
Turbocharger And Charge Air Cooler (CAC) Systems

Turbocharger System

A turbocharger is an exhaust gas driven device used to increase the power output of an engine by the turbocharger compressor increasing the pressure of the air entering the engine. The turbocharger uses exhaust gas energy to drive the turbine connected to the compressor. Compressing the air causes the temperature to increase. The CAC lowers the temperature of compressed air which increases the density of the air before entering the cylinder.

The 6 cylinder engine uses 2 turbochargers in a parallel arrangement with 1 turbine connected to the exhaust of each cylinder bank. This configuration improves engine responsiveness due to the reduced inertia of 2 small rotating assemblies in the place of 1 large rotating assembly while pumping adequate air to achieve the rated power. Emission compliance is achieved by mounting the catalysts very close to the turbo outlet.

The turbocharger bypass valve is used to create a path from the high pressure compressor outlet to the low pressure compressor inlet. This path recirculates airflow to reduce turbocharger lag and prevent unwanted air rush noise from the turbocharger on heavy throttle releases.

The wastegate on the turbocharger turbine side is opened to reduce exhaust gas flow through the turbine when boost pressure is not needed. Either a pneumatic actuator or an electric motor controls the wastegate valve opening. The turbocharger wastegate is controlled by the PCM by either a pulse width modulated (PWM) signal to the turbocharger wastegate regulating valve solenoid or by positive and negative voltage signals to the turbocharger wastegate motor.

The pneumatic wastegate may be pressure or vacuum actuated, and the poppet style wastegate valve could be normally opened or normally closed at idle or low engine airflow conditions depending on vehicle configuration and requirements such as fuel economy and boost performance. The turbocharger wastegate regulating valve solenoid supplies pressure or vacuum to the wastegate actuator to open or close the poppet style wastegate valve.

The turbocharger wastegate motor is an electric stepper motor. The PCM controls the turbocharger wastegate motor to change the position of the actuator linkage open or closed based on various engine airflow conditions depending on vehicle configuration and requirements such as fuel economy and boost performance. The turbocharger wastegate motor also contains an integral position sensor for turbocharger wastegate position feedback to the PCM.

The 6 cylinder pneumatic turbocharger wastegates are coupled by having one control output from the turbocharger wastegate regulating valve solenoid that drives both turbocharger wastegate actuators.

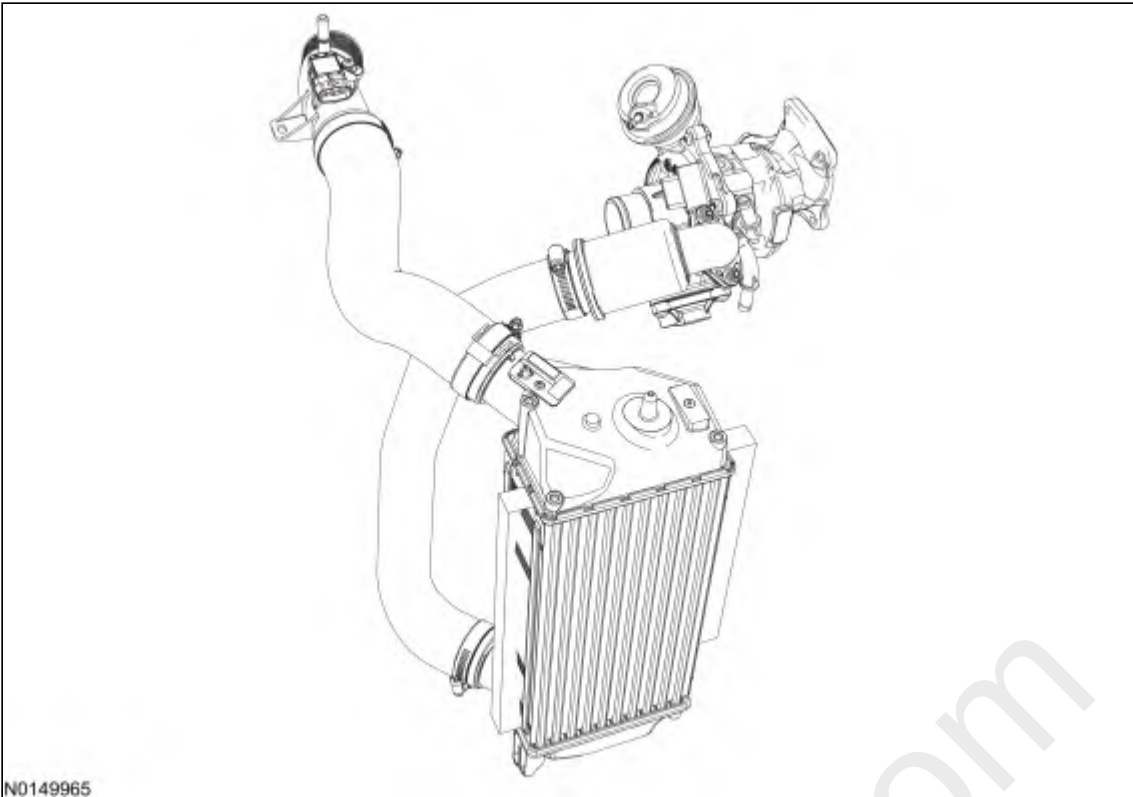
The 6 cylinder electric turbocharger wastegate motors may be controlled independently with separate PCM control circuits for each bank.

