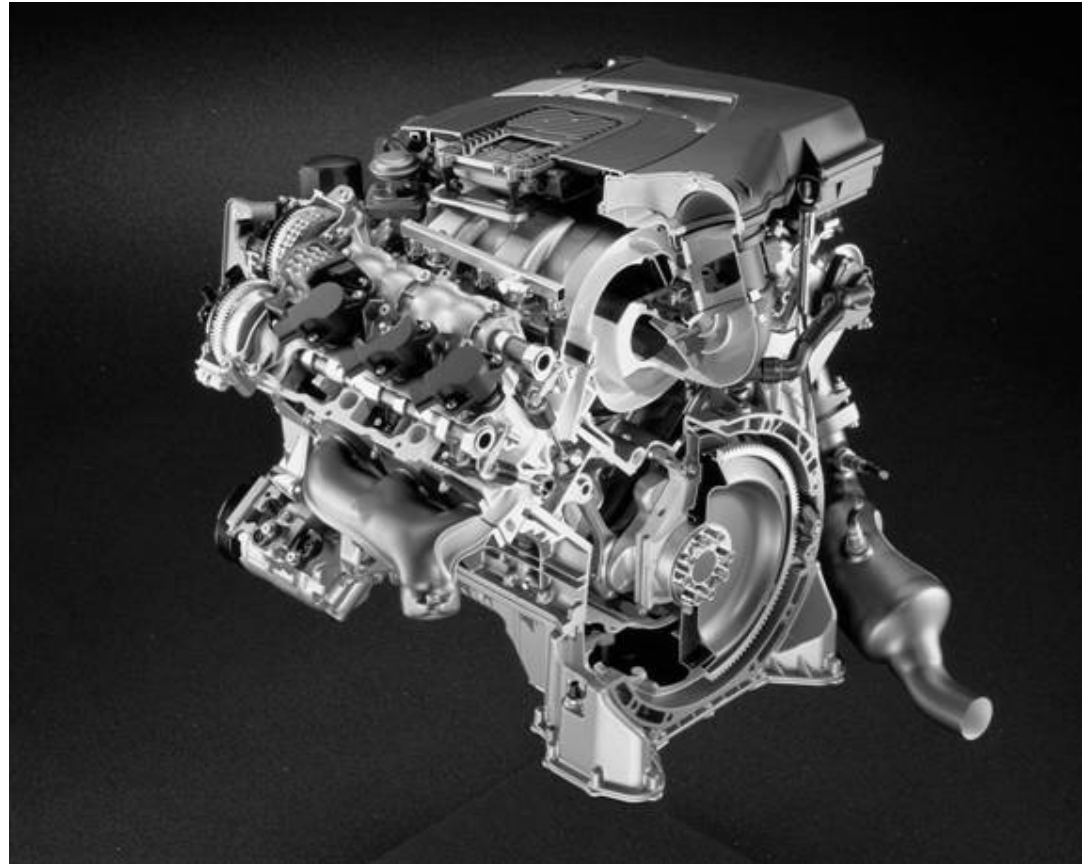




Mercedes-Benz

# M272 Engine



# Objectives

Students will be able to:

- identify differences between M112 and M272
- explain the camshaft adjusters operation
- identify major components of the M272
- explain function of the swirl flaps
- explain function of the temperature management system

# Contents

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# M272 – M112 Comparison

## **M272**

**3.5 litre**

268 hp @ 6000 rpm

258 lb-ft @ 2500 to 5000 rpm

Compression Ratio 10.7 : 1

Sparkplugs per cylinder 1

ME 9.7

Coil On Plug

## **M112**

**3.2 litre**

214 hp @ 5700 rpm

228 lb-ft @ 5700 rpm

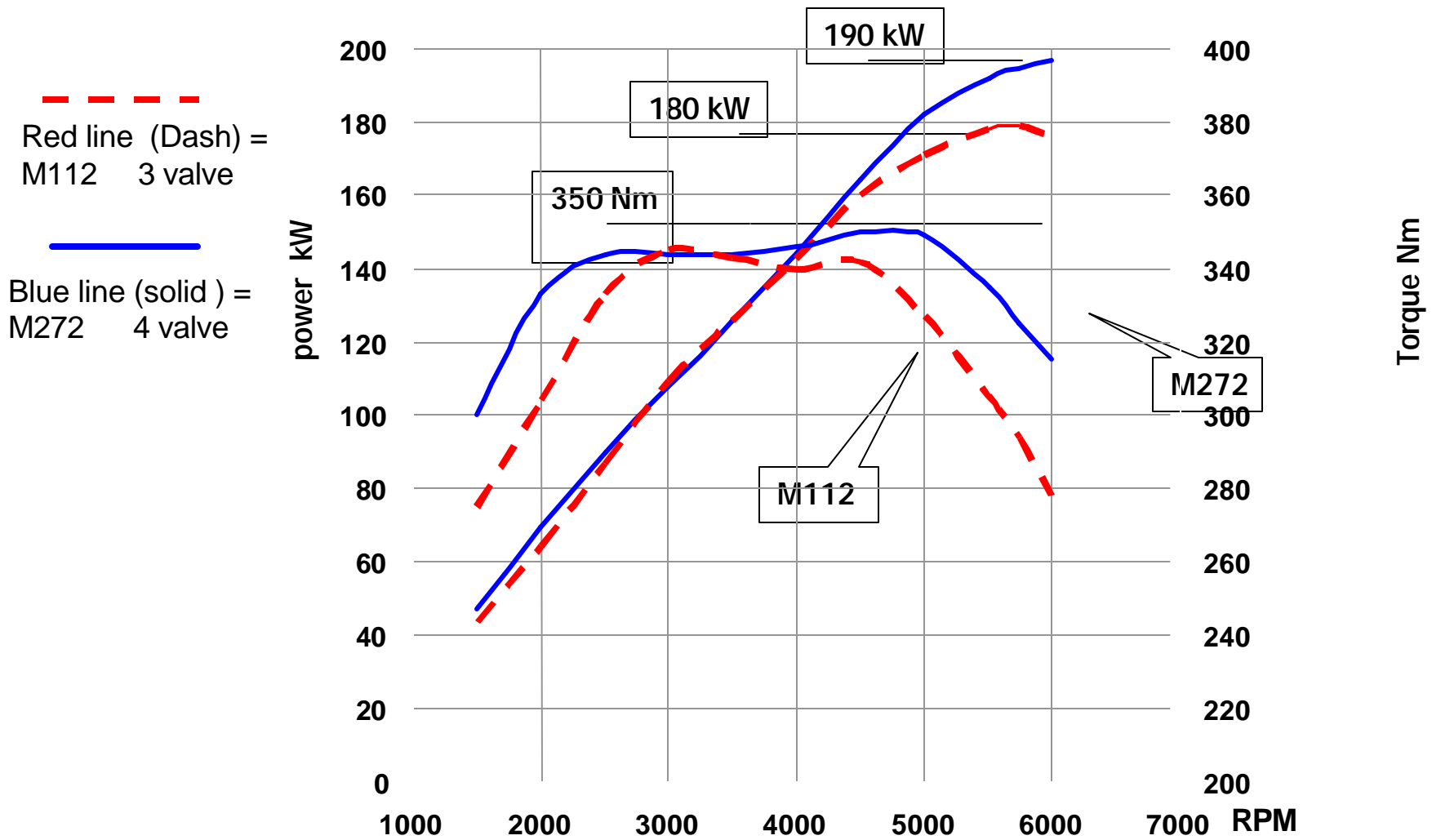
Compression Ratio 10.0 : 1

Sparkplugs per cylinder 2

ME 2.8

Double ignition coils

# Comparison



New M272 introduced in the new SLK 171

Lets look at some highlights

# M272 HighLights

- M112 replacement
- 3.5 litre displacement
- Counter rotating balance shaft
- Stiffer engine with lateral main bearing attachments
- 4 valve continuously variable camshafts intake and exhaust (DOHC)



# M272 HighLights



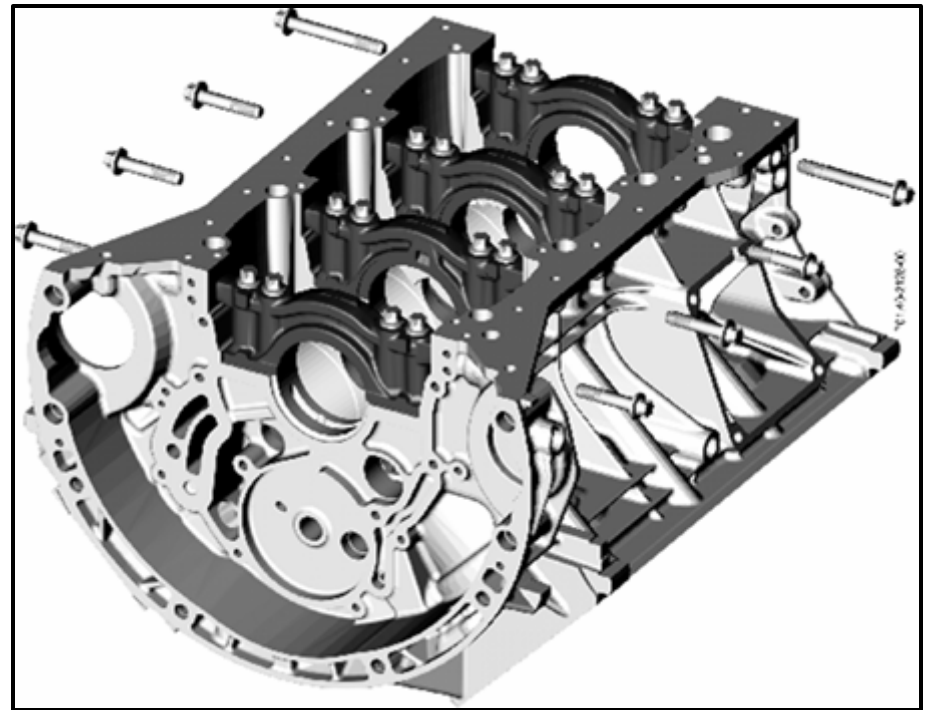
- 90 degree V-6
- Two stage Intake manifold
- Turbulence flaps in the intake ports
- ME 9.7 control unit mounted on top of engine
- Electrically assisted thermostat
- No EGR valve
  - Both cams adjust



Lets take a look at what changed mechanically

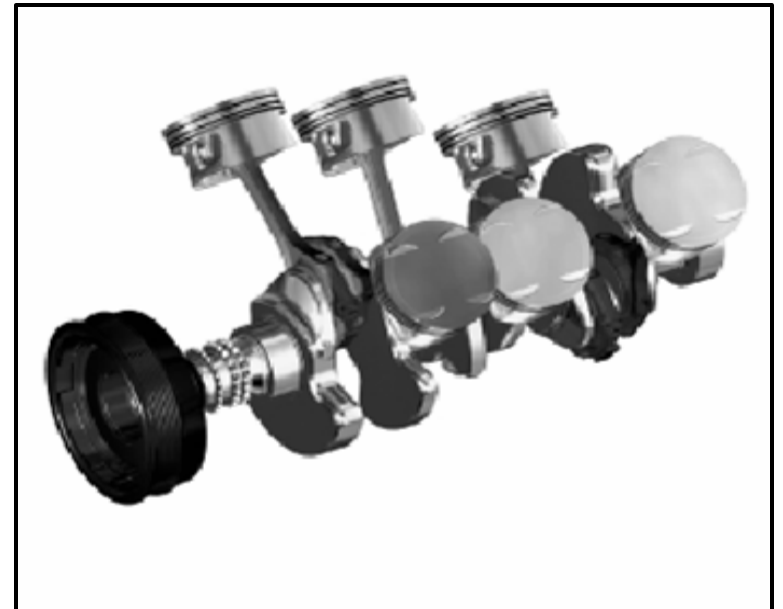
# Motor Mechanicals

- Based off of M112 engine
- Bore and Stroke increase compared to M112
- Die cast aluminum crankcase
- Silitec coated cylinder liners
- Starter openings both sides of block
- 8 lateral main bearing bolts



# Crankshaft

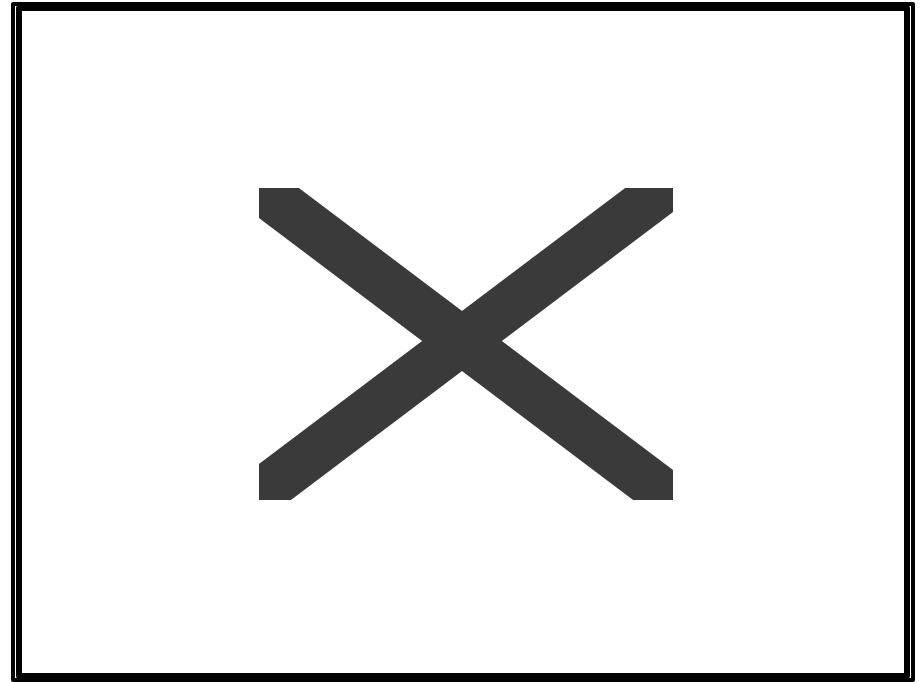
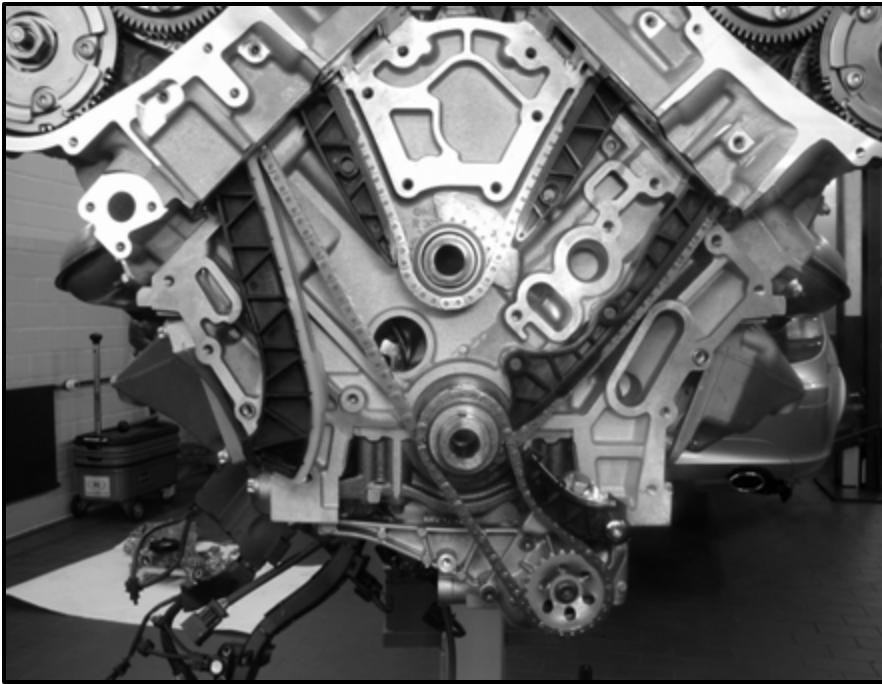
- Crankshaft lighter as compared to M112
- Wider main bearings as compared to M112 used to reduce vibration
- Iron coated cast aluminum pistons



