Turbocharger

General Equipment

Ford diagnostic equipment

Principles of Operation

The turbocharger is an exhaust-driven centrifugal air compressor. Its purpose is to increase power output by supplying compressed air to the engine.

Expanding exhaust gases drive the turbine shaft assembly to speeds up to 200,000 rpm. Filtered air entering the compressor side of the turbocharger is compressed and delivered through a charge air cooler. The very hot compressed air is cooled by the charge air cooler, then continues on to fill the intake manifold at a higher pressure than atmospheric pressure. Because considerably more air is forced into the intake manifold, the results are increased power, fuel efficiency and the ability to maintain power at higher altitudes.

The turbocharger is governed by a wastegate actuator. The wastegate actuator redirects some of the exhaust gas past the turbine and therefore acts as a governor.

The intake air system is fitted with a turbocharger bypass valve. This vents the intake air system when the throttle is closed and recirculates the air back into the intake air system. It also releases pressure on the turbocharger which will reduce turbo lag and improve acceleration and increase engine performance.

The turbocharger housing is both water and oil cooled. The oil supply also lubricates the turbocharger bearings.

The EcoBoost turbocharger is connected to the cylinder head. This configuration improves engine responsiveness due to the reduced inertia of a small turbocharger. This also leads to an improved turbocharger package and better utilization of heat energy from the compact cylinder head to turbocharger flange. The compact design of the system allows the catalysts to be located very close to the turbocharger outlet for improved emissions.

Inspection and Verification

NOTE: *This section provides mechanical diagnosis of the turbocharger assembly. If there is a MIL illuminated, or a DTC is present, these should be diagnosed prior to performing turbocharger mechanical diagnosis.*

1. For a PCM DTC,
   REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.3L EcoBoost (201kW/273PS), Diagnosis and Testing).
   For driveability symptoms without a DTC, Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. See Section 3 Symptom Charts.

2. Verify the customer concern.

3. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Air cleaner element – Air cleaner intake pipe – Air cleaner outlet pipe – Charge air cooler – Charge air cooler intake pipe – Charge air cooler outlet pipe – Coolant leaks – Oil leaks – Turbocharger coolant return tube – Turbocharger coolant supply tube – Turbocharger housing – Turbocharger intake tube – Turbocharger oil return tube – Turbocharger oil supply tube – Wastegate actuator – Wastegate valve	– Electrical connectors – Powertrain control module – Turbocharger bypass valve – Wastegate actuator – Wiring harnesses

4. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.

5. If the concern is not visually evident, verify the symptom and refer to the Diagnostic Tab in the Ford diagnostic equipment.

Symptom Chart

Symptom	Possible Sources	Action
• Loss of power/performance	• Clogged air cleaner element	• INSTALL a new air cleaner element. • TEST the system for normal operation.
	• Loose connections or damage to air intake hoses and tubes	• INSPECT for damage. • TIGHTEN the hose clamps. • REPAIR as needed.
	• Malfunctioning fuel system	• Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.
	• Poor fuel quality	• DRAIN the fuel. REFER to: Fuel Tank Draining (310-00 Fuel System - General Information - 2.3L EcoBoost (201kW/273PS), General Procedures). • FILL with fresh fuel.
	• Engine wear (piston rings, valve guides)	• REPAIR as needed. REFER to: Engine (303-00 Engine System - General Information, Diagnosis and Testing).

	• Turbocharger turbine or compressor wheel damage	• INSPECT the turbocharger. • REFER to the Check for Free Rotation — On Vehicle below.
	• Damaged exhaust or exhaust leaks at turbocharger housing	• INSPECT for leaks. Leaks can usually be detected audibly or visually, by a discoloration caused by escaping hot exhaust gases. • REPAIR as needed.
	• Malfunctioning turbocharger bypass valve	• Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.
	• Obstructed wastegate actuator linkage	• INSPECT the turbocharger wastegate linkage for obstructions. • REPAIR as needed.
	• Damaged wastegate actuator linkage	• INSPECT the turbocharger wastegate linkage for damage. • INSTALL a new turbocharger as needed. • REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.3L EcoBoost (201kW/273PS), Removal and Installation).
	• Wastegate actuator operation	• TEST the wastegate actuator operation. Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.
	• PCM — DTC	• REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.3L EcoBoost (201kW/273PS), Diagnosis and Testing).

