wheel is loose, moves, or spins freely.
  - If it is loose, moves, or spins freely replace the fan hub assembly.
- An improperly positioned ARB or loose target wheel can cause the damage in Picture 4.
- Pull / Push on fan - refer to Picture 5.
  - Rotating the fan by hand, the hub should provide a smooth and consistent resistance.
  - If it rotates freely approximately 1" or more before resistance is felt, replace the fan hub assembly.
  - If you have any questions on this process, call Horton customer service at 1 (800) 621-1320 for assistance.







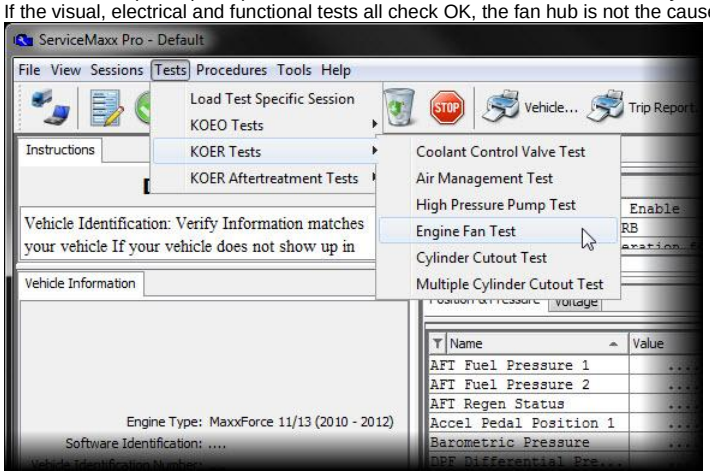


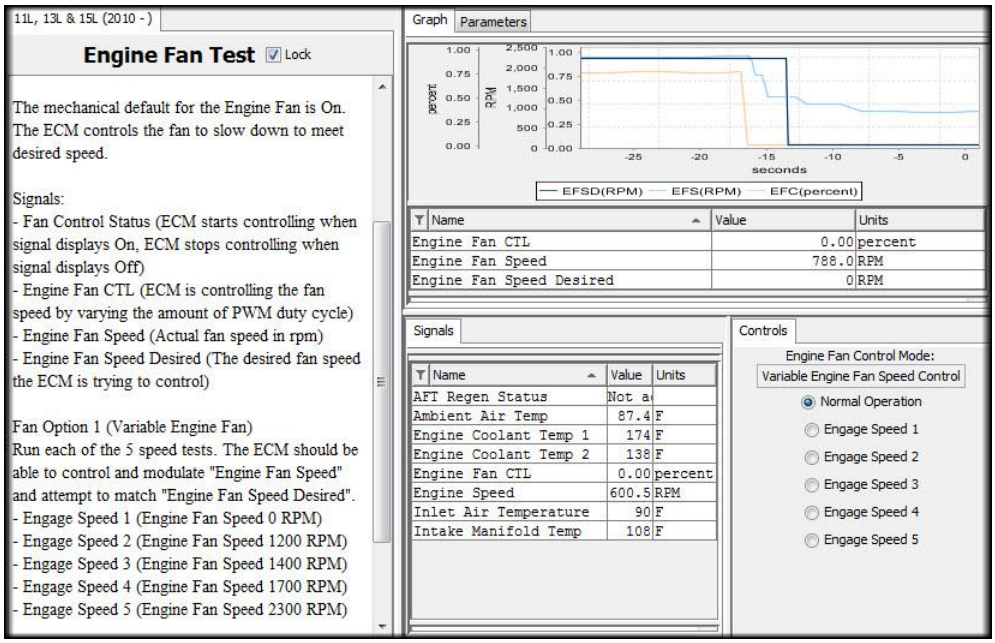


2. Electrical Inspection
   - Ensure the truck is turned off and the key is removed from the ignition.
   - Unplug the fan hub from the chassis connector.
   - Using a digital multimeter, measure the resistance between pins on the fan hub Deutsch connector.
     - Terminal 1 to Terminal 2 (1-2) Spec (>1MΩ)
       - If it fails this test, use In Line Device (ILD) shown in photo. This failure is usually associated with a 3512 code.
     - Terminal 1 to Terminal 3 (1-3) Spec (6Ω to 16Ω)
     - Terminal 2 to Terminal 5 (2-5) Spec (2.5KΩ to 4KΩ)
       - If it fails this test, replace the fan hub assembly.
     - Double check any resistance that are out of spec to ensure an accurate reading