Balance shaft, familiar function

Oil sensor, now a switch

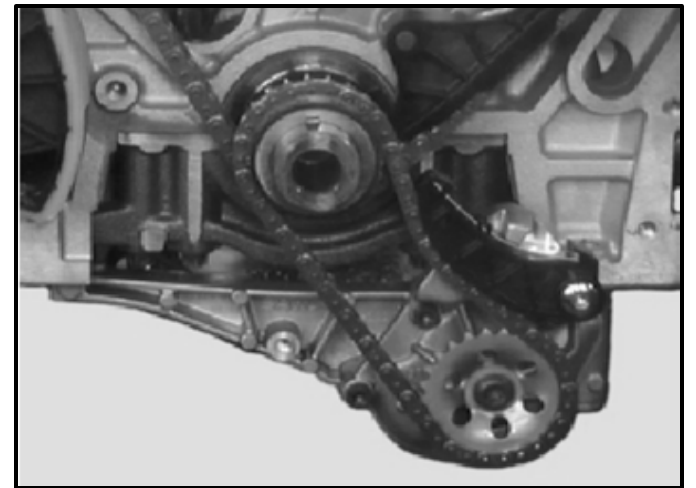
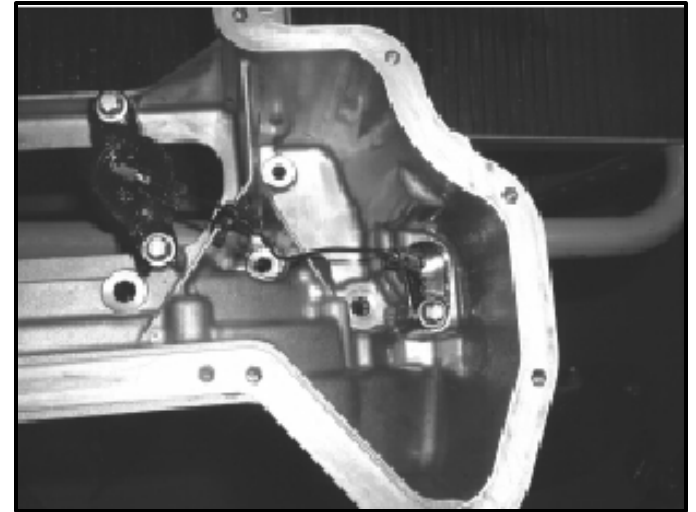
# Balance Shaft



- Balance shaft similar to the M112
- Balance shaft rotates opposite crankshaft

# Oil Level Switch

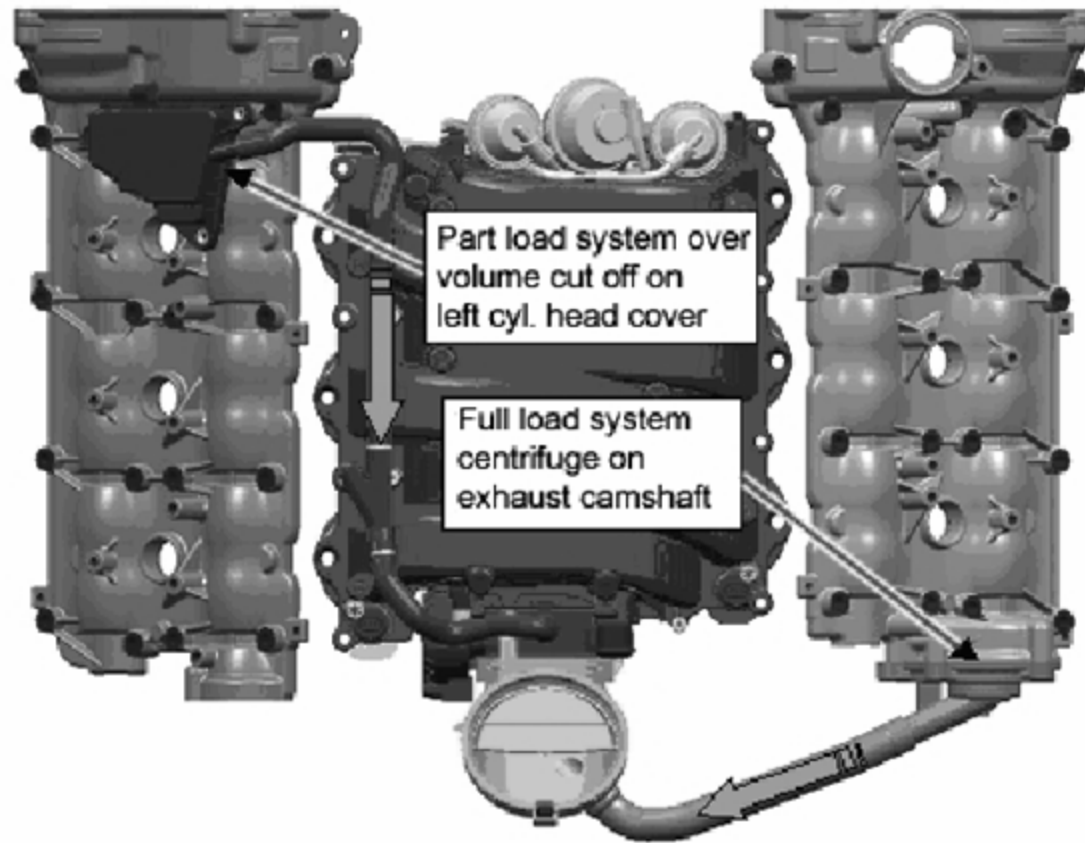
- Reed contact oil level switch S43 replaces B40
- Only one pin of the two pin connector used
- S43 mounted in oil pan
- Chain driven oil pump
- Vehicle equipped with an oil level dipstick



# Partial and full load crankcase ventilation system

# Crankcase Ventilation

Crankcase ventilation diagram





Cylinder head

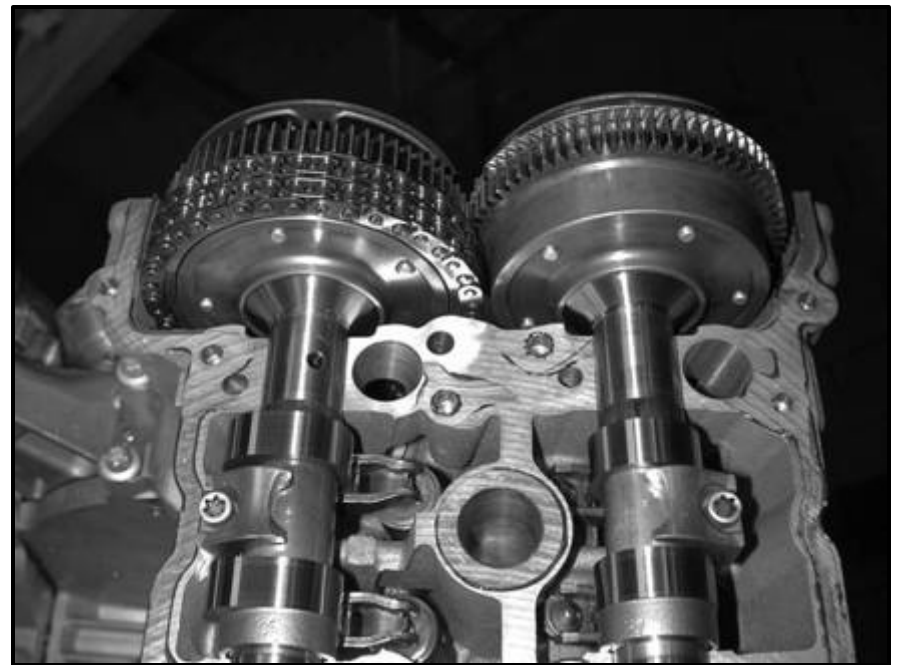
4 valves

DOHC

Cam adjusters

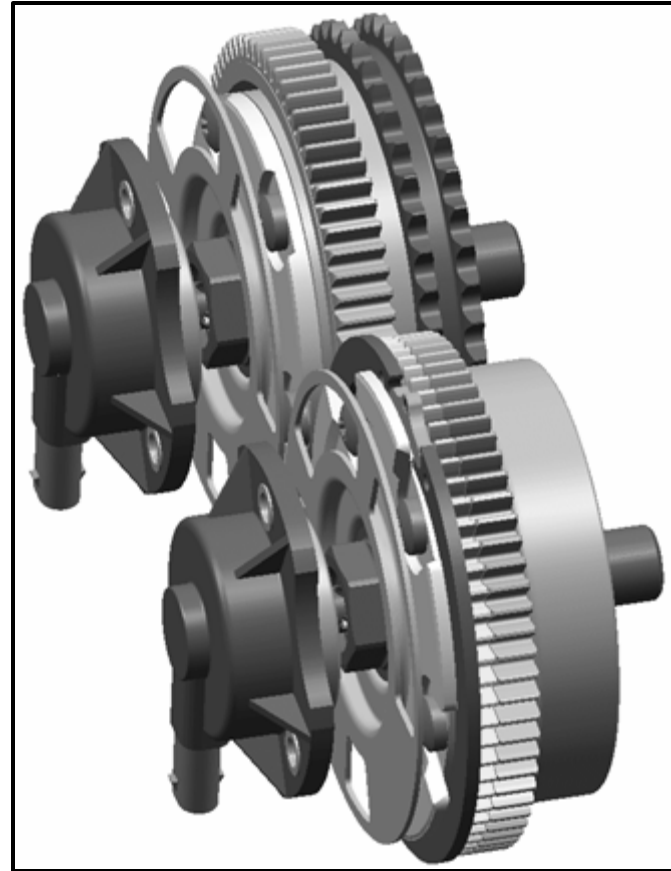
# Cylinder Head

- New design cast aluminum cylinder heads
- 4 overhead camshafts (DOHC)
- 4 valves per cylinder, improve torque and horsepower compared to 3 valve engines
- Camshaft upper bearing surfaces integrated into cam housing cover
- Nickel coated high strength steel exhaust valves



# Cylinder Head

- 4 Cam adjusters
- 4 Cam Sensors
- ME can detect Cam position with ignition on
- Intake cam is chain driven and drives exhaust cam via gear



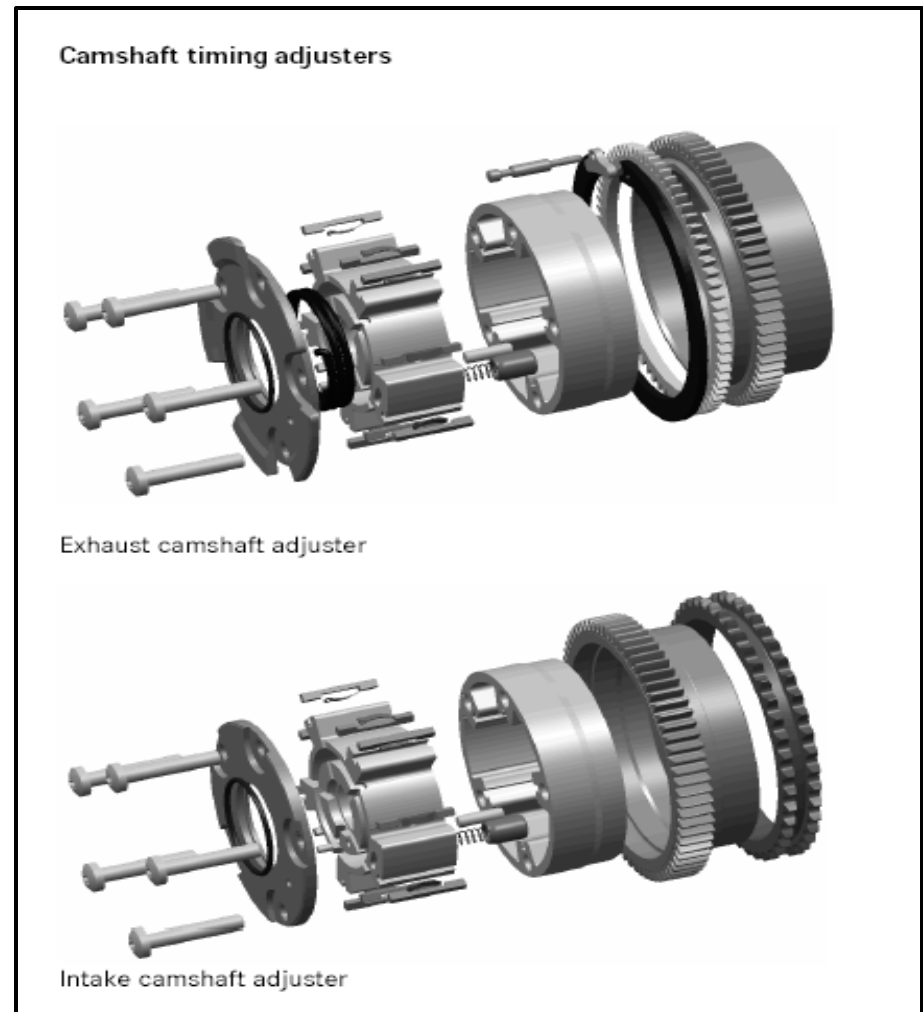
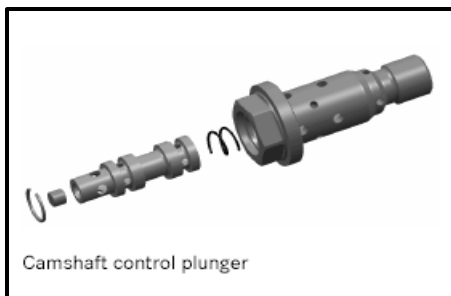
# Chain Tensioner

