

F150 3.5L EcoBoost Cooling Fan Relay Logic

By: 52merc (F150forum)
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Introduction

There are two cooling fans for the 3.5L GDTI EcoBoost engine in the F150. These fans operate at two different speeds, a low and a high. The fans operate at low speed until engine parameters monitored by the PCM (Powertrain Control Module) triggers the fans to operate at high speed. The fans are controlled by the PCM and three Engine Cooling Fan Relays located in the BJB (Battery Junction Box). The PCM provides the appropriate solenoid grounds to provide the desired fan motor speeds. The circuits are designed such that a failure of the PCM controls results in both fan motors operating at high speed.

The PCM monitors a host of parameters to determine Engine Cooling Fan Motor speeds. This document does not address the logistics used by the PCM to determine the fan motor speeds.

Electrical circuit labels and wiring colours are shown for a MY2016 F150. Other Model Years may vary from those shown in this document.

Cooling Fan Relays

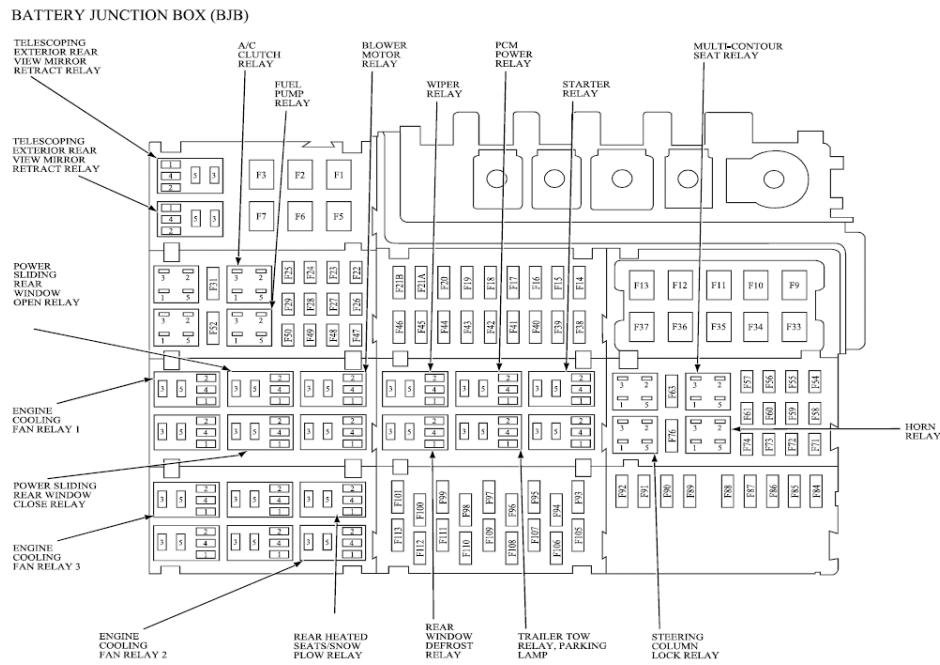
The PCM controls the Cooling Fan Relays with two circuits by switching the relay solenoids to a ground provided by the PCM. These two circuits are labelled as follows:

1. LFC – Low Fan Control
2. HFC – High Fan Control

The Battery Junction Box has three Engine Cooling Fan Relays which are SPDT Micro ISO relays as follows:

1. Engine Cooling Fan Relay 1 – This relay is utilized as a SPST relay in a make-break circuit and is controlled by the PCM LFC circuit.
2. Engine Cooling Fan Relay 2 – This relay is utilized as a SPDT relay in a change-over circuit and is controlled by the PCM HFC circuit.
3. Engine Cooling Fan Relay 3 – This relay is utilized as a SPST relay in a make-break circuit and is controlled by the PCM HFC circuit.

The following diagram shows the location of the Engine Cooling Fan Relays in the BJB.



Cooling Fan Relay 1

The electrical circuits for this relay are as follows:

Pin No.	Circuit Label	Wire Colour	Description
1	CBK03	GY	BJB Fuse-97 (10 A) Hot in Start/Run Solenoid Power [VPWR]
2	CEC02	GN-BU	PCM Low Fan Control Switched Solenoid Ground [LFC]
3	SBB37	GY-RD	BJB Fuse-37 (50 A) Hot at All Times Power [VBATT]
4	—	—	Not Used
5	CEC05	VT-GY	Switched Power to Engine Cooling Fan Motor 1

Cooling Fan Relay 2

The electrical circuits for this relay are as follows:

Pin No.	Circuit Label	Wire Colour	Description
1	CBK03	GY	BJB Fuse-97 (10 A) Hot in Start/Run Solenoid Power [VPWR]
2	CEC01	WH-BU	PCM High Fan Control Switched Solenoid Ground [HFC]
3	CEC06	YE-OG	Return from Engine Cooling Fan Motor 1
4	CEC08	GN-WH	Switched Engine Cooling Fan Motor 1 Return to BJB Fuse-24 (25 A)
5	CEC05	VT-GY	Switched Power to Engine Cooling Fan Motor 1