The 4 cylinder system uses only 1 turbocharger, 1 turbocharger wastegate and 1 turbocharger bypass valve. The turbocharger bypass valve can be electric or pneumatic and may be mounted in the intake air system or in the turbocharger housing.

The 3 cylinder system uses only 1 turbocharger, 1 turbocharger wastegate and 1 turbocharger bypass valve. The turbocharger bypass valve is mounted in the turbocharger housing and is PCM controlled.

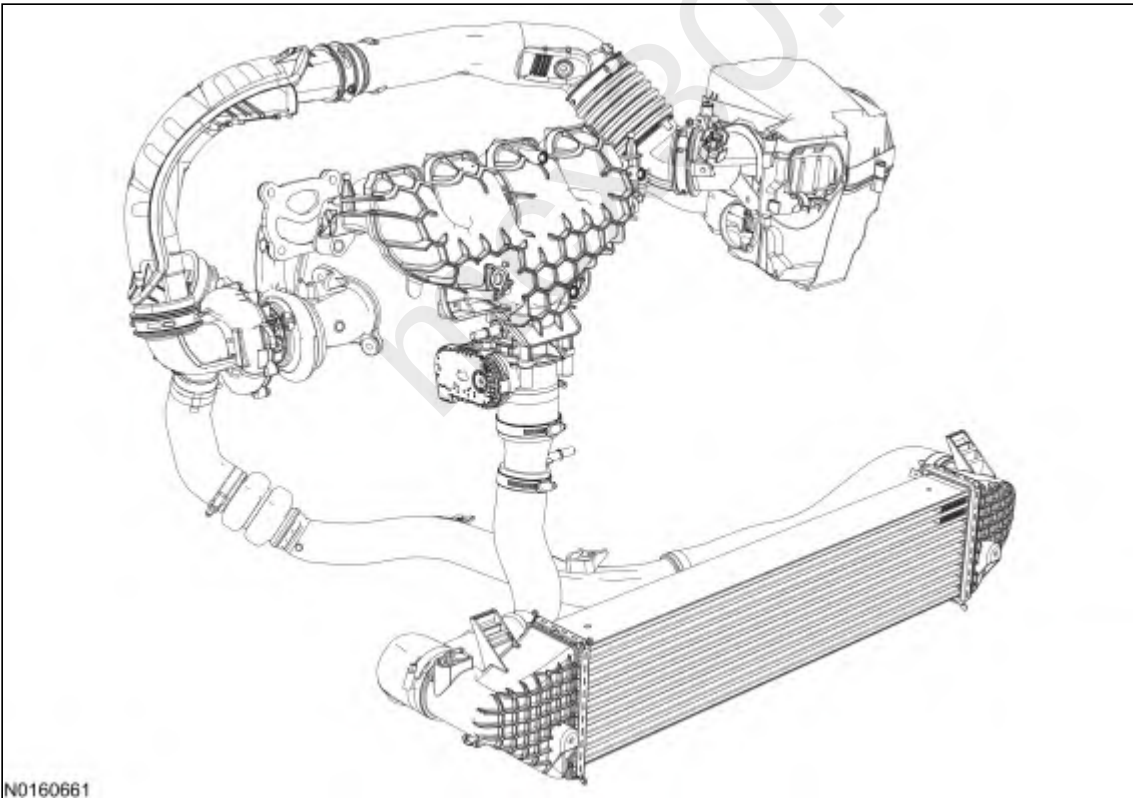
Charge Air Cooler (CAC) System — Air To Air Cooled

The CAC system cools the intake air which has been heated by the turbocharger. The removal of heat from the pressurized air going into the CAC increases the air density which improves combustion efficiency, engine horsepower, and torque. The system consists of a CAC radiator in the grille and tubing to interconnect these components. The CAC is positioned after the turbocharger directly in the flow of the intake air. As the heated air flows through the CAC, it is cooled by the airflow through the grille. The PCM maintains a desirable intake air temperature by monitoring the TCBP/CACT (located at the throttle body) and the MAP/IAT2 (located at the intake manifold) sensors.