- Step type chain tensioner with internal spring
- Located at the lower right front engine
- Must be manually reset if removed
- **Failure to preset tensioner before assembly will result in engine damage**

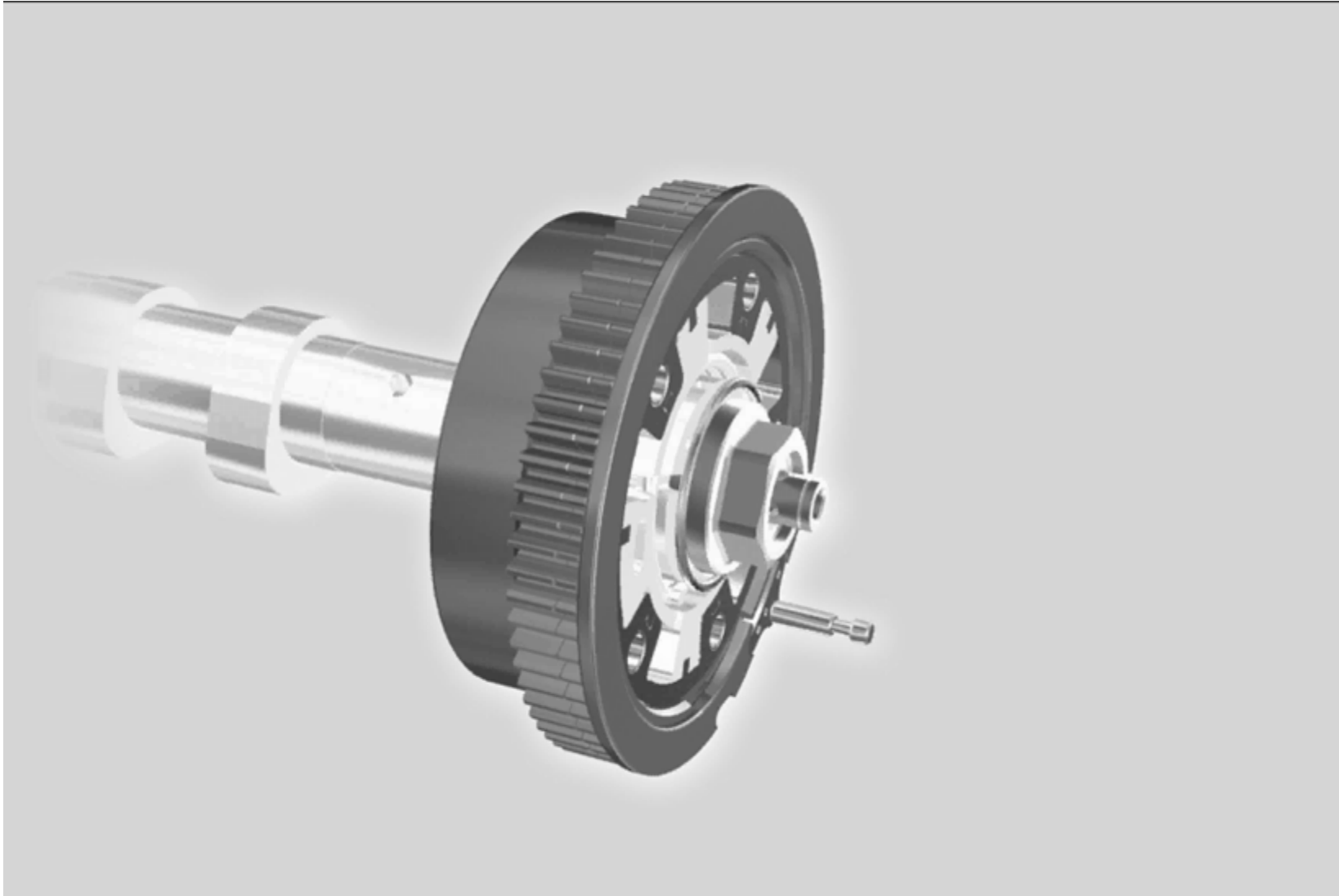


# Camshaft Timing Adjusters

- Vane type, oil pressure controlled adjusters
- Continuously variable
- 40° advanced for intake (from 4° BTDC to up to 36° ATDC)
- 40° retard for exhaust (from 30° BTDC to up to 10° ATDC)



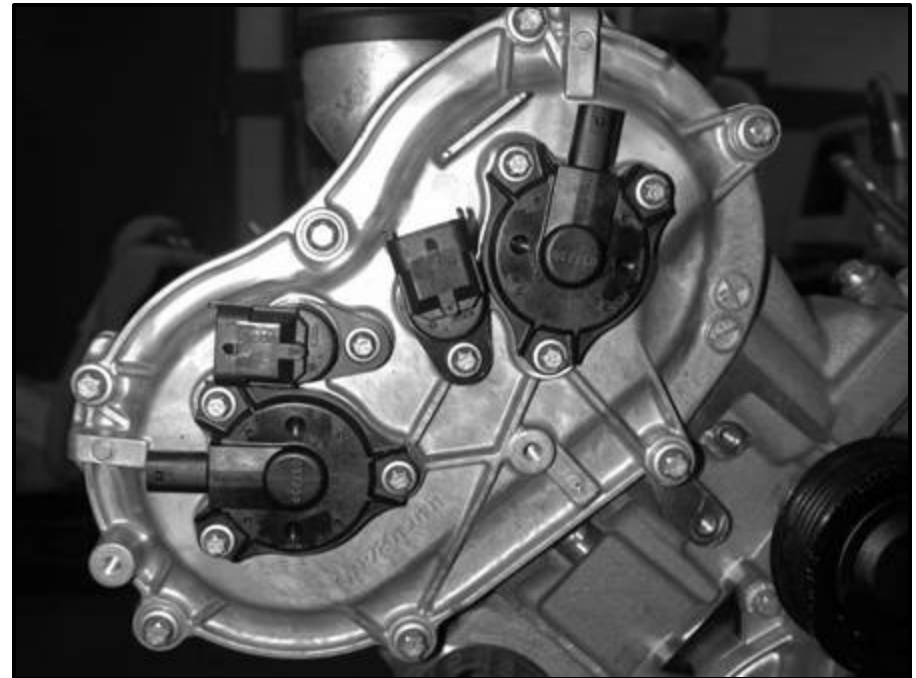
# Exhaust Cam Gear



Note: Retaining nut at front timing adjuster is reverse thread

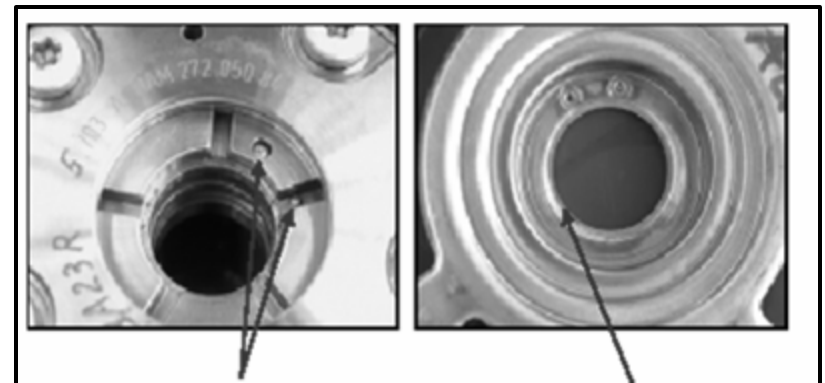
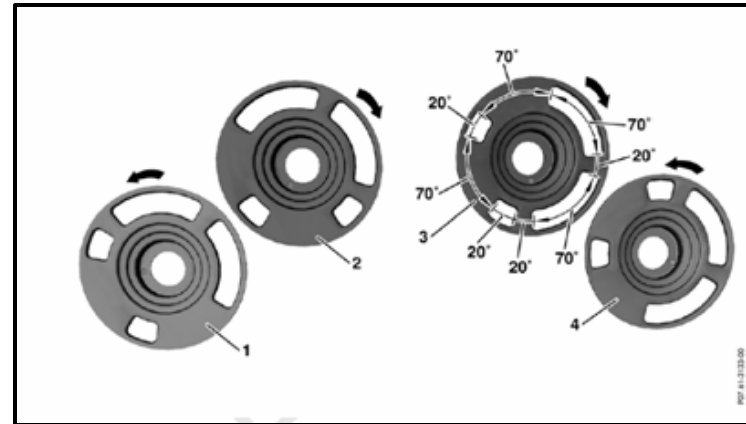
# Camshaft Position Sensors

- 4 Hall effect sensors, one for each camshaft
- True Power On (TPO) sensor technology capable of detecting cam position with stationary engine
- Right and left camshaft signals staggered by 240° camshaft angle
- Signal is low in absence of a window



# Impulse Wheels

- Four impulse wheels used on the M272 mounted on the front of each camshaft timing adjuster
  - Each impulse wheel has a different part number
- The openings of the impulse wheels help ME determine the camshafts exact position
- **Can only be used one time!**
- **If new impulse wheels are not used the pins could shear off causing massive damage to adjusters**



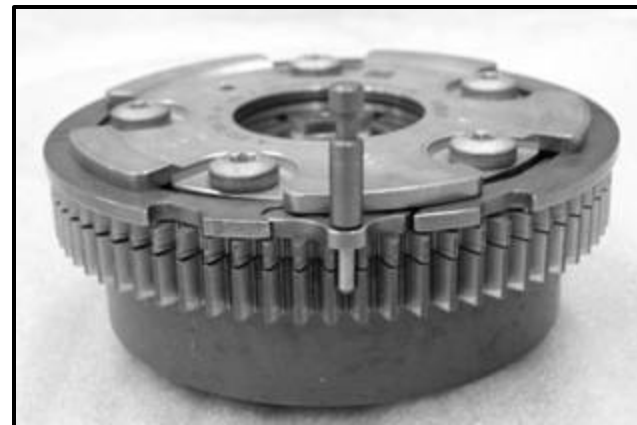
Both locating pins sheared off when reinstalled

Gouging of mounting surface

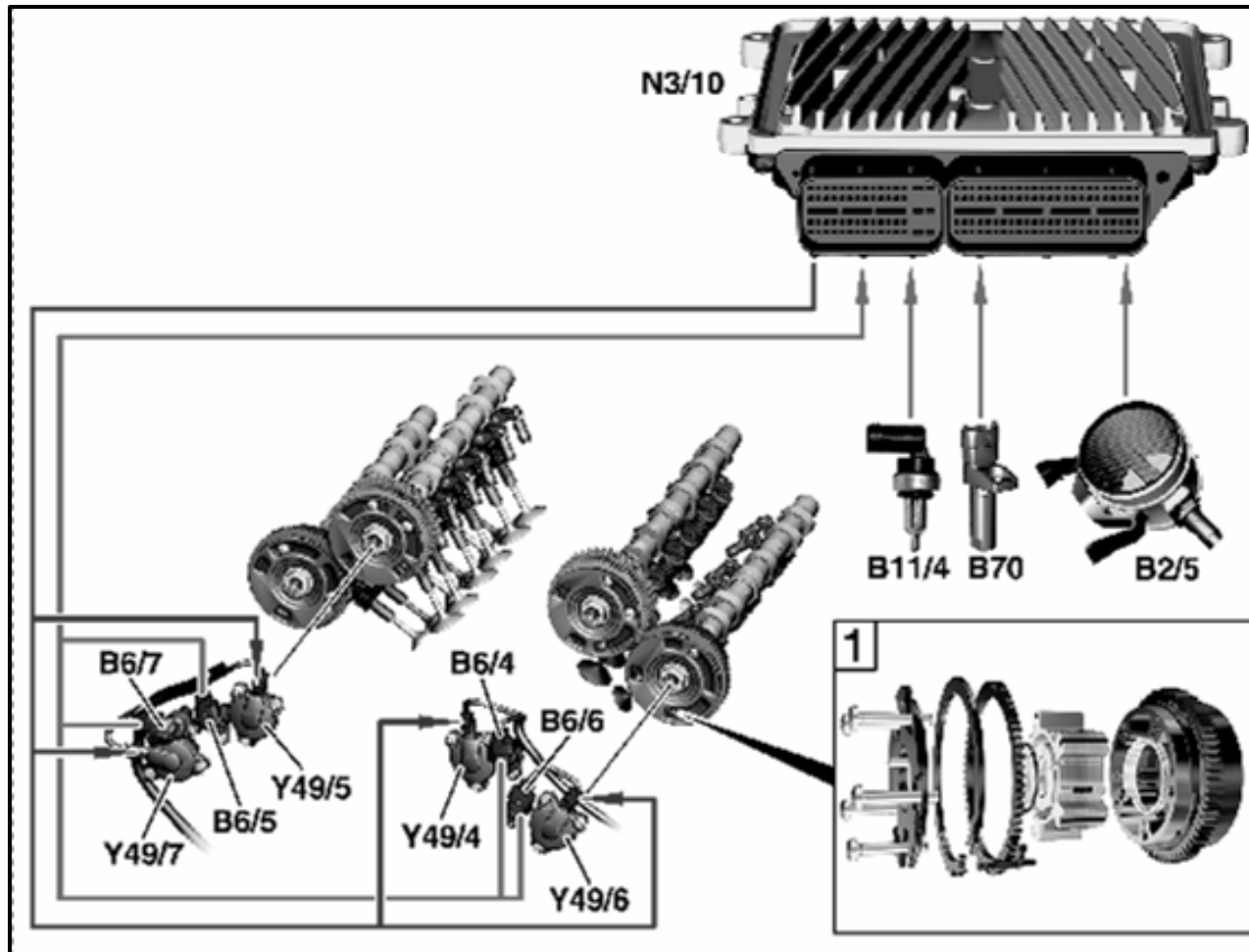


# Exhaust Cam Gear

- Exhaust Cam 2 piece gear
- Smaller outer gear spring loaded for noise reduction
- Gear must be held in place prior to disassembly
- Segment Ring must be replaced once removed
- Adjuster bolt reverse threaded