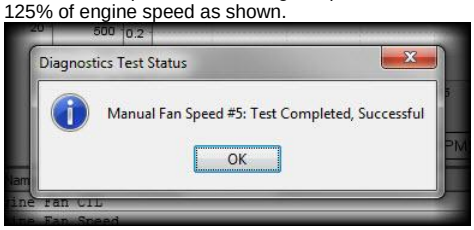
SPN	FMI	DESCRIPTION	REPAIR PROCEDURE
647	3	EFC Short to PWR	Check coil resistance. Spec: 6Ω to 16Ω Replace fan hub assembly if out of spec. EPA10 only.
	4	EFC Short to GND	
	5	EFC Open Load / Circuit	
1639	3	EFS Unrealistically HIGH	Do not replace the fan hub assembly. Update ECM calibration to 3.5.4 or later.
	4	EFS Unrealistically LOW	
	8	EFS Frequency Signal Error	
3512	14	VREF4 Voltage Deviation ECM Terminals: C1-37, C1-43, C1-49, C2-08, E1-58, E1-91	Install Horton ILD (In Line Device) P/N 800922R91 Replace fan hub assembly if both codes 3512 and 647 are present. EPA10 only.

3. Functional Test
   - Manually apply 12 volts to Pin 3 and Ground to Pin 1, checking fan operation. It should be disengaged. Some surging may be normal depending on the temperature of the fan hub.
   - Bring engine to operating temperature. 175°F-180°F.
   - Connect with ServiceMaxx and perform "Engine Fan Test".
   - The entire test (5 test points) must be recorded and submitted with the warranty claim.
   - If the visual, electrical and functional tests all check OK, the fan hub is not the cause of the customer complaint. Do NOT replace the fan hub.



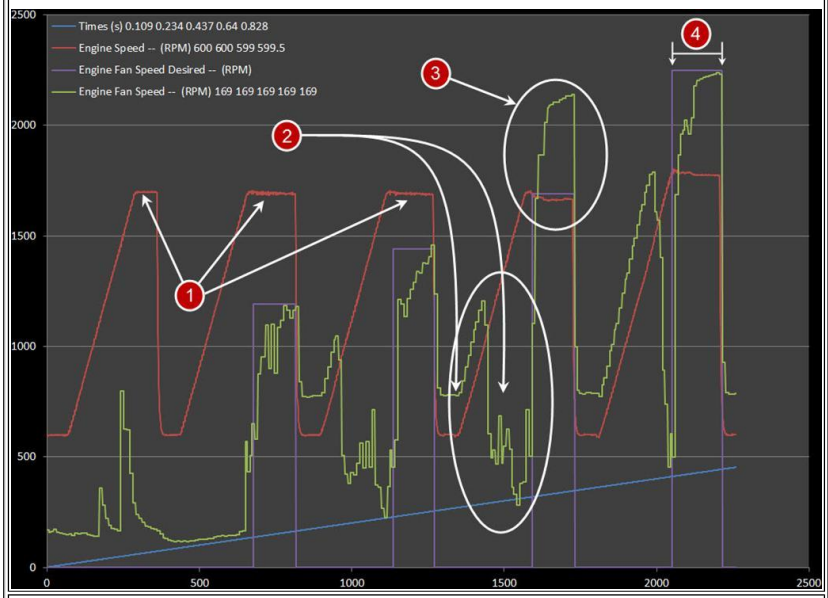


4. Engine Fan Test Results
   - You will need to monitor the entire fan test while it is running to determine if the fan has passed or failed.
   - The fan needs to operate within the limits at each test point. The fan should engage and remain engaged during the entire engagement request.
   - The actual fan speed should be approx ± 250 RPM of desired. Some viscous properties of the fan hub may vary the results. See examples below.
   - Notice in the chart below, when the engine ramps with 0 RPM desired fan speed, the fan does pick up some speed. This is normal due to the viscous properties of the fan hub.
   - Also as Item 3 points out, the engine speed and desired fan speed nearly match. If the fan is requested on 100%, the fan may actually engage at 125% of engine speed as shown.



   - The "Test Completed, Successful" window at the conclusion of the test does not indicate the fan has passed. It only indicates the test has been completed successfully. You will need to determine if the fan has passed or failed.