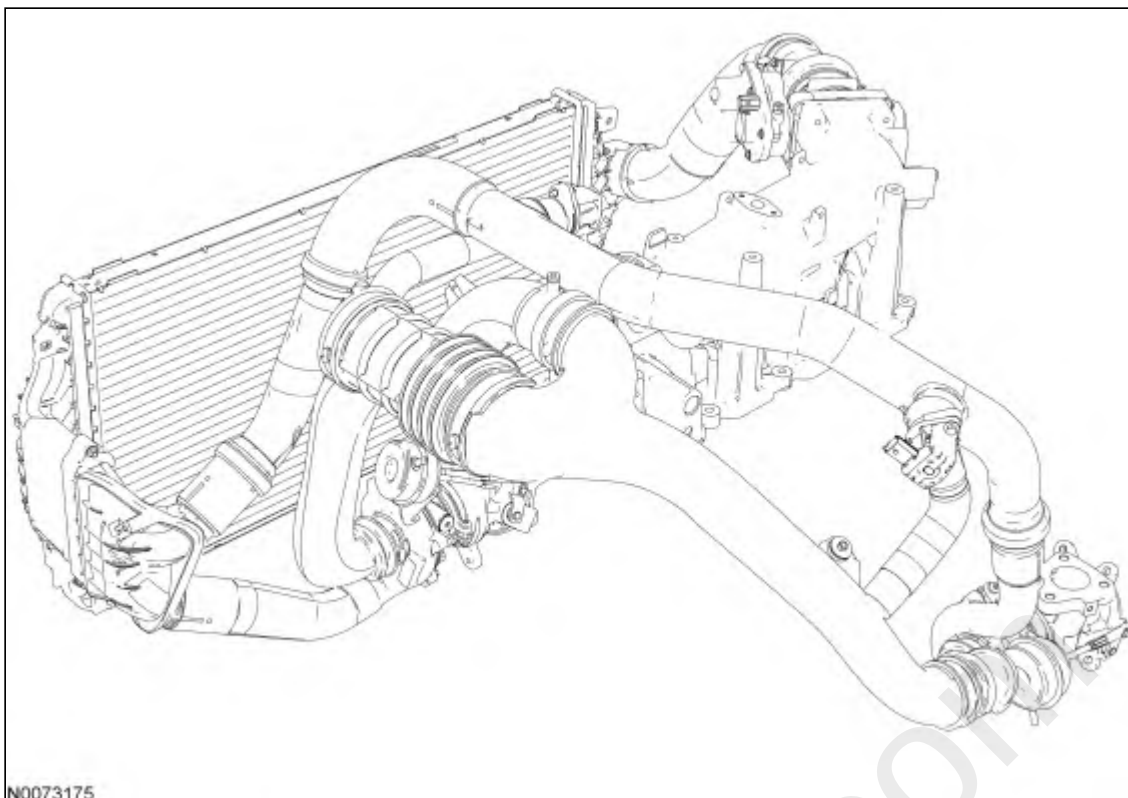
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Typical 3 Cylinder Turbocharger System — Air To Air Cooled



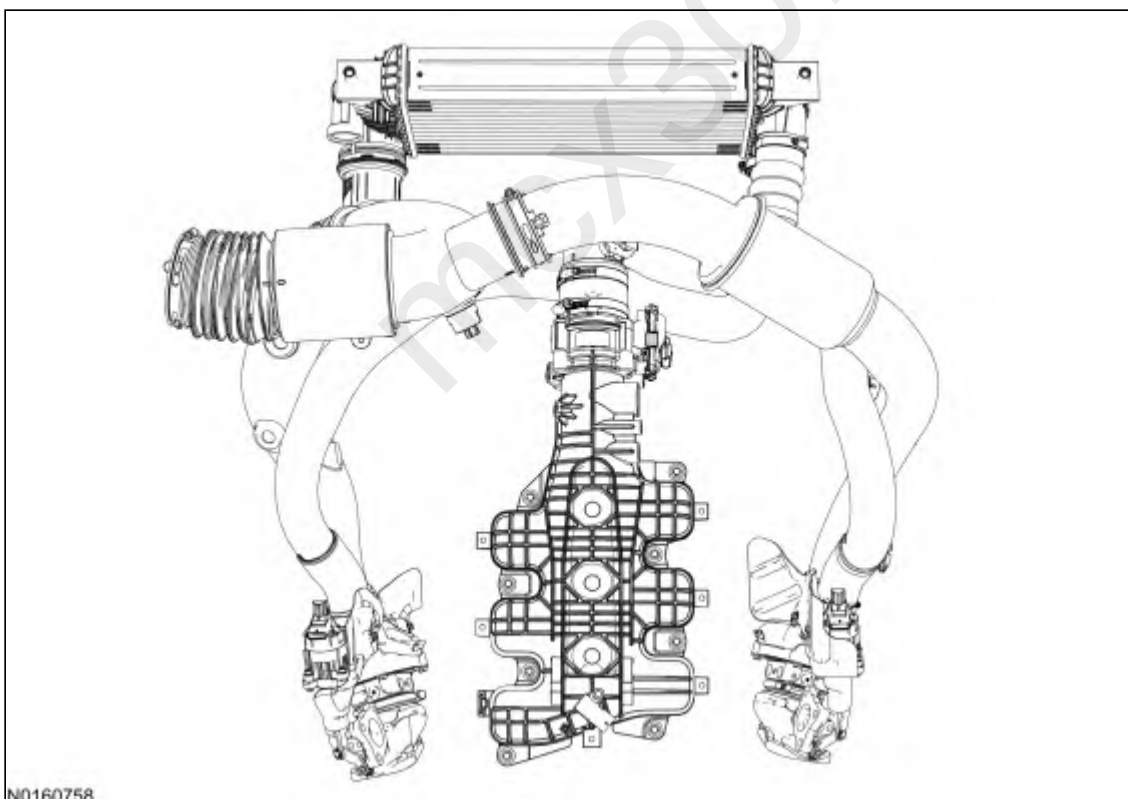
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Typical 4 Cylinder Turbocharger System — Air To Air Cooled