# Camshaft Timing Network



- B6/4 – Camshaft position sensor (intake left)
- B6/6 – Camshaft position sensor (exhaust left)
- B6/7 – Camshaft position sensor (exhaust right)
- B6/5 – Camshaft position sensor (intake right)
- B11/4 – Engine coolant temperature sensor
- B70 – Crankshaft hall sensor
- B2/5 – MAF
- N3/10 – ME 9.7
- Y49/5 – Camshaft timing control solenoid (exhaust right)
- Y49/7 – Camshaft timing control Solenoid (Intake right)
- Y49/4 – Camshaft timing control solenoid (intake left)
- Y49/6 – Camshaft timing control Solenoid (exhaust left)

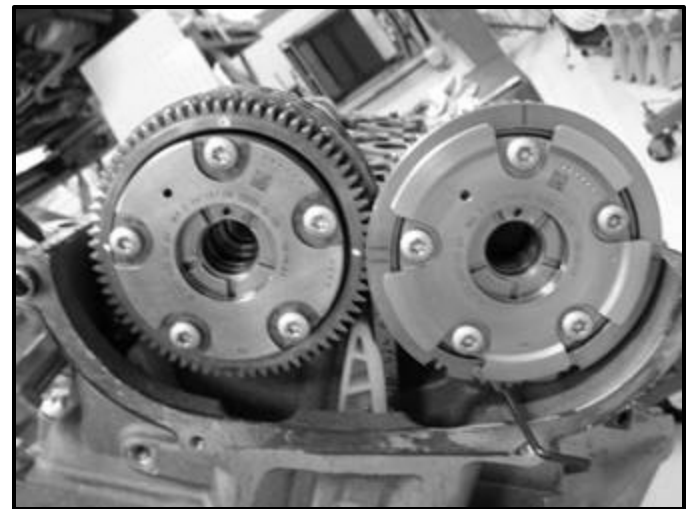
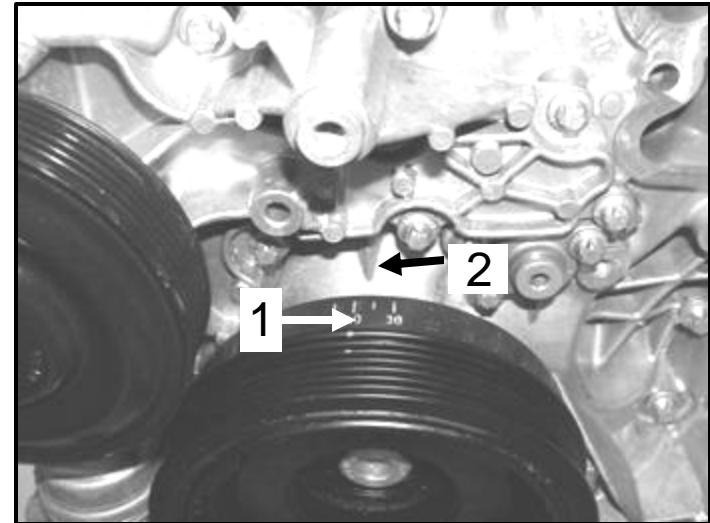
# Camshaft Position

- Remove camshaft sensors
- Align balancer (305°) to front cover pointer
- Check impulse wheels stamped numbers
- If above line up properly cam positions are correct



# Camshaft Timing Basic Position

1. Align balancer to 40° ATDC to front cover pointer
2. Front cover pointer
3. Upper camshaft marks
4. Camshaft marks aligned to head



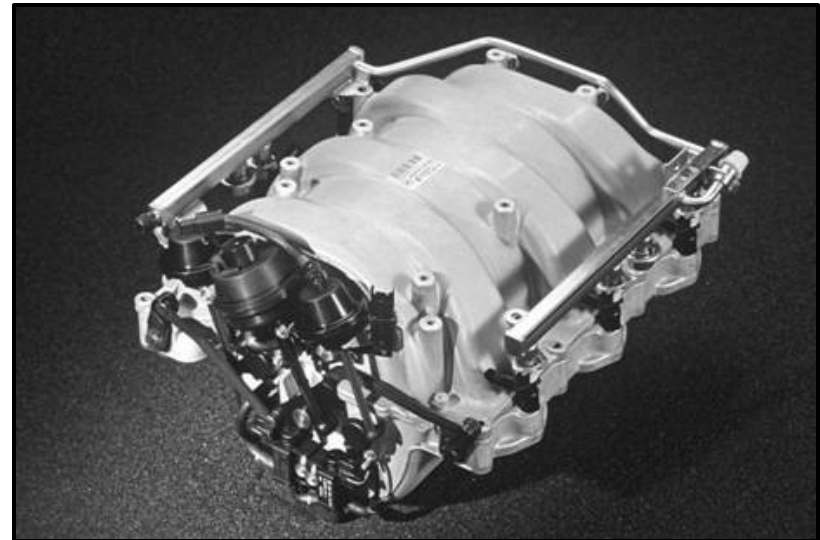
Intake

Variable runners

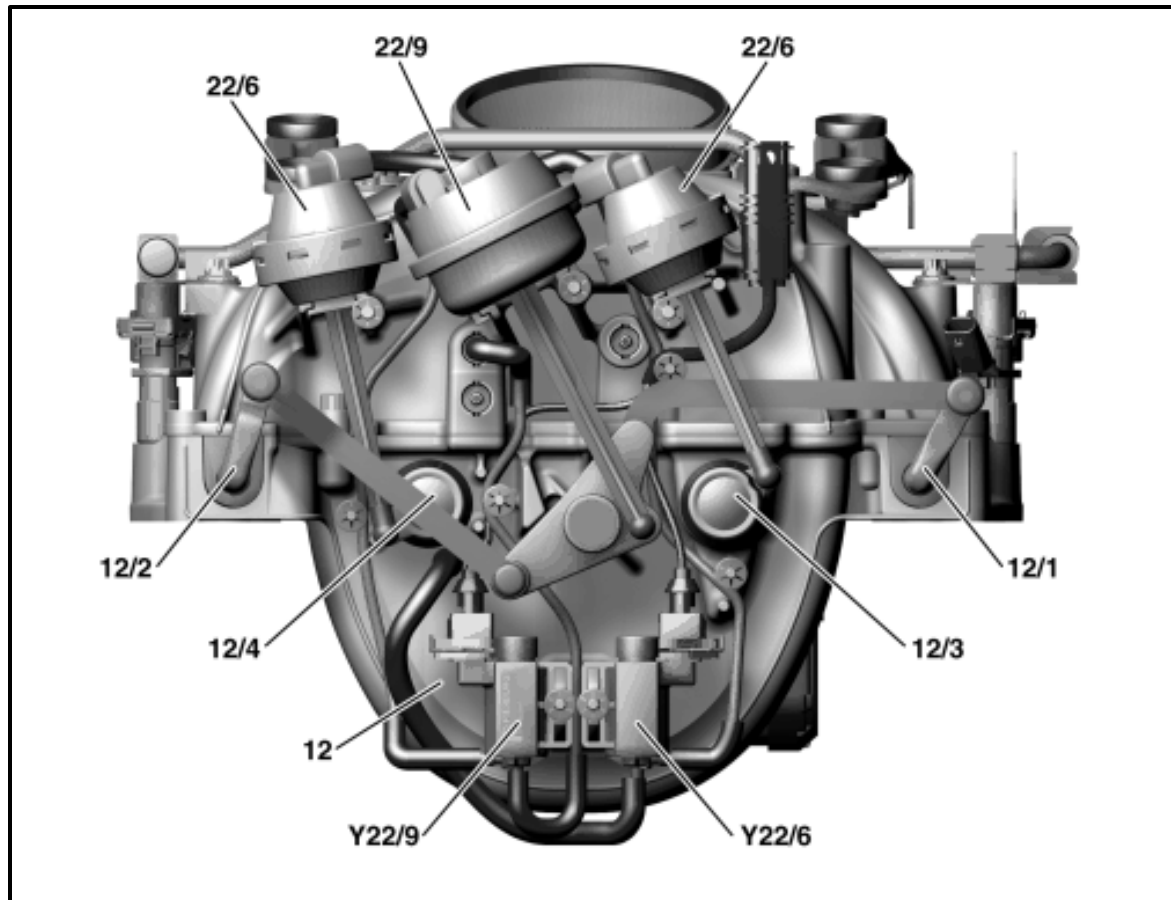
Swirl flaps

# Intake Manifold

- Magnesium cast sectional intake manifold with integrated vacuum reservoir
- Variable intake runner
- Short runner for higher RPM
- Long runner for lower RPM
- Swirl-Flaps also added providing better fuel mixture



# Intake Components



12 Intake manifold with integral vacuum reservoir

12/1 Swirl flap shaft, left cylinder bank

12/2 Swirl flap shaft, right cylinder bank

12/3 Longitudinal switch flap shaft, right cylinder bank

12/4 Longitudinal switch flap shaft, left cylinder bank

22/6 Intake manifold switchover diaphragm

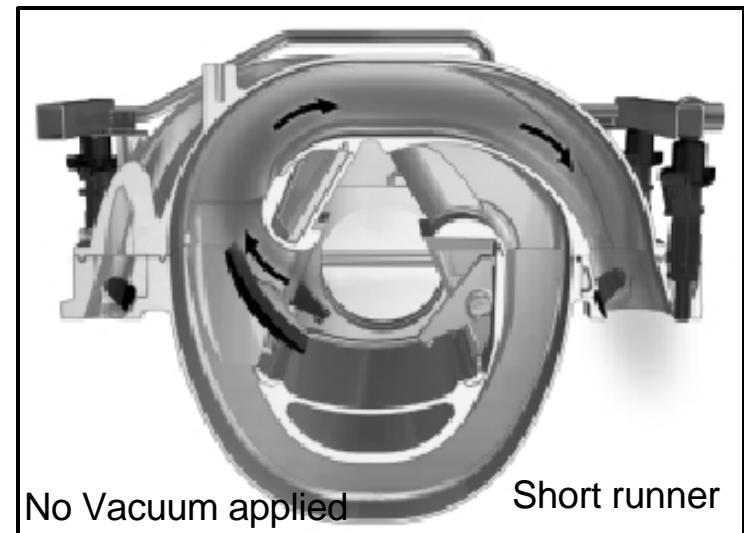
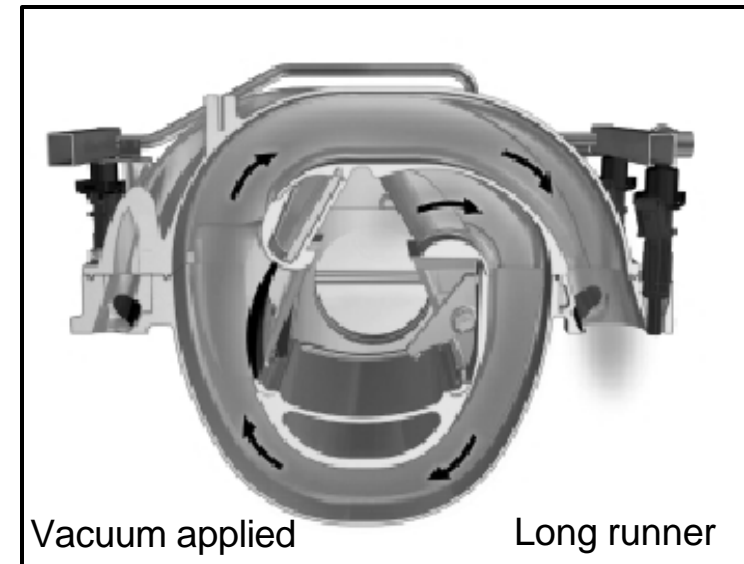
22/9 Swirl valve switchover diaphragm

Y22/6 Variable intake manifold switchover valve

Y22/9 Intake manifold swirl flap switchover valve

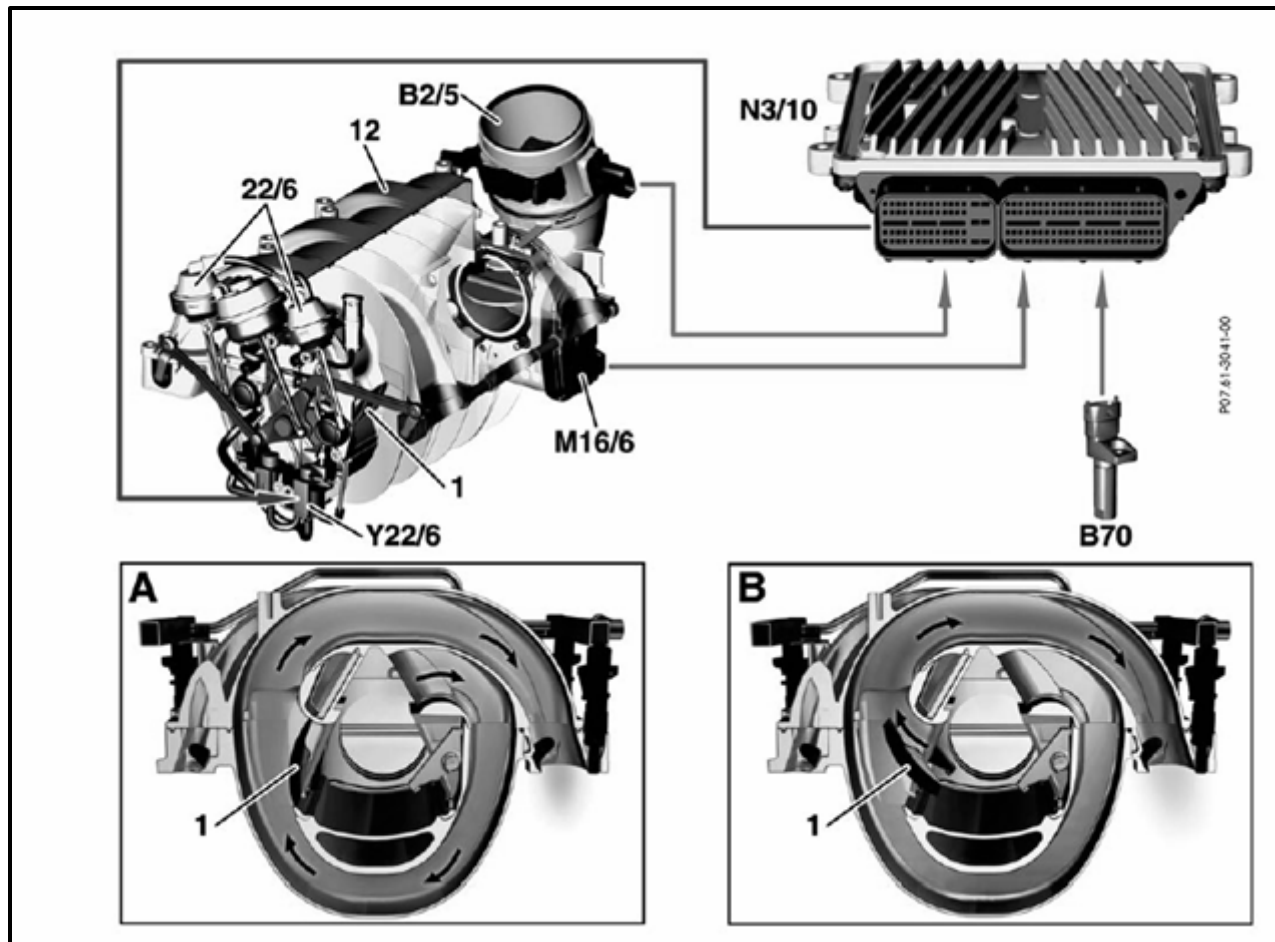
# Variable Length Intake Manifold

- Engine load over 50% from approx. 1750 RPM intake flaps closed (long runner)
  - Better cylinder filling and increased torque
- Above 3900 RPM switchover solenoid deactivated via ME intake flaps open (short runner)
  - Incoming air follows short runner
- Unlike M112, M272 has two diaphragm actuators