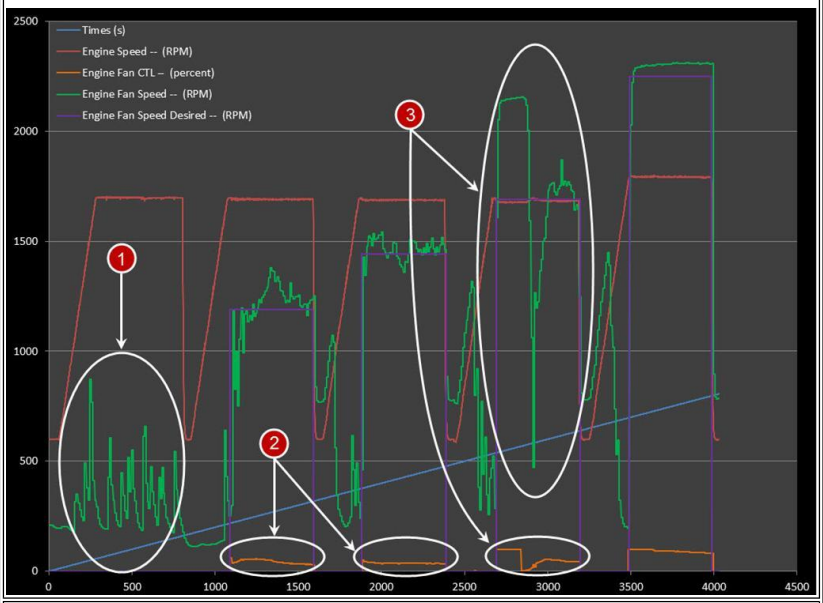
Properly Working Fan Hub Assembly



1. The engine ramps to the same speed for each section of the test
2. When the ECM is no longer requesting a set fan speed, the fan disengages. However, as the engine ramps to start the next section of the test, the fan speed increases. This is normal due to the viscous characteristics of the fan hub. As the fan hub stabilizes you see

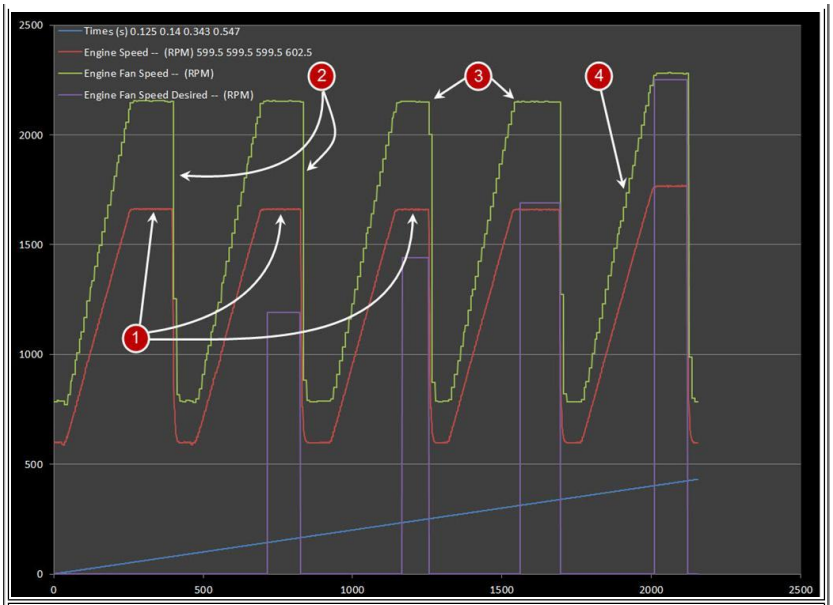
the fan speed then continues to decrease.
3. This section of the test shows the fan speed higher than the desired fan speed. This is due to engine speed and desired speed being very similar values. The fan is then commanded ON, and the fan speed is 125% of desired. This is normal.
4. This is showing the duration of the fan on command. Notice in each section the fan does not match up and perfectly align. This is due to the PWM (Pulse Width Modulated) signal that is being sent to the fan hub.
    - You can review your fan test in ServiceMaxx to see a chart view of the signals shown in this chart.
    - If you have any questions of the results, attach your fan test snapshot to your case file for review.

Properly Working Fan Hub Assembly (Example 2)



1. Again, notice the fan speed varies when the engine ramps for the first time and desired fan speed is zero. This is normal due to the viscous properties of the fan hub, and is normal operation.
2. The Fan Control % has been added to this chart.
3. As stated in the chart above, due to the engine speed and desired fan speed being very similar values, the ECM commands the fan on at 98.04%. However, in this test the ECM tries to change the fan speed by changing the fan control percent. The fan control percent drops near zero to attempt to achieve this. While this is a different reaction for this portion of the test then the chart above, it is still normal operation.
    - You can review your fan test in ServiceMaxx to see a chart view of the signals shown in this chart.
    - If you have any questions of the results, attach your fan test snapshot to your case file for review.