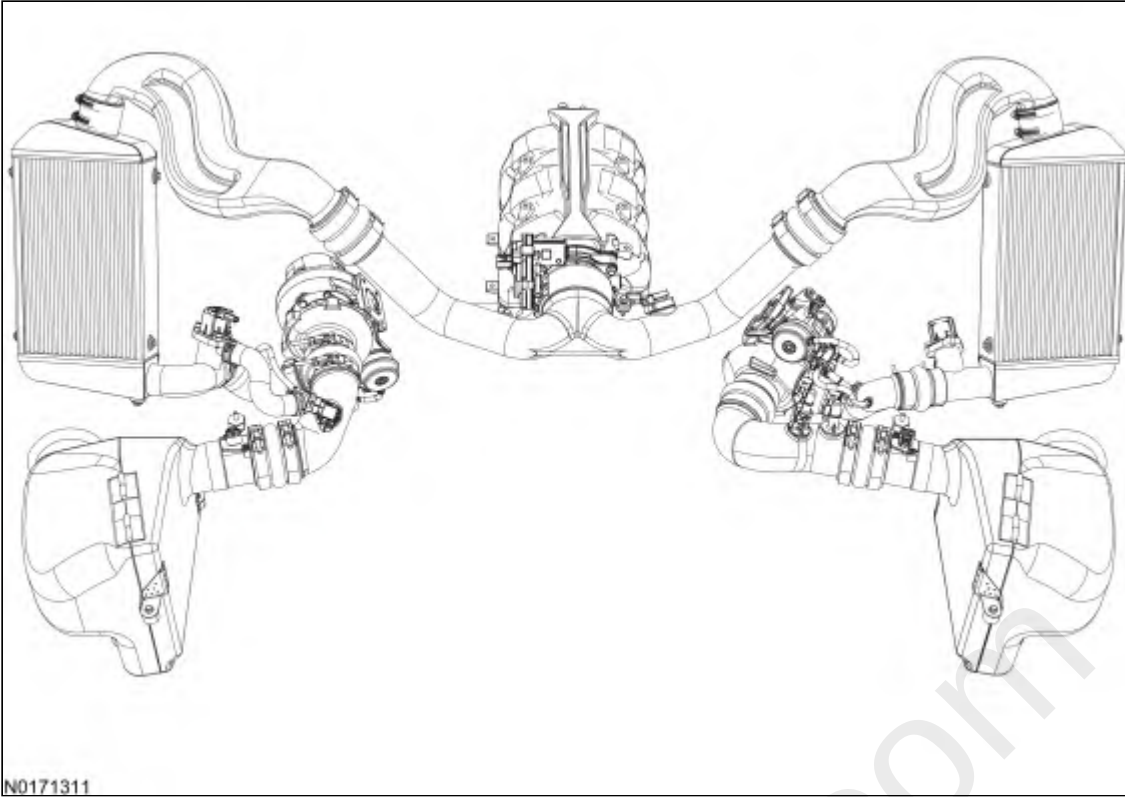
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Typical 6 Cylinder Turbocharger System — Air To Air Cooled (FWD Or AWD)



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Typical 6 Cylinder Turbocharger System — Air To Air Cooled (RWD Or 4WD)