# Intake Functional Diagram



A – Long runner

B – Short runner

1- Switchover flaps

12 – Intake manifold with integral vacuum reservoir

B2/5 – Hot film mass airflow sensor

22/6 – Intake manifold switchover diaphragm

Y22/6 – Variable intake manifold switchover valve

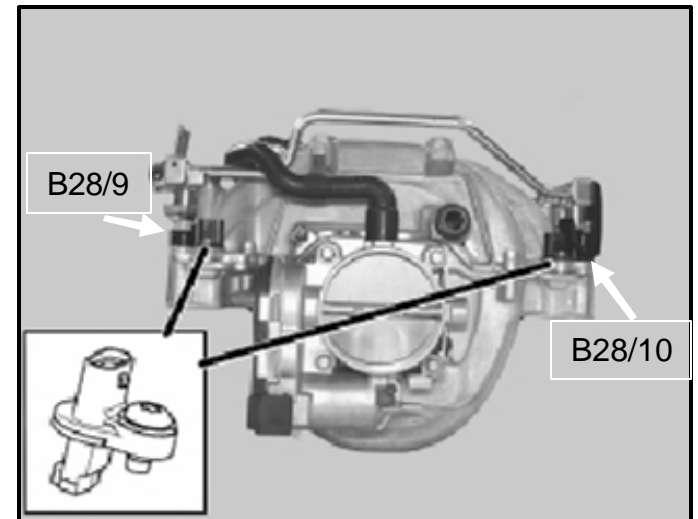
M16/6 – Throttle valve actuator

B70 – Crankshaft hall sensor

N3/10 – ME 9.7

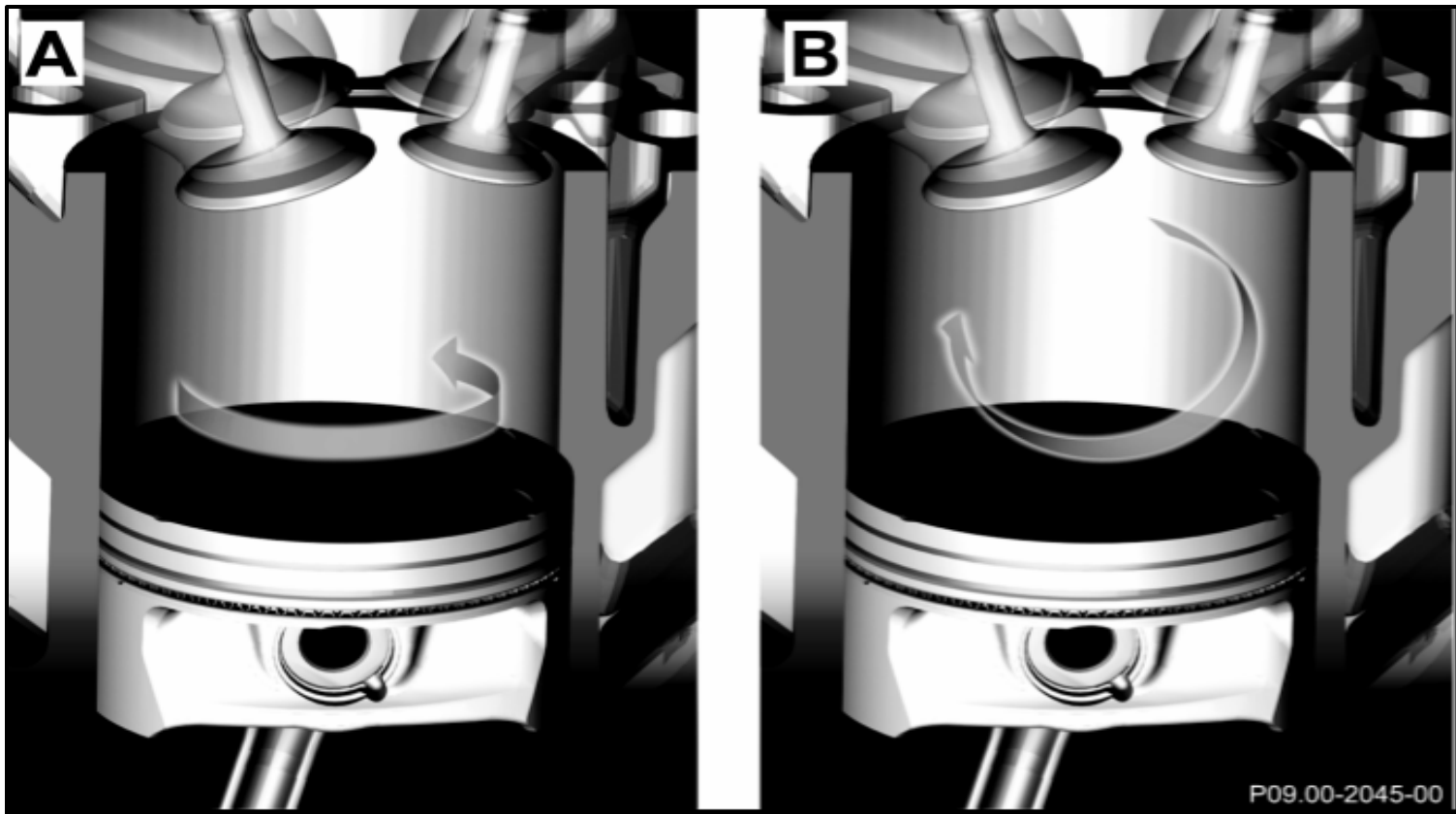
# Swirl Flaps

- Under certain operating conditions intake air is swirled via swirl flap for improved mixture process
- Vacuum diaphragm driven by ME controls flap position
- Swirl flap position sensors (hall sensors) monitor 2 magnets attached to swirl flap actuating shafts to determine flap position (activated/not activated)
- Sensors located at rear of intake manifold