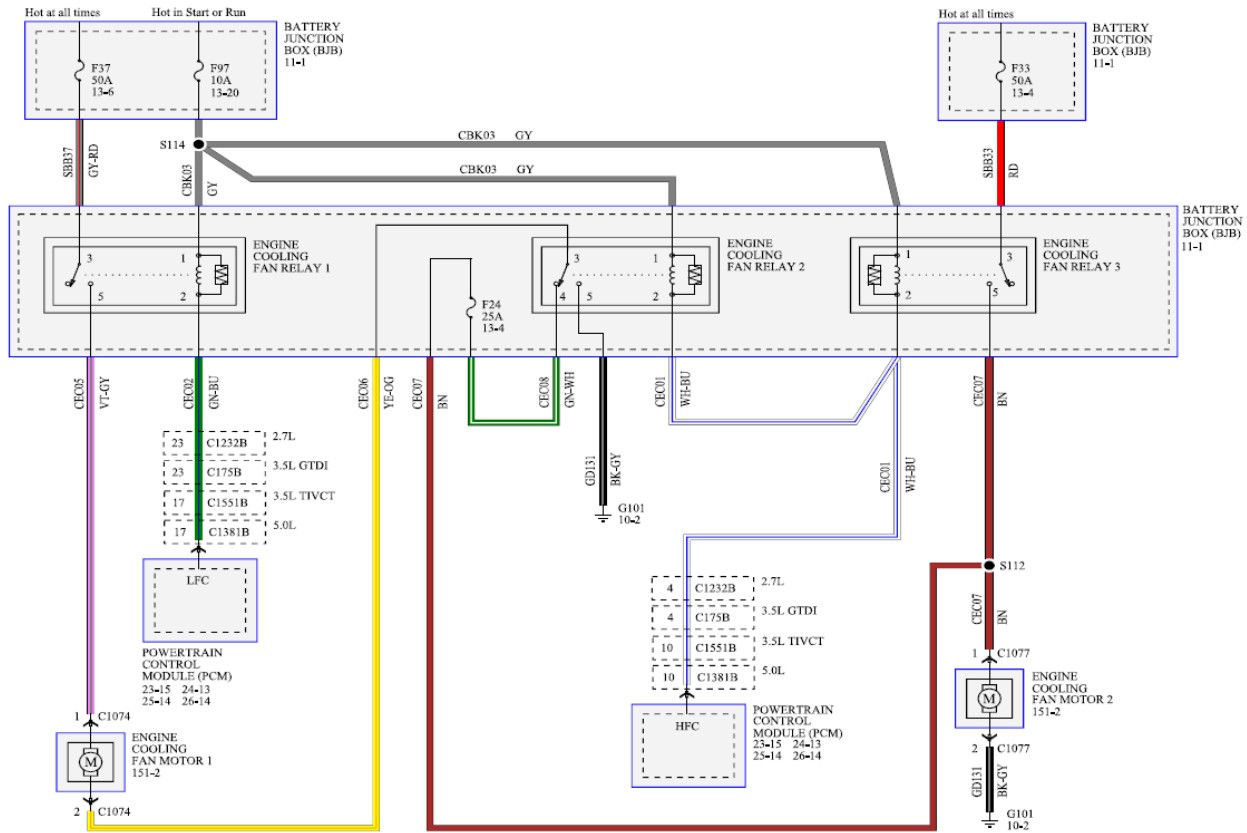
Cooling Fan Relay 3

The electrical circuits for this relay are as follows:

Pin No.	Circuit Label	Wire Colour	Description
1	CBK03	GY	BJB Fuse-97 (10 A) Hot in Start/Run Solenoid Power [VPWR]
2	CEC01	WH-BU	PCM High Fan Control Switched Solenoid Ground [HFC]
3	SBB33	RD	BJB Fuse-33 (50 A) Hot at All Times Power [VBATT]
4	—	—	Not Used
5	CEC07	BN	Switched Power to Engine Cooling Fan Motor 2

Engine Cooling Fan Electrical Schematic

The following is the electrical schematic for the Engine Cooling Fan relays and Engine Cooling Fan Motors.



Low Fan Control

When the PCM issues a LFC circuit CEC02 is grounded, energizing the relay coil in Engine Cooling Fan Relay-1, and closing the contact between Pin-3 and Pin-5. Power from BJB Fuse-37 (50 A) is then supplied to circuit CEC05 which provides power to Engine Cooling Fan Motor-1. Fuse-37 provides over-current protection for Engine Cooling Fan Motor-1. The return side of Engine Cooling Fan Motor-1, circuit CEC06, provides power to Engine Cooling Fan Relay-2. This in turn provides power through the NC Pin-3 to Pin-4

circuit of Engine Cooling Fan Relay-2, and circuit CEC08 provides power to BJB Fuse-24 (25 A). Fuse-24 provides over-current protection for Engine Cooling Fan Motor-2. The output of Fuse-24, circuit CEC07, provides power to Engine Cooling Fan Motor-2. The return side of Engine Cooling Fan Motor-2, through circuit GD131, is grounded to the vehicle chassis. The above results in Engine Cooling Fan Motors 1 and 2 being connected in series. This results in both Fan motors operating at low speed.