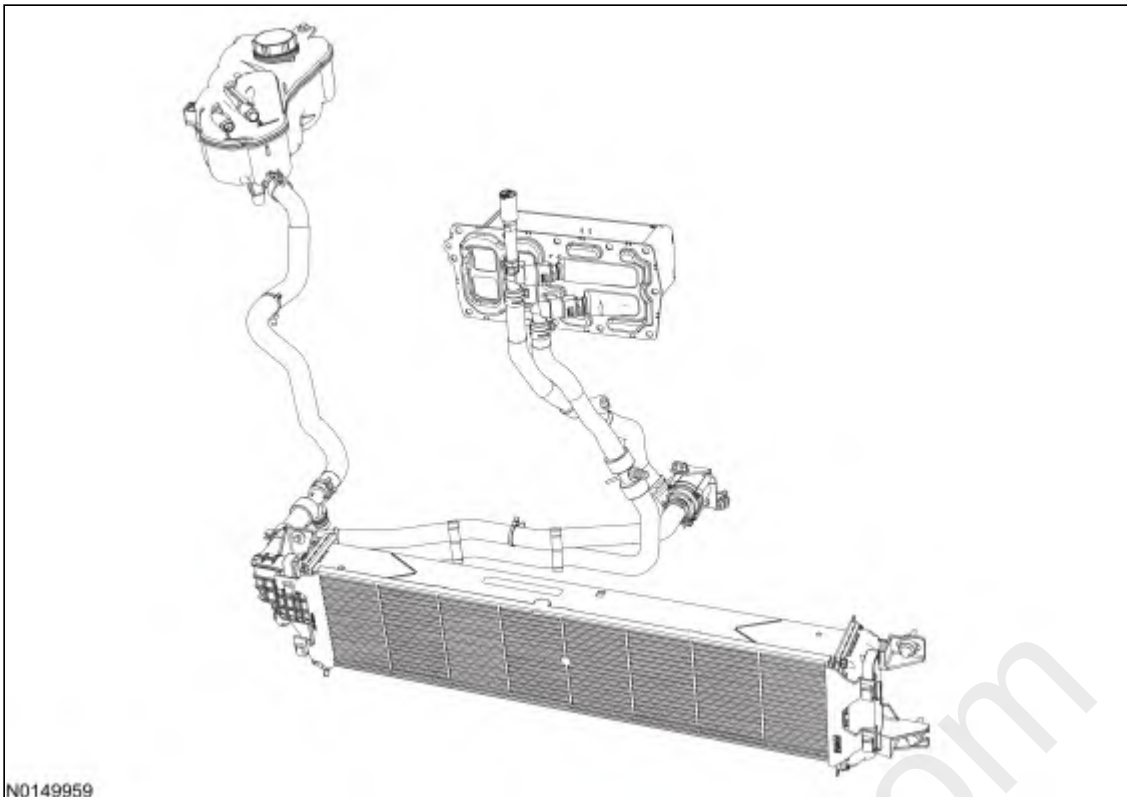


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Ford GT 6 Cylinder Dual Intake Air Turbocharger System — Air To Air Cooled (RWD)

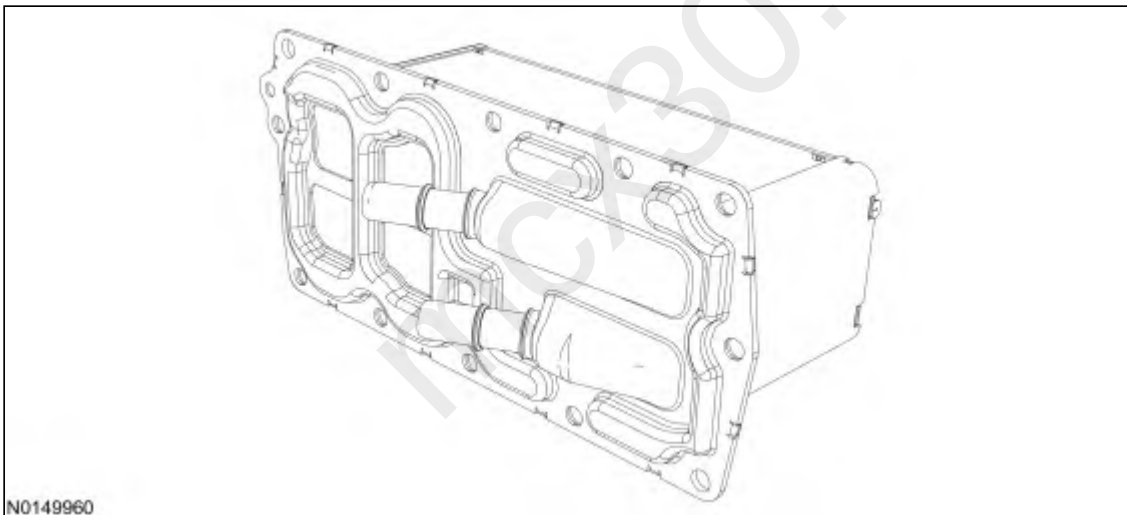
Charge Air Cooler (CAC) System — Air To Liquid Cooled

The CAC system cools the intake air which has been heated by the turbocharger. The removal of heat from the pressurized air going into the CAC increases the air density which improves combustion efficiency, engine horsepower, and torque. The system consists of an additional CAC radiator in the grille, a reservoir, an electric water pump, the CAC located in the intake manifold, and tubing to interconnect these components. The CAC is positioned after the turbocharger directly in the flow of the intake air. As the heated air flows through the CAC, heat is transferred to the coolant which is circulated back to the CAC radiator to be cooled by the airflow through the grille. The CAC pump is controlled by PCM. The PCM maintains a desirable intake air temperature by monitoring the CAC coolant temperature sensor in the CAC radiator.



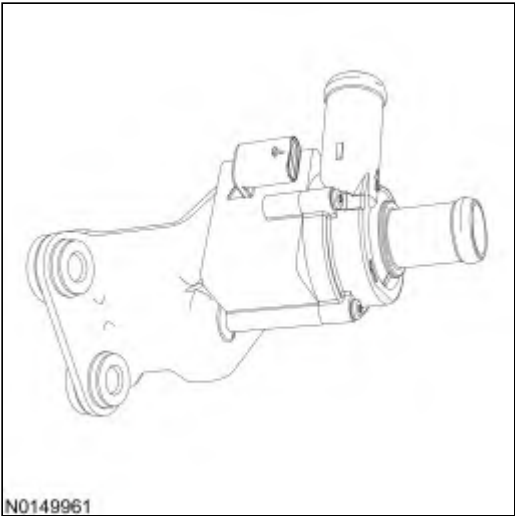
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Typical CAC System — Air To Liquid Cooled