Swirl flap position sensors

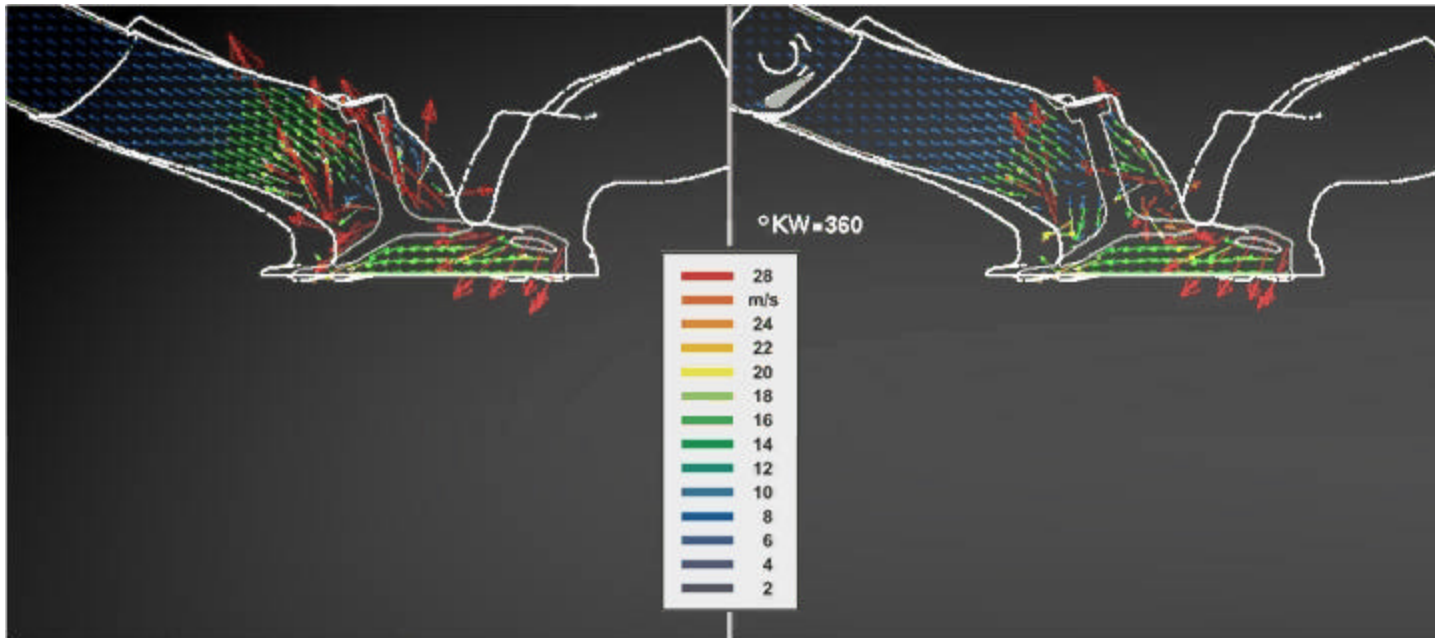
# Swirl Flaps



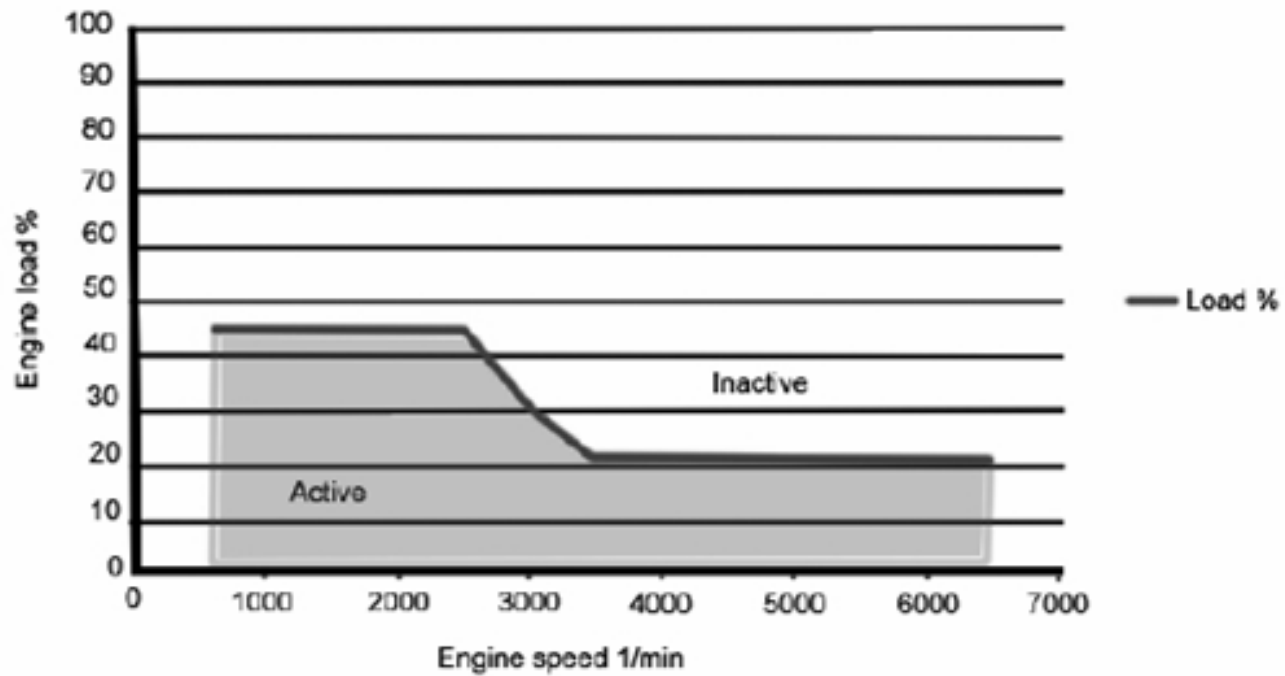
A = Non swirl not active

B = Swirl active

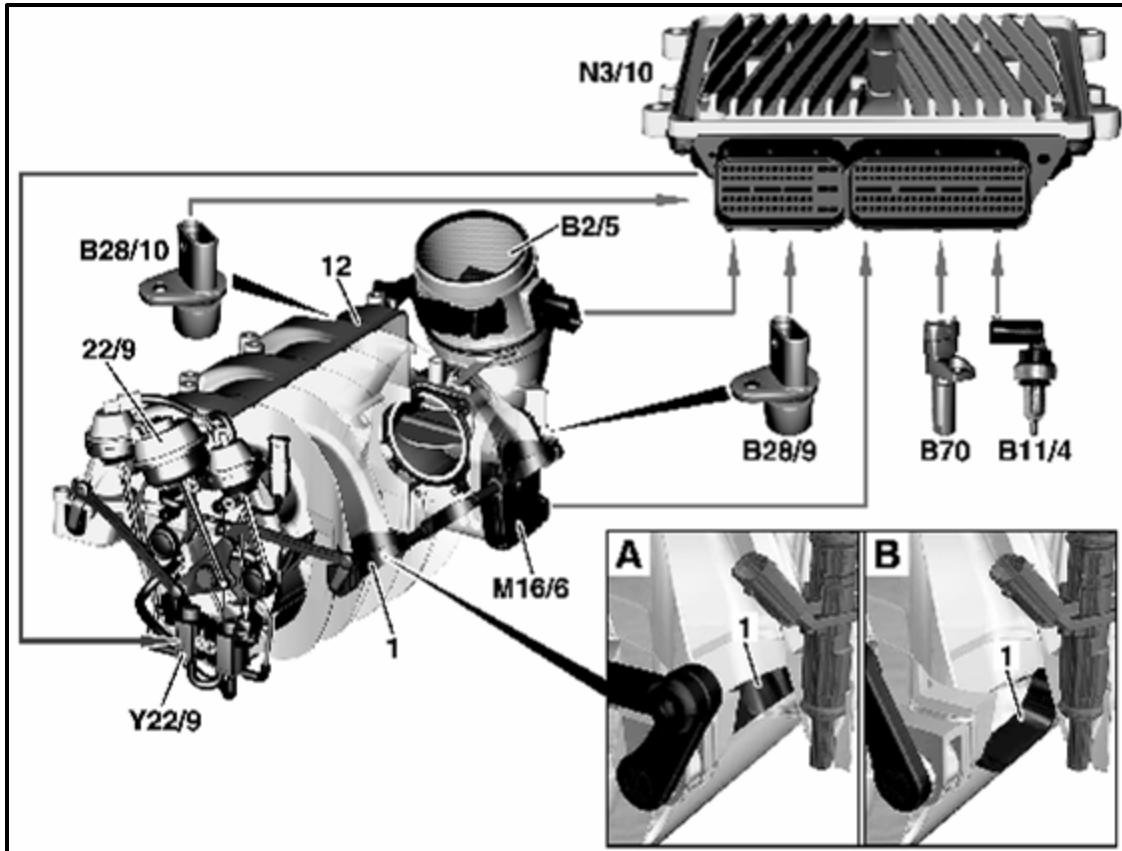
# Swirl Flaps



# Swirl Flap Operating Parameters



# Swirl Flap Functional Diagram



- 12 – Intake manifold
- 1 – Swirl flap
- 22/9 – Aneroid capsule swirl flap Switchover
- B11/4 – Coolant temperature sensor
- B70- Crankshaft hall sensor
- B28/9 – Left intake manifold swirl flap position sensor
- B28/10 – Right intake manifold swirl flap position sensor
- B2/5 – Hot film mass airflow sensor
- M16/6 – Throttle valve actuator
- N3/10 – ME 9.7
- Y22/9 – Intake manifold swirl flap switchover valve
- A – Swirl flap recessed (no swirl)
- B – Swirl flap outward (swirl)

ME 9.7

Inputs

Outputs

# ME 9.7

Control Module function:

- Cylinder sequential injection
- Single spark plug coil (control and diagnostics)
- Electronic throttle plate positioning
- LIN communication with alternator
- Turbulence flap regulation
- Variable length intake runner control
- After run process



N3/10 – ME 9.7

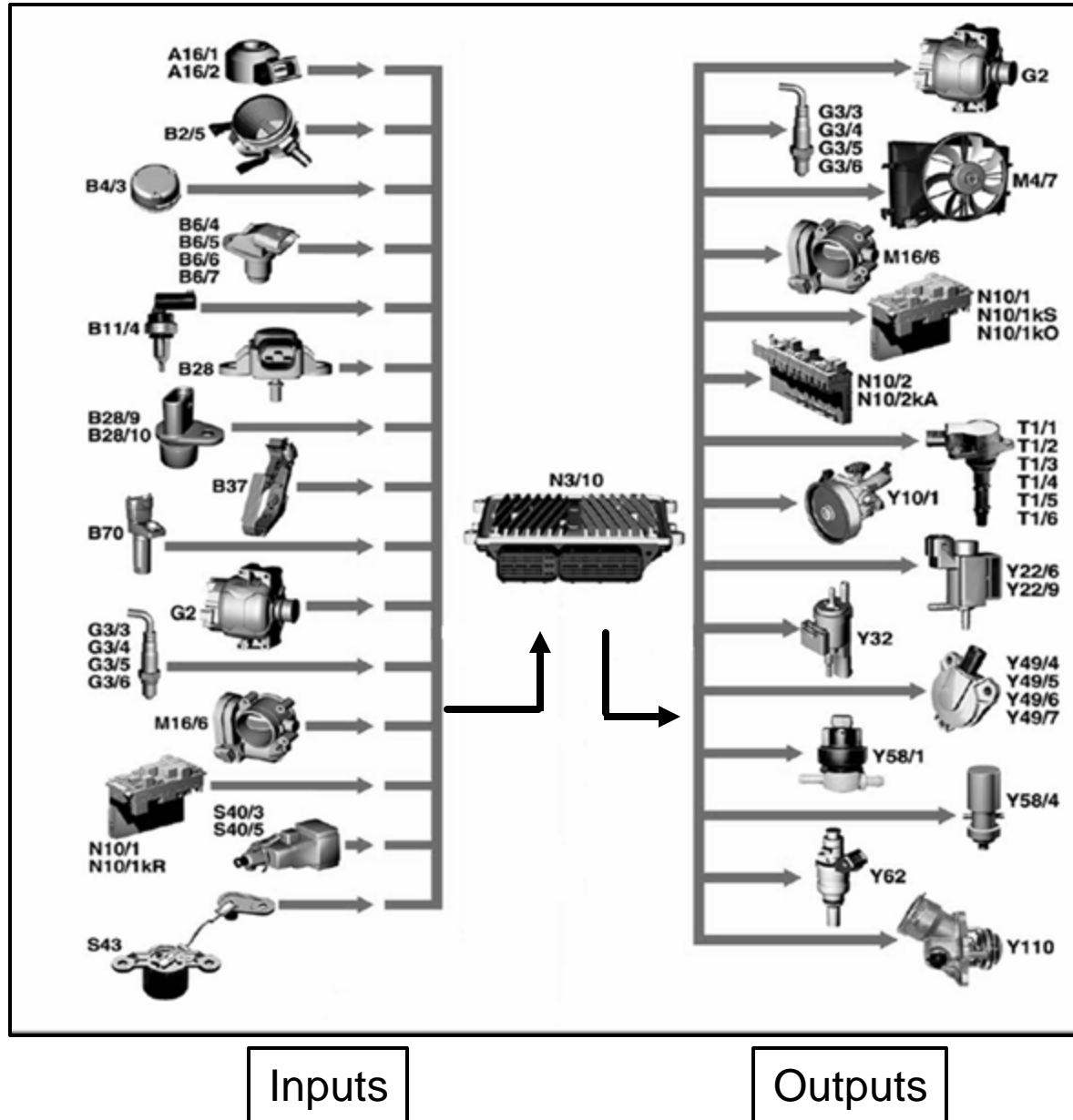
**Note: When erasing DTC's you must wait for the after run function to finish otherwise faults may remain.**



# ME After Run Process

- ME performs an after run process when circuit 15 is switched off
- After run is determined by ME and required to store inputs
- After run time is typically 5 seconds but can take several minutes longer depending on various functions (temperature management, OBD, DAS3 etc.)
  - at 176°F approx. 4 seconds, at 68°F approx. 60 seconds and at -22°F approx. 150 seconds
  - After cycling key off, must wait ~ 150 seconds
- This is the period in which the fault memory is over-written

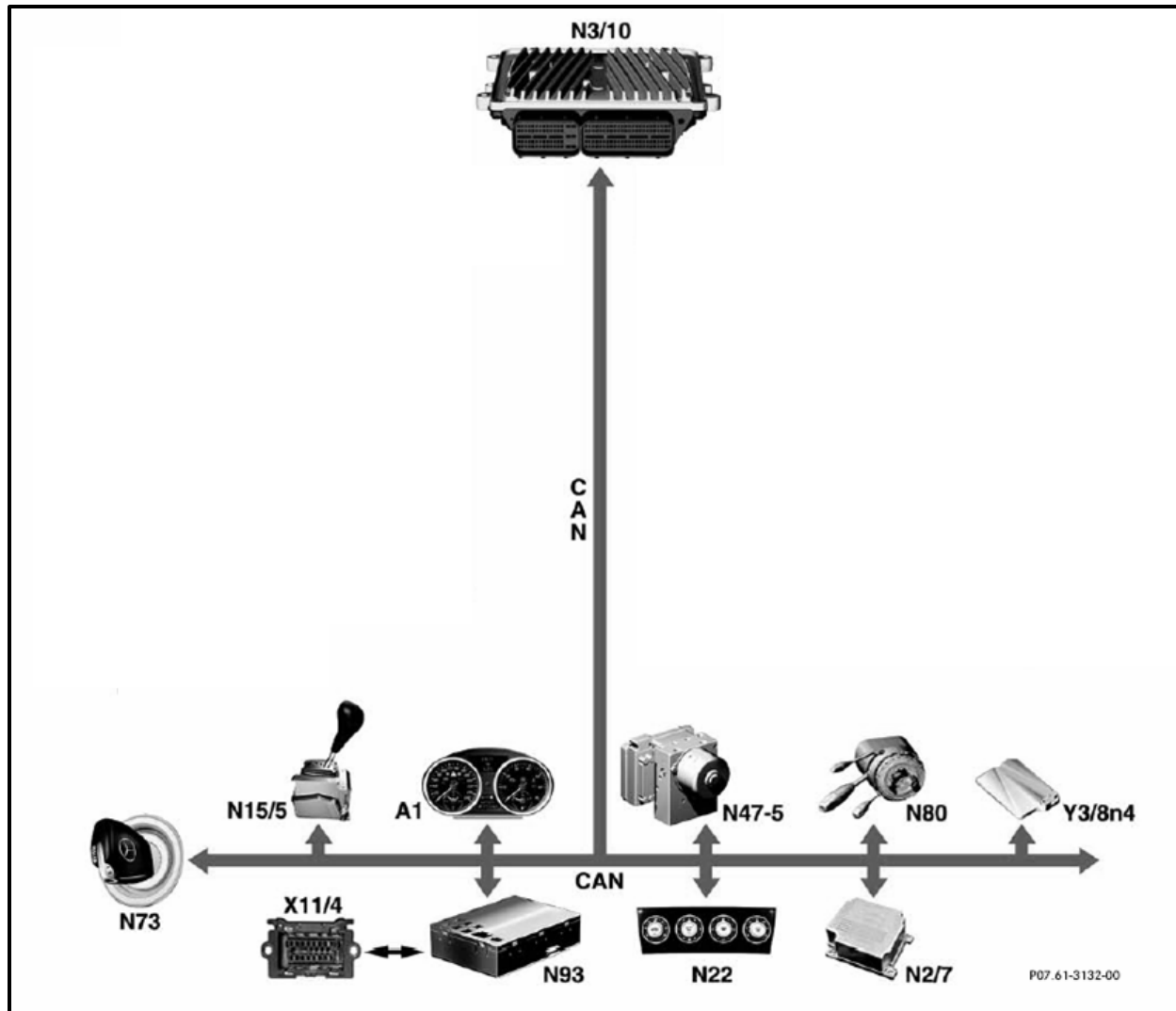
# ME 9.7 Inputs/Outputs



# ME 9.7 Inputs/Outputs Legend

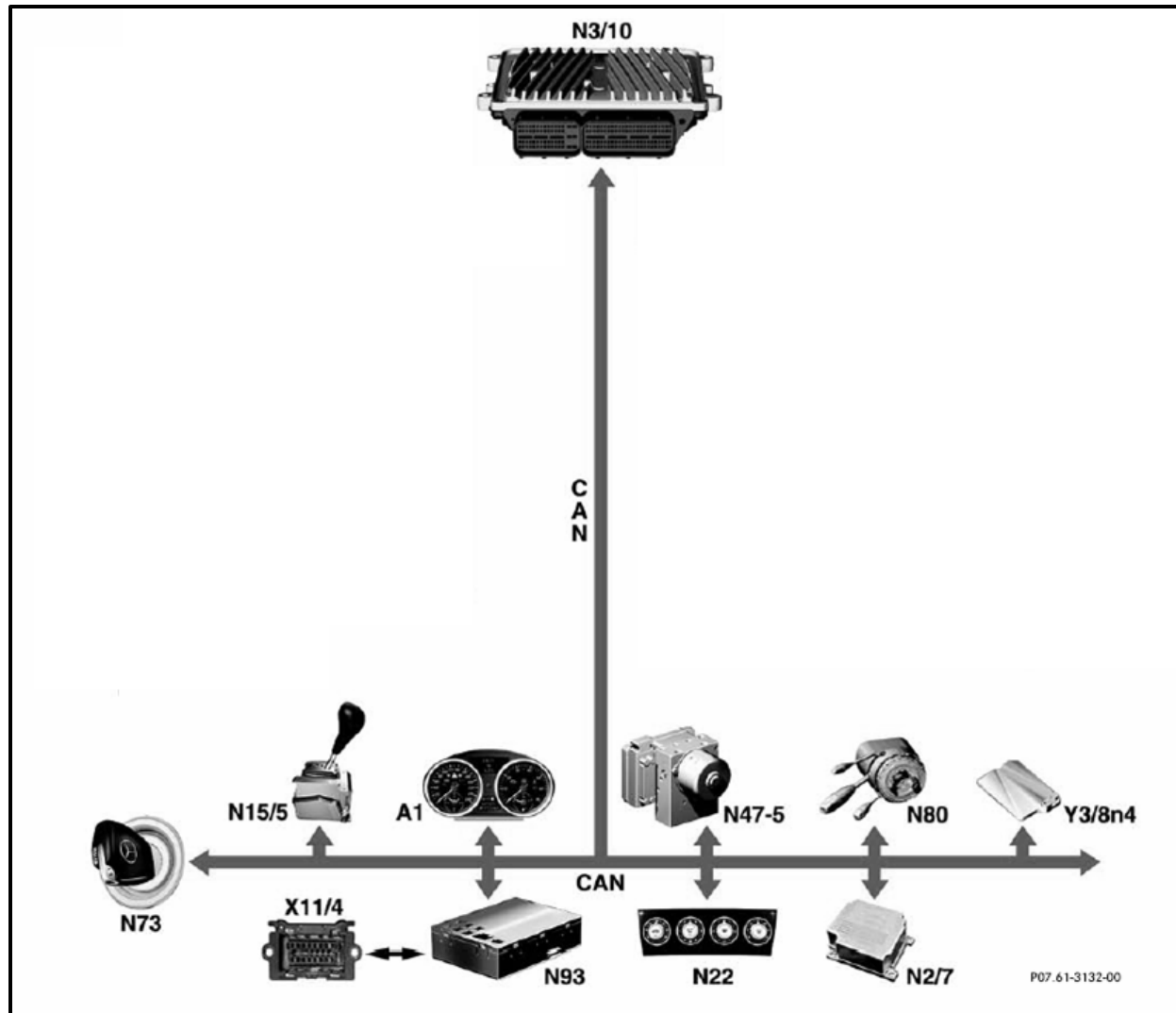
- A16/1 – Right knock sensor
- A16/2 – Left knock sensor
- B2/5 – Hot film mass air flow sensor
- B4/3 – Fuel tank pressure sensor
- B6/4 – Left intake camshaft hall sensor
- B6/5 – Right intake camshaft hall sensor
- B6/6 – Left exhaust camshaft hall sensor
- B6/7 – Right exhaust camshaft hall sensor
- B11/4 – Coolant temperature sensor
- B28 – Intake manifold pressure sensor
- B28/9 – Left intake manifold swirl flap position sensor
- B28/10 – Right intake manifold swirl flap position sensor
- B37 – Accelerator pedal sensor
- B70 – Crankshaft hall sensor
- G2 – Alternator
- G3/3 – Left O2 sensor upstream of TWC
- G3/4 – Right O2 sensor upstream of TWC
- G3/5 – Left O2 sensor in TWC
- G3/6 – Right O2 sensor in TWC
- M16/6 – Throttle valve actuator
- N10/1 – Driver SAM
- N10/1kR – Circuit 87 relay
- N10/1kS – Starter relay
- N10/1kO – Air pump relay
- N10/2 – Rear SAM
- N10/2kA – Fuel pump relay
- S40/3 – Clutch pedal switch
- S40/5 – Start enable clutch pedal switch
- S43 – Oil level check switch
- M4/7 – Suction fan
- T1/1 -6 – Ignition coils 1 to 6
- Y10/1 – Power steering pump pressure regulator valve
- Y22/6 – Variable intake manifold switchover valve
- Y22/9 – Intake manifold swirl flap switchover valve
- Y32 – Air pump switchover valve
- Y49/4 – Left camshaft intake solenoid
- Y49/5 – Right camshaft intake solenoid
- Y49/6 – Left camshaft exhaust solenoid
- Y49/7 – Right camshaft exhaust solenoid