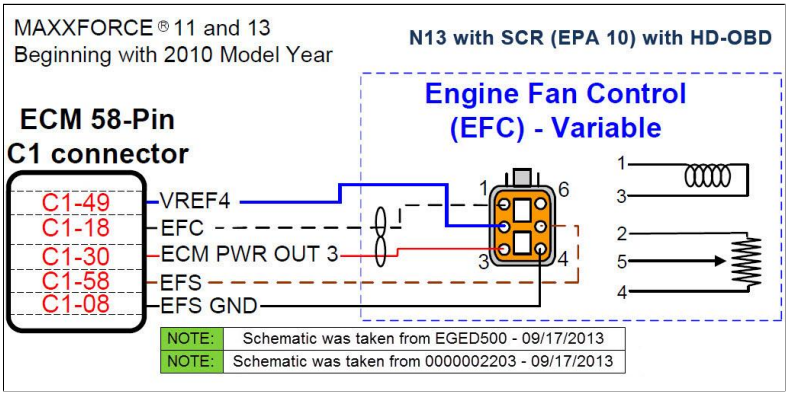
Failed Fan Hub Assembly

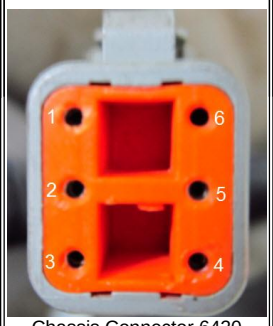


1. Engine ramps to the same speed for each section of the test.
2. When the ECM is no longer requesting a set fan speed, the fan disengages. However, in this example, the viscous portion of the fan is not responding, allowing the fan speed to drop off rapidly.
3. Notice the fan speed is always engaging to over 2000 RPM. The fan is turning on fully. This is not normal operation for the fan test.
4. This is showing when the fan is commanded off, the fan hub speed increases with engine speed. Fan speed never drops back off, as shown in the working fan example above.
   - Note: This is one example of a failed fan. Not every fan hub will fail this way.
   - You can review your fan test in ServiceMaxx to see a chart view of the signals shown in this chart.

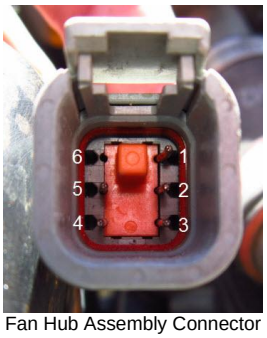
OPERATION

- The default state of the fan is ON. Ground is required to turn the fan OFF.
- ECM C1-18 controls the fan by supplying a Ground PWM signal.
- ECM C1-58 is feedback for the fan speed.





Chassis Connector 6420
Front side



Fan Hub Assembly Connector

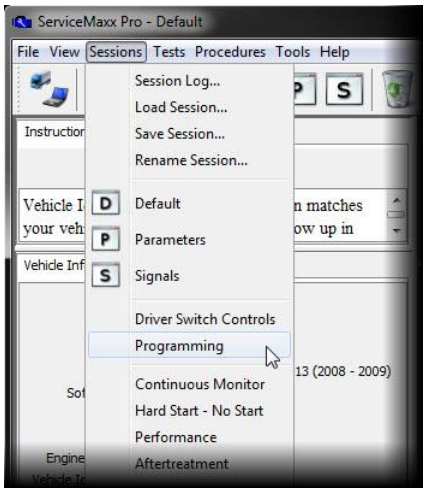
EPA07 MaxxForce 11 / 13

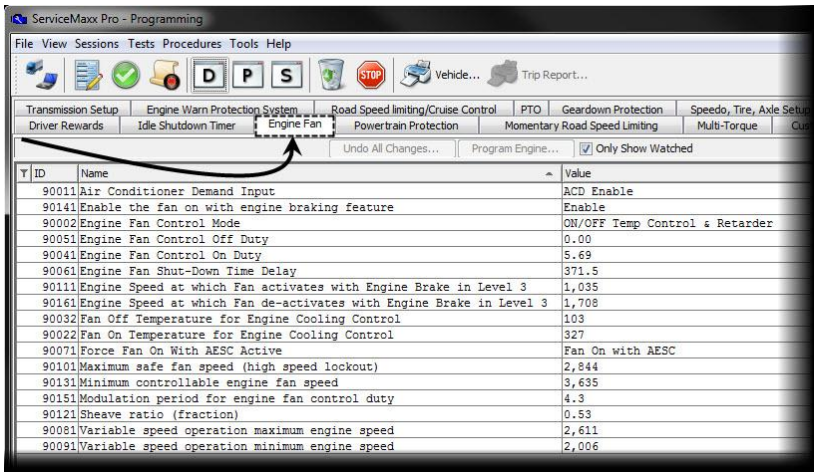
This fan hub is controlled by the EIM using a Pulse Width Modulated (PWM) control. 100% duty cycle indicates the fan is off. The lower the duty cycle the faster the fan operates.