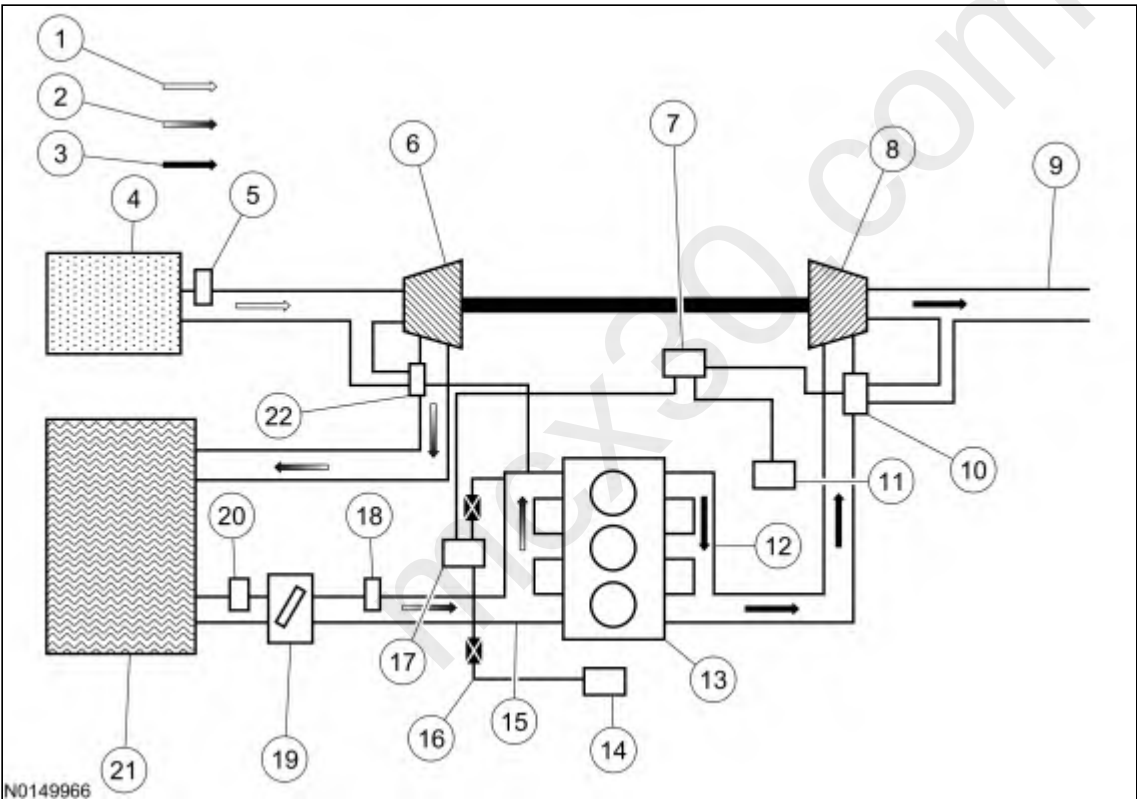
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Typical CAC — Air To Liquid Cooled



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Typical CAC Pump — Air To Liquid Cooled

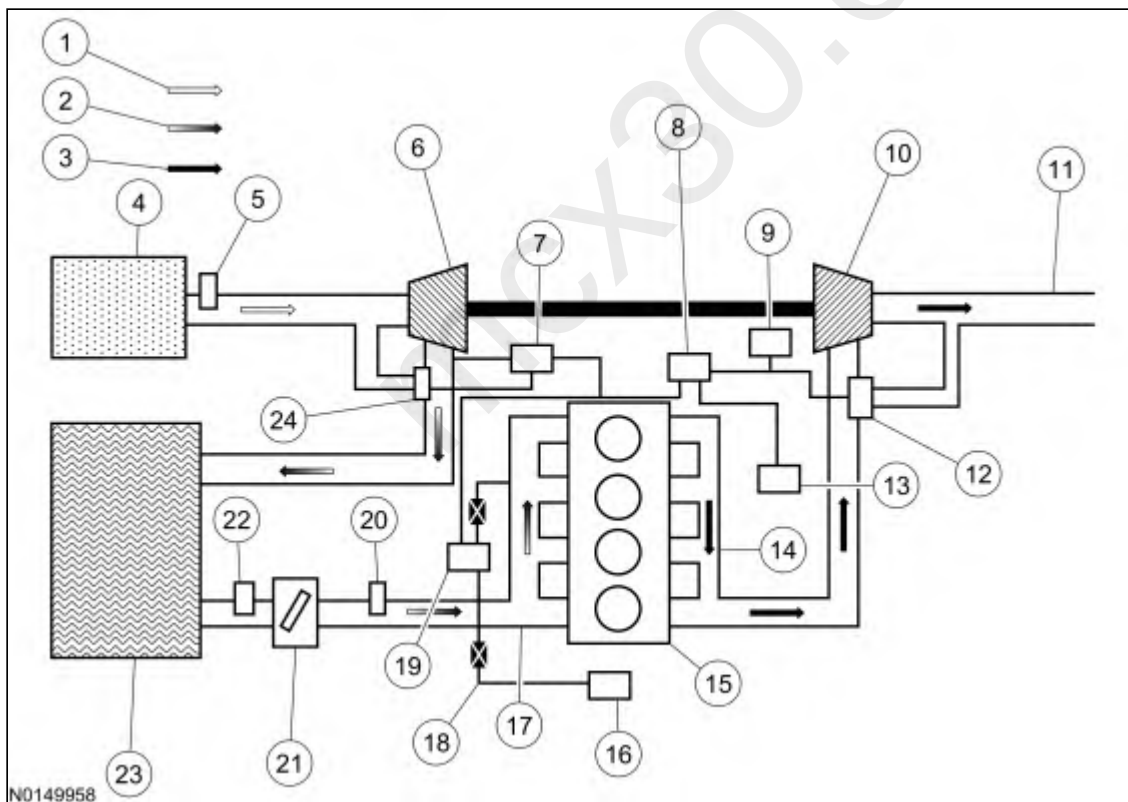


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Typical 3 Cylinder Turbocharger Airflow Diagram — Vacuum Actuated Wastegate