# ME 9.7 Network Signals



- N73 – EIS
- N15/5 – Electronic selector lever module control unit
- A1 – Instrument Cluster
- N47-5 – ESP and BAS control unit
- N80 – Steering column module
- Y3/8n4 – Fully integrated transmission control unit
- X11/4 – Diagnostic connector
- N93 – Central gateway control unit
- N22 – AAC control and operating unit
- N2/7 - Restraint systems control unit

# ME 9.7 Network Signals



Crank sensor (Hall)

O2 sensors

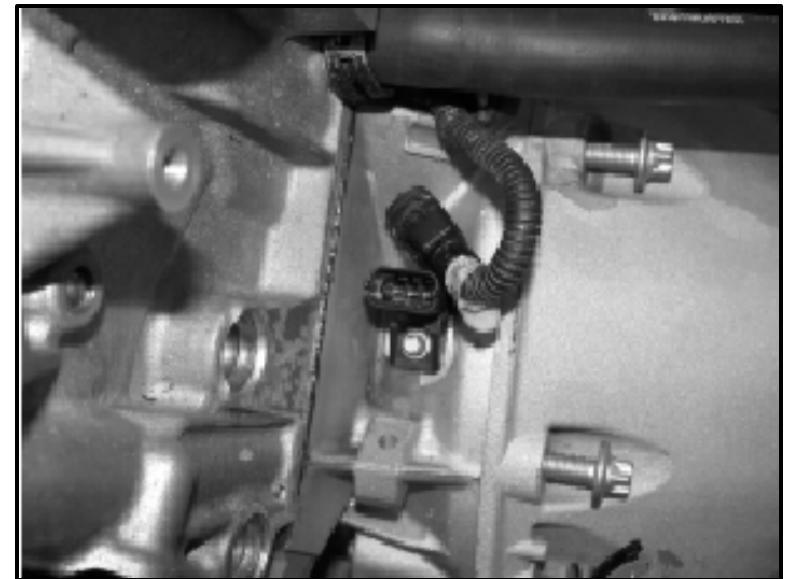
Three way catalytic converters

Ignition coil

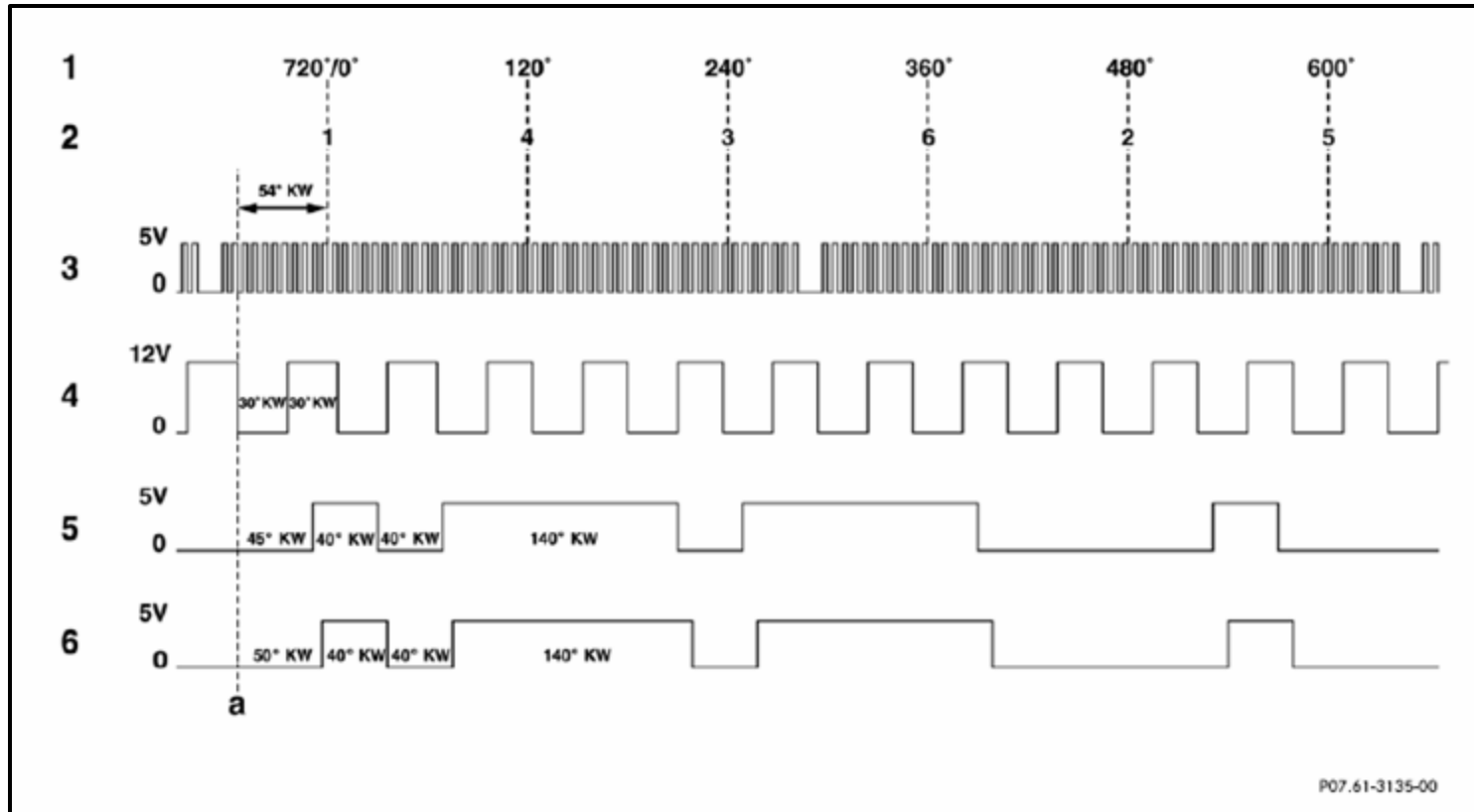
Mass airflow

# Crank Sensor

- Hall effect sensor (not inductive)
- Output signal switches between ground and 5 volts
- Incremental ring gear 58 teeth (60–2) is carry over



# Sensor Signals



P07.61-3135-00

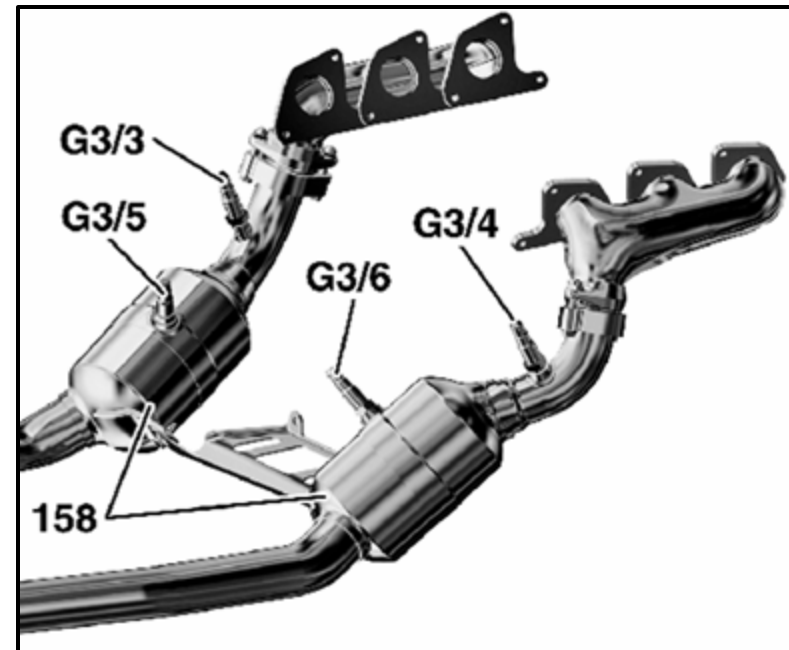
- 1 - Crank angle (CKA)
- 2 - Ignition TDC cylinder (in firing order)
- 3 - Signal of crankshaft Hall sensor (B70)
- 4 - Rpm signal TNA
- 5 - Camshaft Hall sensor intake signal, left and right
- 6 - Camshaft hall sensor exhaust signal, left and right

- A = Recognition of ignition TDC of cylinder 1
  - second negative signal edge of crankshaft hall sensor after the gap
  - Signals 5 and 6 are "LOW"
  - Rpm signal (4) changes from "HIGH" to "LOW"



# O2 Sensors

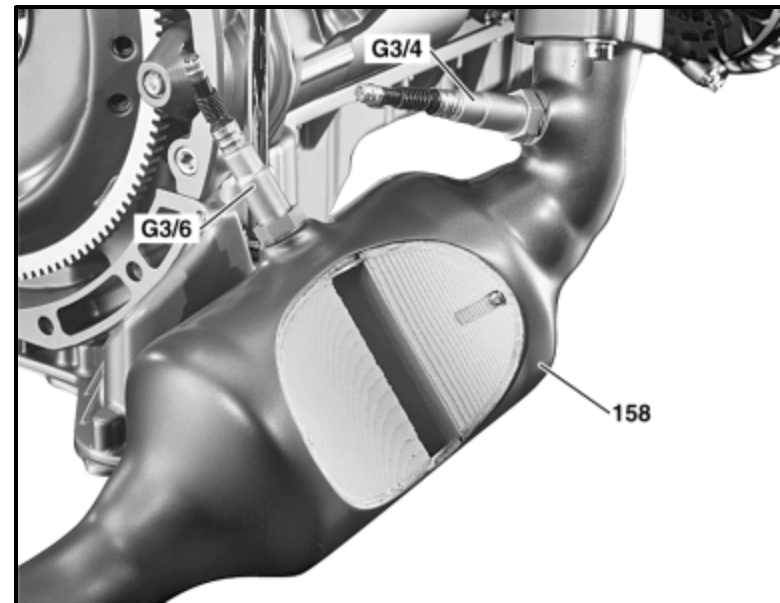
- Upstream wide-band O2 sensors as known from the M271 and OM648
- Downstream planar type O2 sensors mounted in catalytic converter housing
- Three Way Catalytic Converters (TWC)



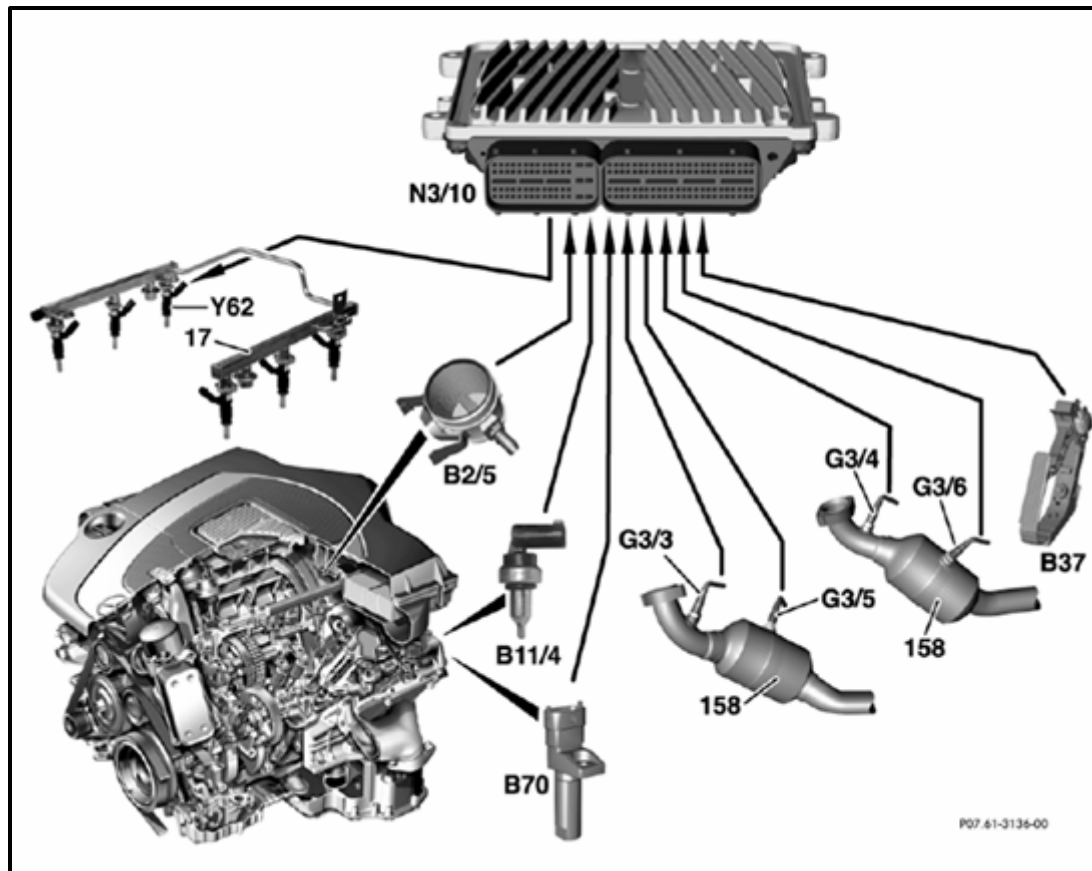
- G3/3 – Left upstream O2 sensor
- G3/5 – Left downstream O2 sensor
- 158 – Catalytic converter
- G3/4 – Right upstream O2 sensor
- G3/6 – Right downstream O2 sensor