- Desired Fan Speed and Actual Fan Speed may not always match due to the fan speed to engine ratio and normal viscous delays.
- The fan hub may seem to surge or operate erratically. This may be normal operation.
- The fan may be commanded on for a data link message from other modules, such as A/C demand or Transmission temperature.
- Any engine temperature sensor input to the ECM can cause the EIM to turn the fan on.

TROUBLESHOOTING

- Perform the visual inspection on the harness as shown in the section above.
- The "Engine Fan Test" is not available for the EPA07 engine.
- Measure resistance from Terminal 1 to Terminal 3 (1-3) Spec (6Ω to 16Ω)
- Manually apply 12 volts to Pin 3 and Ground to Pin 1, checking fan operation. It should be disengaged. Some surging may be normal depending on the temperature of the fan hub.
- Open a Programming session in ServiceMaxx and view the Engine Fan tab to monitor signals.

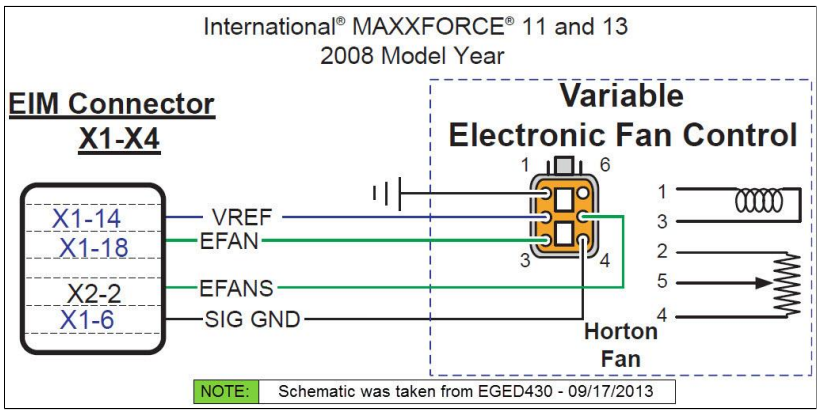


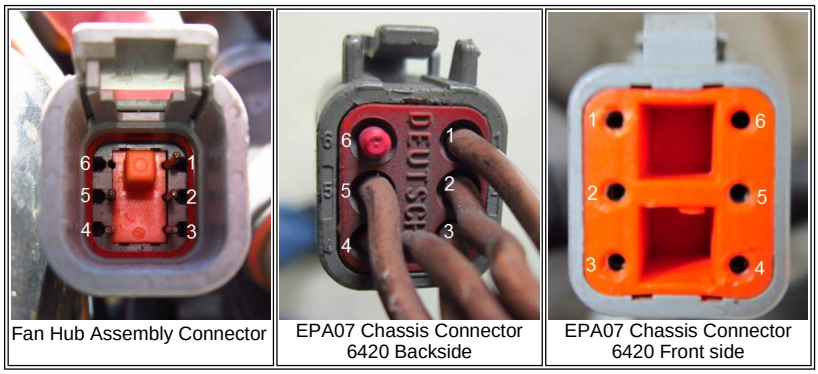


ID	Name	Value
90011	Air Conditioner Demand Input	ACD Enable
90141	Enable the fan on with engine braking feature	Enable
90002	Engine Fan Control Mode	ON/OFF Temp Control & Retarder
90051	Engine Fan Control Off Duty	0.00
90041	Engine Fan Control On Duty	5.69
90061	Engine Fan Shut-Down Time Delay	371.5
90111	Engine Speed at which Fan activates with Engine Brake in Level 3	1,035
90161	Engine Speed at which Fan de-activates with Engine Brake in Level 3	1,708
90032	Fan Off Temperature for Engine Cooling Control	103
90022	Fan On Temperature for Engine Cooling Control	327
90071	Force Fan On With AESC Active	Fan On with AESC
90101	Maximum safe fan speed (high speed lockout)	2,844
90131	Minimum controllable engine fan speed	3,635
90151	Modulation period for engine fan control duty	4.3
90121	Sheave ratio (fraction)	0.53
90081	Variable speed operation maximum engine speed	2,611
90091	Variable speed operation minimum engine speed	2,006

OPERATION

- The default state of the fan is ON. B+ is needed to turn the fan OFF.
- EIM X1-18 controls the fan by supplying a B+ PWM signal.
- EIM X2-2 is feedback for the fan speed.





Fan Hub Assembly Connector	EPA07 Chassis Connector 6420 Backside	EPA07 Chassis Connector 6420 Front side

HARNESS RE-ROUTE PROCEDURE

Wiring on the Horton Stratis Fan Hub has shown to be rubbing, causing DTC codes. Re-routing of the wiring harness before a failure will prevent future failures, re-routing after a failure will prevent multiple failures.