Symptom	Possible Sources	Action
• Excessive oil consumption	• Incorrect type or grade of oil	• DRAIN the oil. • FILL with specified oil. REFER to: Specifications (303-01 Engine - 2.3L EcoBoost (201kW/273PS), Specifications).
	• Oil in the cylinder head to turbocharger flange	• REPAIR as needed.
	• Clogged air cleaner element	• INSTALL a new air cleaner element. • TEST the system for normal operation.
	• Blocked or restricted turbocharger oil return tube	• INSPECT the turbocharger oil return tube. • REPAIR as needed. REFER to: Turbocharger Oil Return Tube (303-04B Fuel Charging and Controls - Turbocharger - 2.3L EcoBoost (201kW/273PS), Removal and Installation).
	• Damaged or collapsed air intake hoses and tubes	• INSPECT for damage. • TIGHTEN the hose clamps. • REPAIR as needed.
	• Damaged exhaust or	• INSPECT for leaks. Leaks can usually be

	exhaust leaks at turbocharger housing to cylinder head	detected audibly or visually, by a discoloration caused by escaping hot exhaust gases. • REPAIR as needed.
	• Turbocharger oil seals leaking	• REFER to Turbocharger Internal Oil Leak Test below.
	• Damaged crankcase ventilation system	• Visually INSPECT the crankcase ventilation system. • REPAIR as needed.

Symptom	Possible Sources	Action
• Excessive noise	• Turbocharger compressor air intake pipe leaking	• INSPECT for damage. • TIGHTEN the hose clamps. • REPAIR as needed.
	• Loose connections or damage to air intake hoses and tubes	• INSPECT for damage. • TIGHTEN the hose clamps. • REPAIR as needed.
	• Air leaks at turbine housing, blown joints or damaged exhaust	• INSPECT for leaks. Leaks can usually be detected audibly or visually, by a discoloration caused by escaping hot exhaust gases. • REPAIR as needed.
	• Carbon build up in the turbine housing causing contact with turbine wheel	• INSPECT the turbocharger. • REFER to the Check for Free Rotation — On Vehicle below.
	• Turbocharger imbalance due to foreign object/damage	• INSPECT the turbocharger. • REFER to the Check for Free Rotation — On Vehicle below.
	• Turbine bearing failure	• INSPECT the turbocharger. • REFER to the Check for Free Rotation — On Vehicle below.
	• Inoperative turbocharger bypass valve	• Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.

Symptom	Possible Sources	Action
• Engine emits excessive smoke (black/blue/white)	• Clogged air cleaner element	• INSTALL a new air cleaner element. • TEST the system for normal operation.
	• Incorrect type or grade of oil	• DRAIN the oil. • FILL with specified oil. REFER to: Specifications (303-01 Engine - 2.3L EcoBoost (201kW/273PS), Specifications).
	• Blocked or restricted turbocharger oil return tube	• INSPECT the turbocharger oil return tube. • REPAIR as needed. REFER to: Turbocharger Oil Return Tube (303-04B Fuel Charging and Controls - Turbocharger - 2.3L EcoBoost (201kW/273PS), Removal and Installation).

	• Damaged/restricted or leaking turbocharger compressor air intake pipe	• INSPECT for damage. • TIGHTEN the hose clamps. • REPAIR as needed.
	• Engine wear (piston rings, valve guides)	• REPAIR as needed. REFER to: Engine (303-00 Engine System - General Information, Diagnosis and Testing).
	• Plugged crankcase ventilation system	• Visually INSPECT the crankcase ventilation system. • REPAIR as needed.
	• Turbocharger oil seals leaking	• REFER to Turbocharger Internal Oil Leak Test below.