Turbocharger System	Component
1	Intake Air
2	Compressed Air
3	Exhaust Air
4	Air Filter
5	MAF/IAT Sensor (If Equipped)
6	Turbocharger Intake Compressor

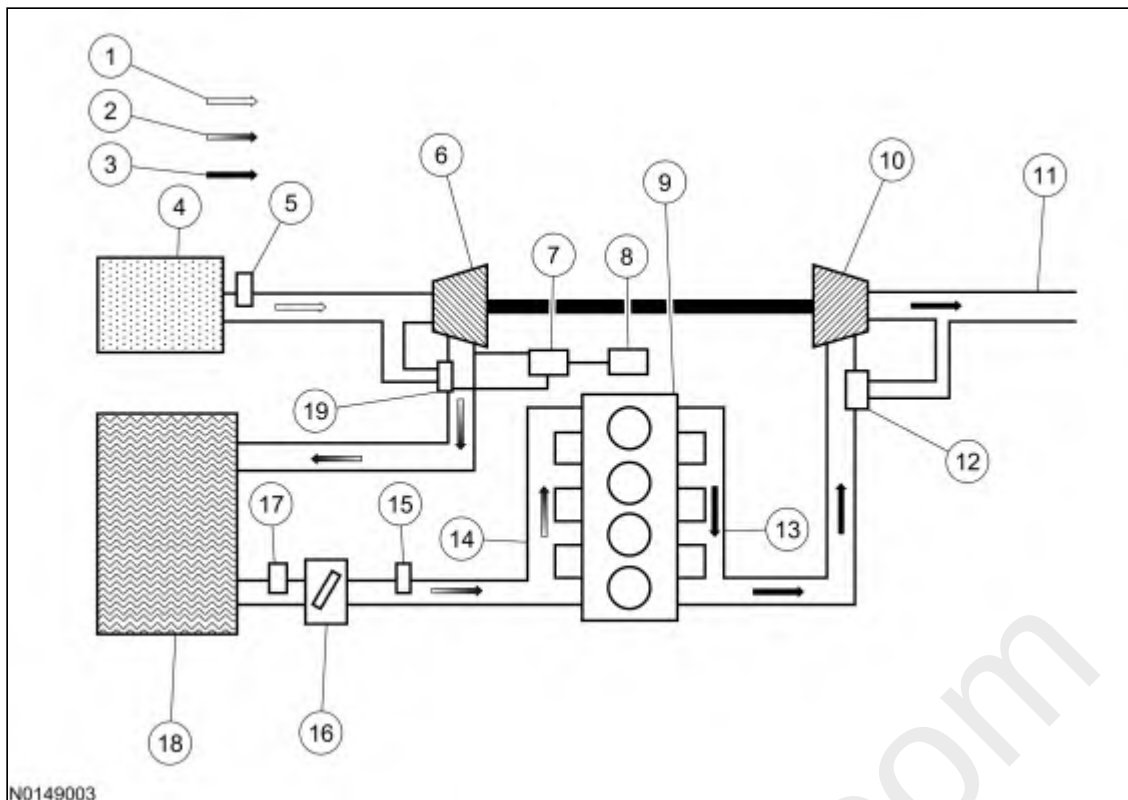
Turbocharger System	Component
7	Turbocharger Wastegate Regulating Valve Solenoid
8	Turbocharger Exhaust Turbine
9	Outlet To Exhaust System
10	Turbocharger Wastegate
11	Turbocharger Wastegate Regulating Valve Solenoid Vent
12	Exhaust Manifold
13	Cylinder Head
14	Vacuum Pump
15	Intake Manifold
16	Vacuum Supply
17	Vacuum Reservoir
18	MAP Sensor
19	Intake Throttle Assembly
20	Turbocharger Boost Pressure/Charger Air Cooler Temperature (TCBP/CACT) Sensor
21	CAC
22	Turbocharger Bypass Valve