SYMPTOMS

Low Power, Erratic Fan Engagement, No Fan Engagement, Vref 4 DTC

NOTE: The Assembly Plants installed a **NEW** lower clip in production on the following dates and will **NOT** require modifications:

- SAP (Springfield Assembly Plant) 02/28/2013
- GAP (Garland Assembly Plant) 02/28/2013
- EAP (Escobedo Assembly Plant) 03/06/2013

RESOLUTION

Inspect the wiring harness; if wires are exposed, repair the fan hub harness and install sheathing (do NOT replace the fan hub), re-route the harness as indicated in the pictures below. If the outside sheathing is rubbed through but not to the wires, insulate the harness sheathing and re-route the harness, replacement of the fan hub is not necessary. Re-route the harness to eliminate future failures on any replaced fan hubs.

ISSUE AND CORRECTION PICTURES

The fan clutch harness can rub on the fan wiring harness bracket and cause intermittent fault codes. Some of the symptoms can include: Low Power, Erratic Fan Engagement, No Fan Engagement, or a VREF 4 DTC. This repair will require rerouting the harness, inspecting the harness for abrasions, and repairing the harness if required.

PARTS INFORMATION

Table 1 - Parts Information

Part Number	Description	Quantity
3014391C1	Strap, Tie (Cap)	1
1821643C1 or equivalent	Bolt, Flange, M6 x 25 MM	1
3667668C1 or equivalent	Strap, Lock Cable	1
3544378C1 or equivalent	Nut, Hex M6 (Prevailing Torque)	1

SERVICE PROCEDURE

WARNING: Park vehicle on hard flat surface, turn the engine off, set the parking brake, and block the wheels to prevent the vehicle from moving in both directions. Failure to do so may result in property damage, personal injury, and / or death.

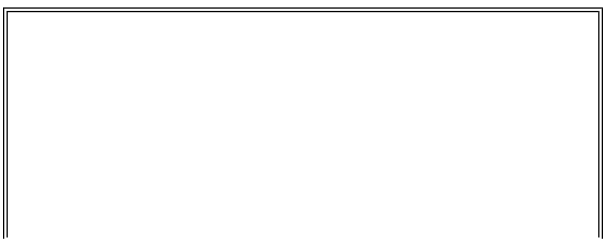
WARNING: If the vehicle must be raised, do not work under the vehicle supported only by jacks. Jacks can slip or fall over, potentially resulting in property damage, personal injury, and / or death.

WARNING: Always wear safe eye protection when performing vehicle maintenance. Failure to do so may result in personal injury and / or death.

WARNING: Keep flames or sparks away from vehicle and do not smoke while servicing the vehicle's batteries. Batteries expel explosive gases. Failure to do so may result in property damage, personal injury, and / or death.

WARNING: Remove the ground cable from the negative terminal of the battery box before disconnecting any electrical components. Always connect the ground cable last. Failure to do so may result in property damage, personal injury, and / or death.

1. Bring truck into shop and park on a flat surface.
2. Shift transmission to park or neutral, set parking brake and install wheel chocks.
3. Unlatch and open hood.
4. Disconnect negative battery cable.