Symptom	Possible Sources	Action
• External oil leaks or oil tube leaks	• Turbocharger oil tube seals and/or oil tube leaking	• Visually INSPECT the turbocharger oil tubes and the turbocharger oil tube seals/gaskets. • REPLACE the turbocharger oil tube seals/gaskets and the turbocharger oil tubes as needed. • REFER to: Turbocharger Oil Return Tube (303-04B Fuel Charging and Controls - Turbocharger - 2.3L EcoBoost (201kW/273PS), Removal and Installation). REFER to: Turbocharger Oil Supply Tube (303-04B Fuel Charging and Controls - Turbocharger - 2.3L EcoBoost (201kW/273PS), Removal and Installation).

Symptom	Possible Sources	Action
• External coolant leaks or coolant tube leaks	• Turbocharger coolant tube seals and/or coolant tube leaking	• Visually INSPECT the turbocharger coolant tubes and the turbocharger coolant tube seals/gaskets. • REPLACE the turbocharger coolant tube seals/gaskets and the turbocharger coolant tubes as needed. • REFER to: Turbocharger Coolant Return Tube (303-04B Fuel Charging and Controls - Turbocharger - 2.3L EcoBoost (201kW/273PS), Removal and Installation). REFER to: Turbocharger Coolant Supply Tube (303-04B Fuel Charging and Controls - Turbocharger - 2.3L EcoBoost (201kW/273PS), Removal and Installation).

Component Tests

Turbocharger Internal Oil Leak Test

NOTE: *It is normal for a small amount of combustion gas to pass into the crankcase. This gas is scavenged into the air intake system through the positive crankcase ventilation system, which incorporates an crankcase vent oil separator that is part of the valve cover. Some engine oil, in the form of a vapor is carried into the air intake system with the blow-by gases (this engine oil also contributes to valve seat durability).*

This means that oil will collect inside the air intake components and the turbocharger. This is not an indication that the turbocharger oil seal has failed. The turbocharger oil seal will generally not fail unless the bearings fail first, which will cause the turbocharger to become noisy or seize. Do not install a new turbocharger due to oil inside the turbocharger or the air intake components. If a leak is detected in the oil supply or return tubes or connections, locate and rectify the source. Do not install a new turbocharger due to an oil leak.

Check the turbocharger compressor inlet for evidence of oil. If excessive oil is present, this indicates that the failure could be in the engine or turbocharger.
REFER to: Engine (303-00 Engine System - General Information, Diagnosis and Testing).
or the following turbocharger check. If excessive oil is found in the turbocharger compressor outlet, check the charge air cooler for oil contamination. If contamination is present, then flush the charge air cooler.
REFER to: Charge Air Cooler (CAC) Cleaning (303-12 Intake Air Distribution and Filtering - 2.3L EcoBoost (201kW/273PS), General Procedures).

Check the turbocharger turbine outlet for evidence of oil. If excess liquid oil is present in the outlet, remove the turbocharger from the engine and examine the oil supply and return passages in the turbocharger, engine block and the turbocharger oil drain tube for restriction.
REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.3L EcoBoost (201kW/273PS), Removal and Installation).

Check for Free Rotation — On Vehicle

NOTE: *The turbocharger must be pre-oiled before carrying out this check.*

NOTE: *Turbine and compressor wheels must spin freely when turned by hand. No housing contact is permitted.*

Inspect the turbocharger compressor and turbine fins for damage. If the compressor or turbine wheel fins are damaged, install a new turbocharger.
REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.3L EcoBoost (201kW/273PS), Removal and Installation).

Rotate the turbocharger shaft, listen for bearing noise and roughness. If there is bearing noise or roughness a install a new turbocharger.
REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.3L EcoBoost (201kW/273PS), Removal and Installation).

Press and rotate the turbocharger shaft. If either the compressor wheel or the turbine wheel contacts the housing, the bearings are bad and a new turbocharger must be installed.
REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.3L EcoBoost (201kW/273PS), Removal and Installation).