During LFC operation, if either Fuse-24, Fuse-37, or Fuse-87 have blown, neither fan motor will operate. If this situation occurs during engine operation the engine temperature will rise enough sufficiently to trigger the PCM to issue an HFC.

High Fan Control

When the PCM issues a HFC circuit CEC01 is grounded, energizing the relay coils in both Engine Cooling Fan Relay 2 and 3. This closes the contact between Pin-3 and Pin-5 of Engine Cooling Fan Relay-2. Engine Cooling Fan Motor-1 return circuit CEC06 is then grounded through circuit GD131. At the same time, Pin-3 to Pin-4 contact is opened, isolating Engine Cooling Fan Motor-1 from Motor-2. This results in Engine Cooling Fan Motor-1 operating on a dedicated circuit at high speed.

At the same time, the contact between Engine Cooling Fan Relay-3 Pin-3 to Pin-5 closes. Power from BJB Fuse-33 (50 A) is supplied to circuit CEC07, which provides power to Engine Cooling Fan Motor-2. The return from Motor-2 is connected to ground through circuit GD131. Fuse-33 provides over-current protection for Engine Cooling Fan Motor-2. The above results in Engine Cooling Fan Motor-2 operating at high speed (as well as Motor-1).

For circuit component failure results, please refer to the following Failure Mode Results section.

Failure Mode Results

The following analysis assumes only a single failure occurs at a time.

Failed Component	PCM	Result Description
BJB Fuse-24 (25 A)	LFC	Both Engine Cooling Fan Motors stop working
	HFC	Both Engine Cooling Fan Motors operate a high speed
BJB Fuse-33 (50 A)	LFC	Both Engine Cooling Fan Motors operate at low speed
	HFC	Engine Cooling Fan Motor-1 operates at high speed Engine Cooling Fan Motor-2 stops working
BJB Fuse-37 (50 A)	LFC	Both Engine Cooling Fan Motors stop working
	HFC	Engine Cooling Fan Motor-1 stops working Engine Cooling Fan Motor-2 operates at high speed
BJB Fuse-97 (10 A)	LFC	Both Engine Cooling Fan Motors stop working
	HFC	Both Engine Cooling Fan Motors stop working
Engine Cooling Fan Relay 1 Solenoid	LFC	Both Engine Cooling Fan Motors stop working
	HFC	Engine Cooling Fan Motor-1 stops working Engine Cooling Fan Motor-2 operates at high speed

Engine Cooling Fan Relay 1 Contacts fail NC	LFC	Both Engine Cooling Fan Motors operate at low speed and do not stop after shutting down engine
	HFC	Both Engine Cooling Fan Motors operate at high speed and both Motors operate at low speed after shutting down engine
Engine Cooling Fan Relay 1 Contacts fail NO	LFC	Engine Cooling Fan Motor-1 stops working
	HFC	Engine Cooling Fan Motor-1 stops working Engine Cooling Fan Motor-2 operates at high speed
Engine Cooling Fan Relay 2 Solenoid	LFC	Both Engine Cooling Fan Motors operate at low speed
	HFC	Engine Cooling Fan Motor-1 stops working Engine Cooling Fan Motor-2 operates at high speed
Engine Cooling Fan Relay 2 Contacts 3-4 fail NC	LFC	Both Engine Cooling Fan Motors operate at low speed and do not stop after shutting down engine
	HFC	Engine Cooling Fan Motor-1 stops working Engine Cooling Fan Motor-2 operates at high speed
Engine Cooling Fan Relay 2 Contact 3-5 fail NC	LFC	Engine Cooling Fan Motor-1 operates at high speed Engine Cooling Fan Motor-2 stops working
	HFC	Both Engine Cooling Fan Motors operates at high speed
Engine Cooling Fan Relay 3 Solenoid	LHC	Both Engine Cooling Fan Motors operate at low speed
	HFC	Engine Cooling Fan Motor-1 operates at high speed Engine Cooling Fan Motor-2 stops working
Engine Cooling Fan Relay 3 Contacts fail NC	LFC	Engine Cooling Fan Motor-1 stops working Engine Cooling Fan Motor-2 operates at high speed and does not stop after shutting down engine
	HFC	Both Engine Cooling Fan Motors operate at high speed and only Motor-1 stops after shutting down engine
Engine Cooling Fan Relay 3 Contacts fail NO	LFC	Both Engine Cooling Fan Motors operate at low speed
	HFC	Engine Cooling Fan Motor-1 operates at high speed Engine Cooling Fan Motor-2 stops working
Engine Cooling Fan Motor 1	LFC	Both Engine Cooling Fan Motors stop working
	HFC	Engine Cooling Fan Motor-1 stops working Engine Cooling Fan Motor-2 operates at high speed
Engine Cooling Fan Motor 2	LFC	Both Engine Cooling Fan Motors stop working
	HFC	Engine Cooling Fan Motor-1 operates at high speed Engine Cooling Fan Motor-2 stops working