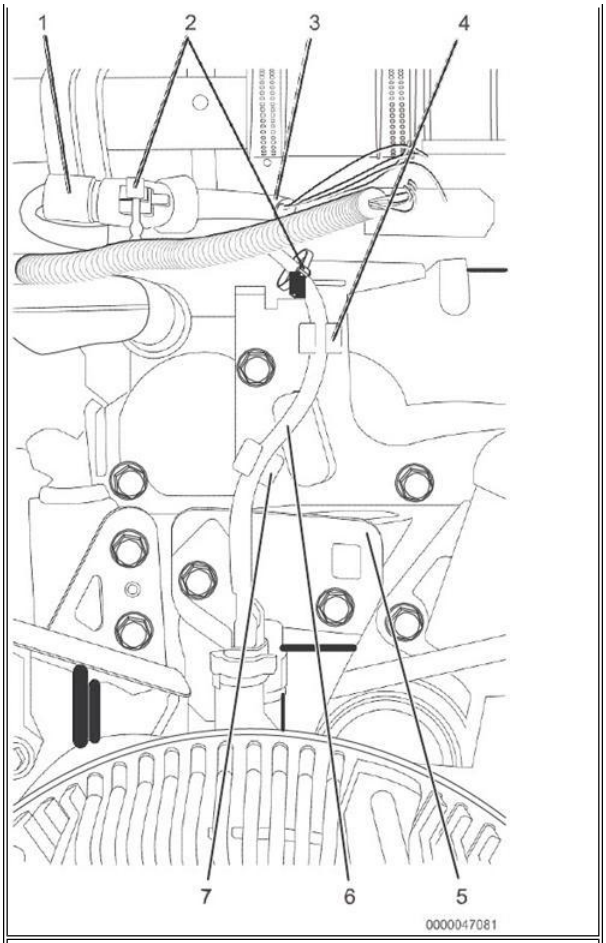


Figure 1. Fan Clutch Harness

1. Fan clutch harness connector
2. Tie Strap (2)
3. Engine harness
4. Push pin (upper)
5. Fan clutch harness bracket
6. Fan clutch harness
7. Push pin (lower)

5. Remove two tie straps (Figure 1, Item 2) securing fan clutch harness (Figure 1, Item 6) to engine harness (Figure 1, Item 3) and fan clutch harness bracket (Figure 1, Item 5). Discard tie straps.
6. Remove harness from upper and lower push pins (Figure 1, Items 4 and 7).
   - a. If secured with two push pins, discard lower push pin (Figure 1, Item 7)
7. Inspect fan clutch harness (Figure 1, Item 6a) for signs of wear from contact with sharp or hard surfaces of harness bracket (Figure 1, Item 5).
   - a. If no damage is observed, proceed to Step 16.
   - b. If insulation chafing is observed or if copper is exposed or damaged, proceed to Step 8.
8. Disconnect harness connector (Figure 1, Item 1).

Figure 2. Primary Lock

9. Using needle nose pliers, remove primary lock from fan clutch harness connector (Figure 2).

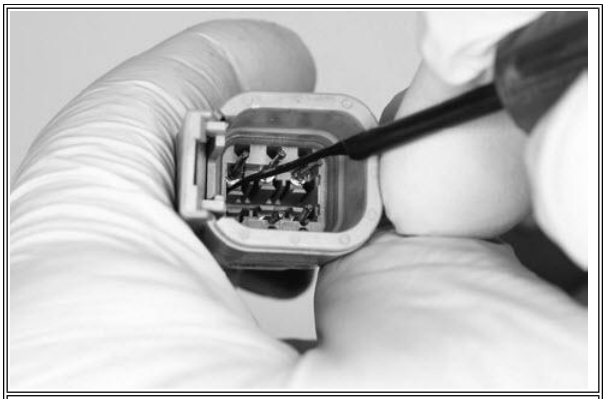


Figure 3. Terminal Lock

NOTE: To aid installation, label all wires before terminal removal.

10. Using pick tool or small flathead screwdriver, remove terminal wires by depressing each terminal lock while pulling corresponding wire out through rear of connector (Figure 3).
11. If damage to copper wiring in fan clutch harness was observed in step 6b, repair fan clutch harness following IK0800269 - Proper Wire Repair before proceeding to Step 12.

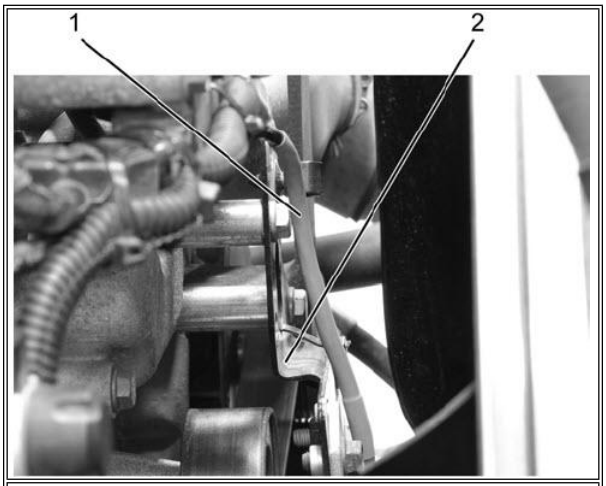


Figure 4. Fan Clutch Harness with Heat Shrink

1. Fan clutch harness with heat shrink installed
2. Fan clutch harness bracket

NOTE: When adding heat shrink, ensure heat shrink does not force the harness to any pre-existing form.