Typical 4 Cylinder Turbocharger Airflow Diagram — Vacuum Actuated Wastegate

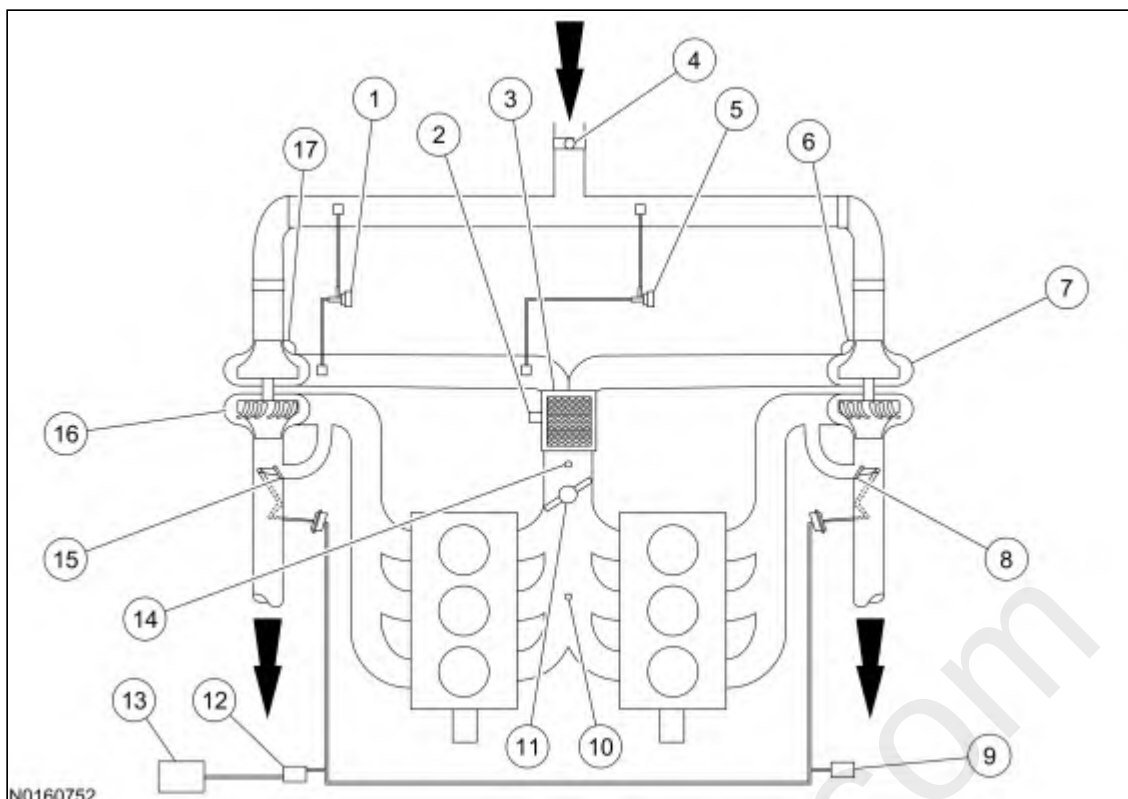
Turbocharger System	Component
1	Intake Air

Turbocharger System	Component
2	Compressed Air
3	Exhaust Air
4	Air Filter
5	IAT Sensor
6	Turbocharger Intake Compressor
7	Turbocharger Bypass Valve Solenoid
8	Turbocharger Wastegate Regulating Valve Solenoid
9	Wastegate Vacuum Sensor
10	Turbocharger Exhaust Turbine
11	Outlet To Exhaust System
12	Turbocharger Wastegate
13	Turbocharger Wastegate Regulating Valve Solenoid Vent
14	Exhaust Manifold
15	Cylinder Head
16	Vacuum Pump
17	Intake Manifold
18	Vacuum Supply
19	Vacuum Reservoir
20	MAP Sensor
21	Intake Throttle Assembly
22	Turbocharger Boost Pressure/Charger Air Cooler Temperature (TCBP/CACT) Sensor
23	CAC
24	Turbocharger Bypass Valve



Typical 4 Cylinder Turbocharger Airflow Diagram — Pressure Actuated Wastegate

Turbocharger System	Component
1	Intake Air
2	Compressed Air
3	Exhaust Air
4	Air Filter
5	IAT Sensor
6	Turbocharger Intake Compressor
7	Turbocharger Bypass Valve Solenoid
8	Vacuum Pump
9	Cylinder Head
10	Turbocharger Exhaust Turbine
11	Outlet To Exhaust System
12	Turbocharger Wastegate
13	Exhaust Manifold
14	Intake Manifold
15	MAP Sensor
16	Intake Throttle Assembly
17	Turbocharger Boost Pressure/Charger Air Cooler Temperature (TCBP/CACT) Sensor
18	CAC
19	Turbocharger Bypass Valve



Typical 6 Cylinder Turbocharger Airflow Diagram

Turbocharger System	Component
1	Turbocharger Bypass Valve Left Bank (Bank 2) (If Equipped)
2	Turbocharger Bypass Valve (Integrated in Charge Air Cooler) (If Equipped)
3	Charge Air Cooler (CAC)
4	Crankcase Pressure (CKCP) Sensor (If Equipped) or Turbocharger Intake Pressure And Temperature (TCIPT) Sensor (If Equipped)
5	Turbocharger Bypass Valve Right Bank (Bank 1) (If Equipped)
6	Turbocharger Bypass Valve Right Bank (TCBY) (Bank 1) (Integrated In Turbocharger) (If Equipped)
7	Turbocharger Right Bank (Bank 1)
8	Wastegate Right Bank (Bank 1)
9	Wastegate Vacuum Sensor (WVS) (If Equipped)
10	Manifold Absolute Pressure/Intake Air Temperature 2 (MAP/IAT2) Sensor
11	Intake Throttle Assembly
12	Turbocharger Wastegate Regulating Valve Solenoid (TCWRVS) (If Equipped)
13	Vacuum Pump (If Equipped)
14	Turbocharger Boost Pressure/Charger Air Cooler Temperature (TCBP/CACT) Sensor
15	Wastegate Left Bank (Bank 2)
16	Turbocharger Left Bank (Bank 2)
17	Turbocharger Bypass Valve Left Bank (TCBY2) (Bank 2) (Integrated In Turbocharger) (If Equipped)

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