12. Install self-sealing dual wall heat shrink on damaged or repaired area of harness (Figure 4, Item 1).

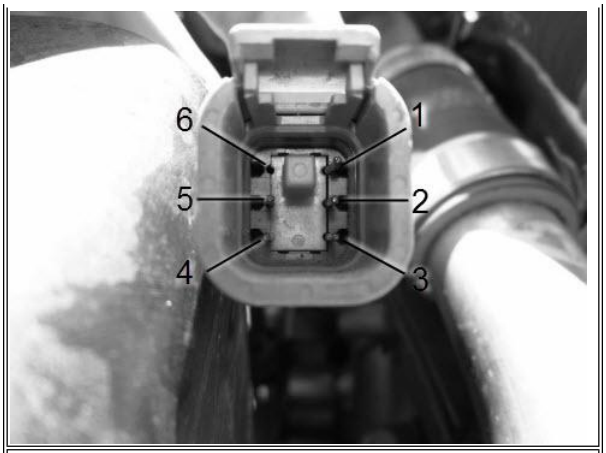


Figure 5. Pin Location Map (Front View)

1. Brown wire
2. Red wire
3. Grey wire
4. Blue wire
5. Green wire
6. Empty

13. Install wires into terminals in fan clutch harness connector following pin location map (Figure 5).

NOTE: If wires are installed incorrectly, fan clutch may run continuously.

14. Make sure wires are correctly installed and locked in place by performing pull test, then install primary lock.
15. Connect fan clutch harness connector to engine harness connector.

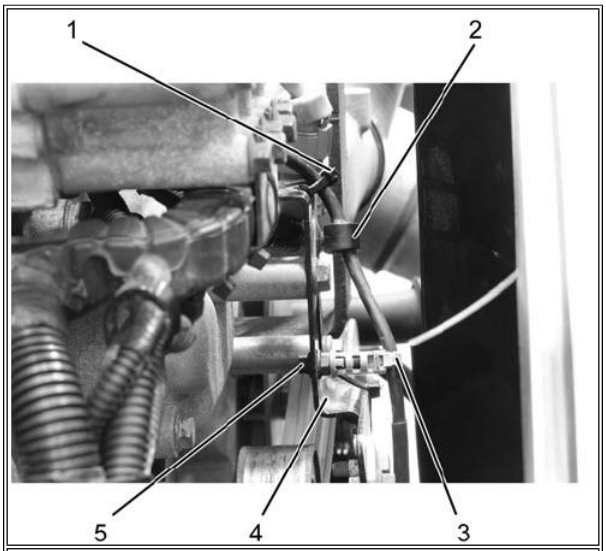


Figure 6. Fan Clutch Harness Reroute

1. Tie strap
2. Push pin (upper)
3. Stud cap tie strap
4. Fan clutch harness bracket
5. M6 x 25 mm bolt and nut

16. Install M6 x 25 mm bolt (Figure 6, Item 5) into fan clutch harness bracket (Figure 6, Item 4), then install M6 prevailing torque nut to bolt and tighten nut to 80 lb-in (9 N•m).
17. Loosely secure fan clutch harness with stud cap tie strap (Figure 6, Item 3) before securing stud cap tie strap to bolt (Figure 6, Item 5). Tighten tie strap when cap is secured to bolt.
18. Remove slack from fan clutch harness, and install harness in upper push pin (Figure 6, Item 2). Verify proper clearance between fan clutch harness and fan clutch harness bracket.

NOTE: When securing harness to bracket with tie strap, ensure harness does not contact any sharp edges.

19. Secure fan clutch harness to fan clutch harness bracket with tie strap (Figure 6, Item 1) above upper push pin location (Figure 6, Item 2).

20. Connect negative battery cable.
21. Start engine to verify proper operation and no fault codes present.
22. Close and latch hood.
23. Remove wheel chocks.

For a printable version of these instructions CLICK HERE

FAN ENGAGES PREMATURELY

Engine fan engages before the programmed fan on temperature. If the fan is engaging from a temperature sensor, the engagement will be very consistent. Intermittent or erratic fan operation will most likely be caused by a wiring issue. Keep in mind if a temperature sensor has a wiring issue, it could read excessively high intermittently and cause erratic fan operation.

DIAGNOSTICS

1. Verify the air conditioning is not requesting the fan on.
2. Monitor the temperatures of all engine temperature sensors. The fan will engage if an engine temperature sensor is reading excessively high.
3. Monitor ECT2, if the engine cooling system is working properly, ECT2 should be approximately 20°F cooler than ECT1 under full engine load. The engine fan will engage for ECT2 at 194°F, and an EGR over temperature fault will be set when ECT2 reaches 204°F
4. If the fan is engaging from high temps on ECT2, further diagnostics on the Coolant Control Valve (CCV) and Low Temperature Radiator (LTR) will be needed. Refer to the appropriate engine diagnostic manual.
5. If further assistance is needed in troubleshooting the issue, follow IK0800374 and get a Helios capture with the engine running and the complaint present. Attach the Helios capture to your case file. This capture can be reviewed to see why the ECM is turning the fan on.

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