# Three Way Catalytic Converters

- Two ceramic monoliths with 600 cells each
- Reduces Hydrocarbons (HC)
- Reduces Carbon Monoxide (CO)
- Reduces Nitrogen Oxides (NOX)
- Downstream O<sub>2</sub> sensor mounted between the monoliths



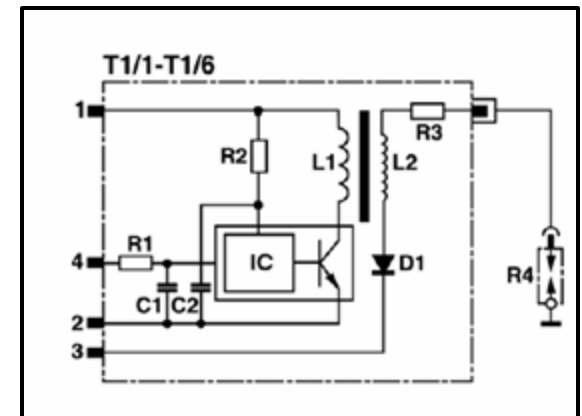
# O2 Sensor Networking



- 17 – Fuel rail
- 158 – Catalytic converter
- B2/5 – Hot film mass airflow sensor
- B11/4 – Coolant temperature sensor
- B70 – Crankshaft hall sensor
- B37 – Accelerator pedal sensor
- G3/3 – Left upstream O2 sensor
- G3/5 – Left downstream O2 sensor
- G3/4 – Right upstream O2 sensor
- G3/6 – Right downstream O2 sensor
- N3/10 – ME 9.7
- Y62 – Fuel injectors

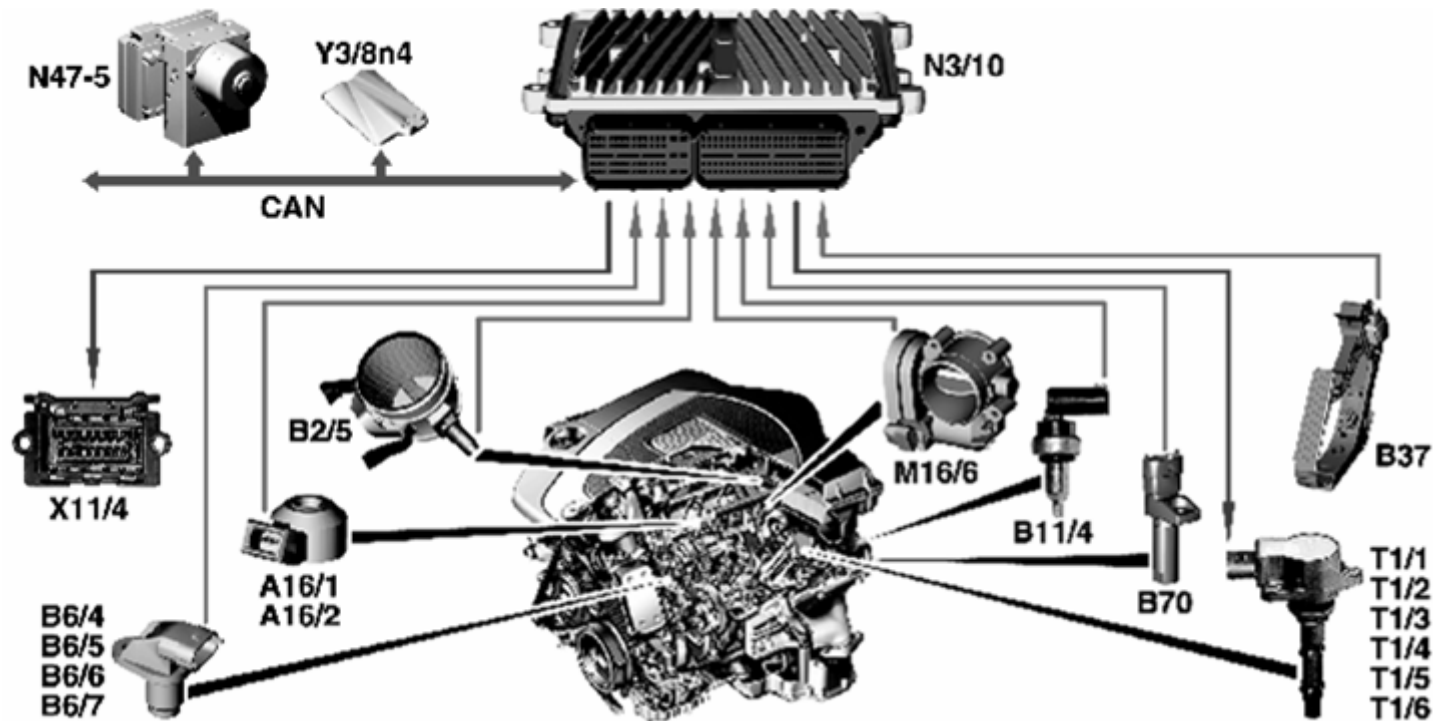
# Ignition Coil

- Individual coil on plug
- Driver located inside coil not in ME 9.7
- Each coil controlled separately
- Diagnostic information sent back to ME
- Bi-directional communication with ME



Pin 1 – batt  
Pin 2 – ground  
Pin 3 – ground  
Pin 4 – control/diagnosis

# Ignition Networking

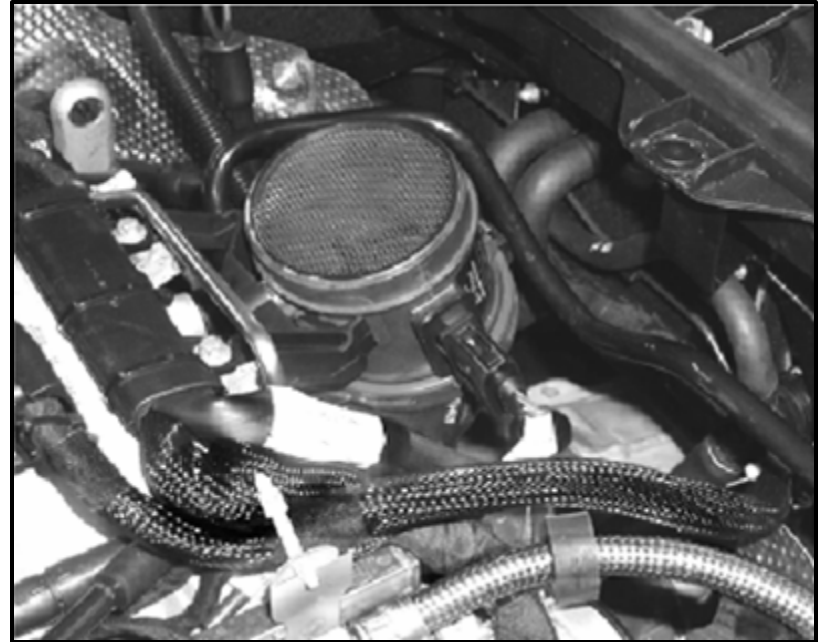


A16/1 – Right knock sensor  
 A16/2 – Left knock sensor  
 B6/4 – Left intake camshaft hall sensor  
 B6/5 – Right intake camshaft hall sensor  
 B6/6 – Left exhaust camshaft hall sensor  
 B6/7 – Right exhaust camshaft hall sensor  
 B2/5 – Hot film mass airflow sensor  
 B11/4 – Coolant temperature sensor  
 B70 – Crankshaft hall sensor

B37 – Accelerator pedal sensor  
 M16/6 – Throttle valve actuator  
 N3/10 – ME 9.7  
 N47-5 – ESP and BAS control unit  
 T1/1 through T1/6 – ignition coil for cylinders 1 to 6  
 Y3/8n4 - Fully integrated transmission control (VGS) control unit  
 X11/4 – Data link connector

# Hot Film Mass Airflow Sensor

- Frequency signal from Mass Airflow to ME
- Integrated Intake air temperature sensor used



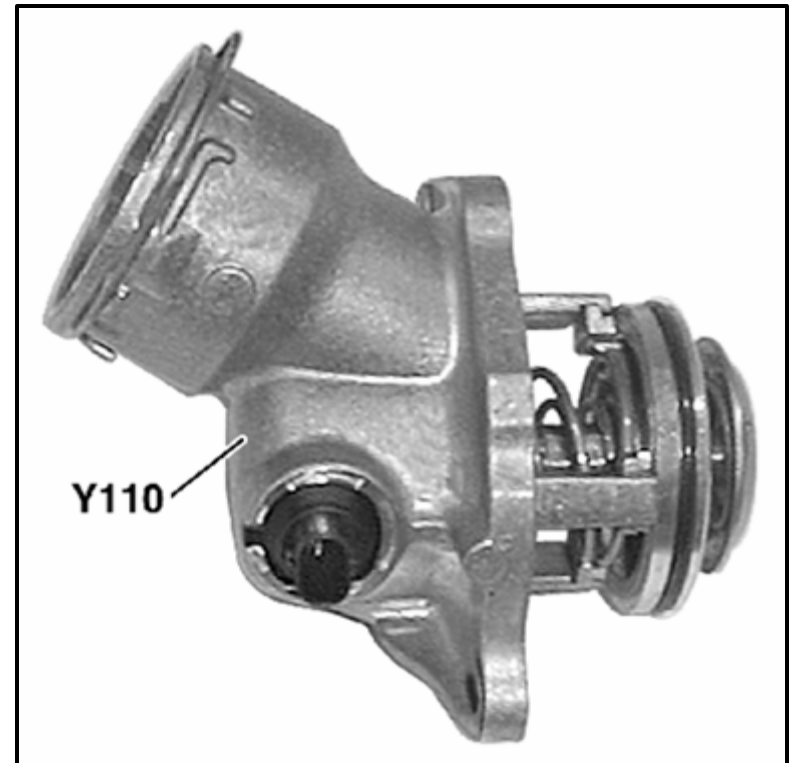
Temperature management

Thermostat

Control

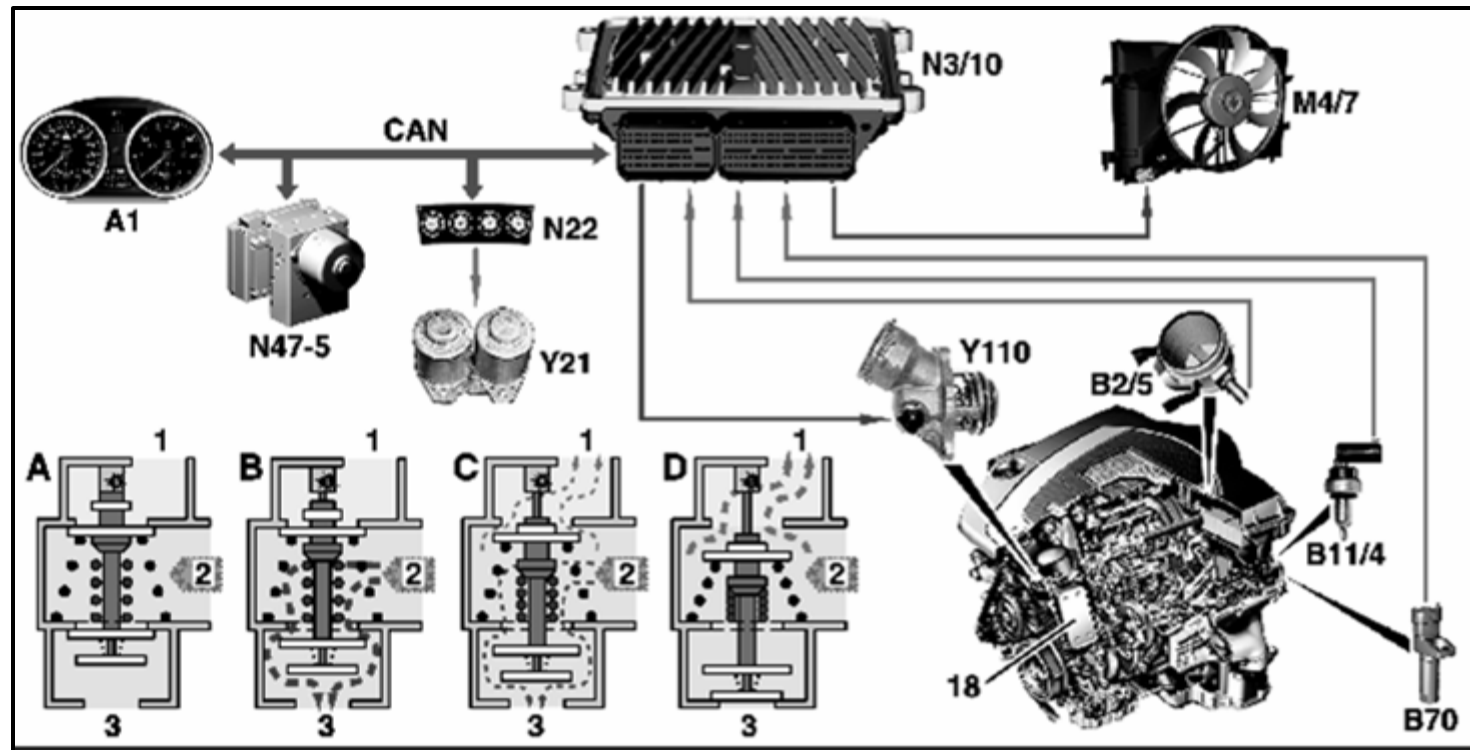
# Temperature Management

- Coolant Temperature is regulated via Me 9.7
- 3 plate thermostat
- Regulates temperature from 185°F to 221°F (85°C to 105°C)
- Heating element in thermostat energized to heat thermostat
- 4 operating modes dependent on engine temperature and load



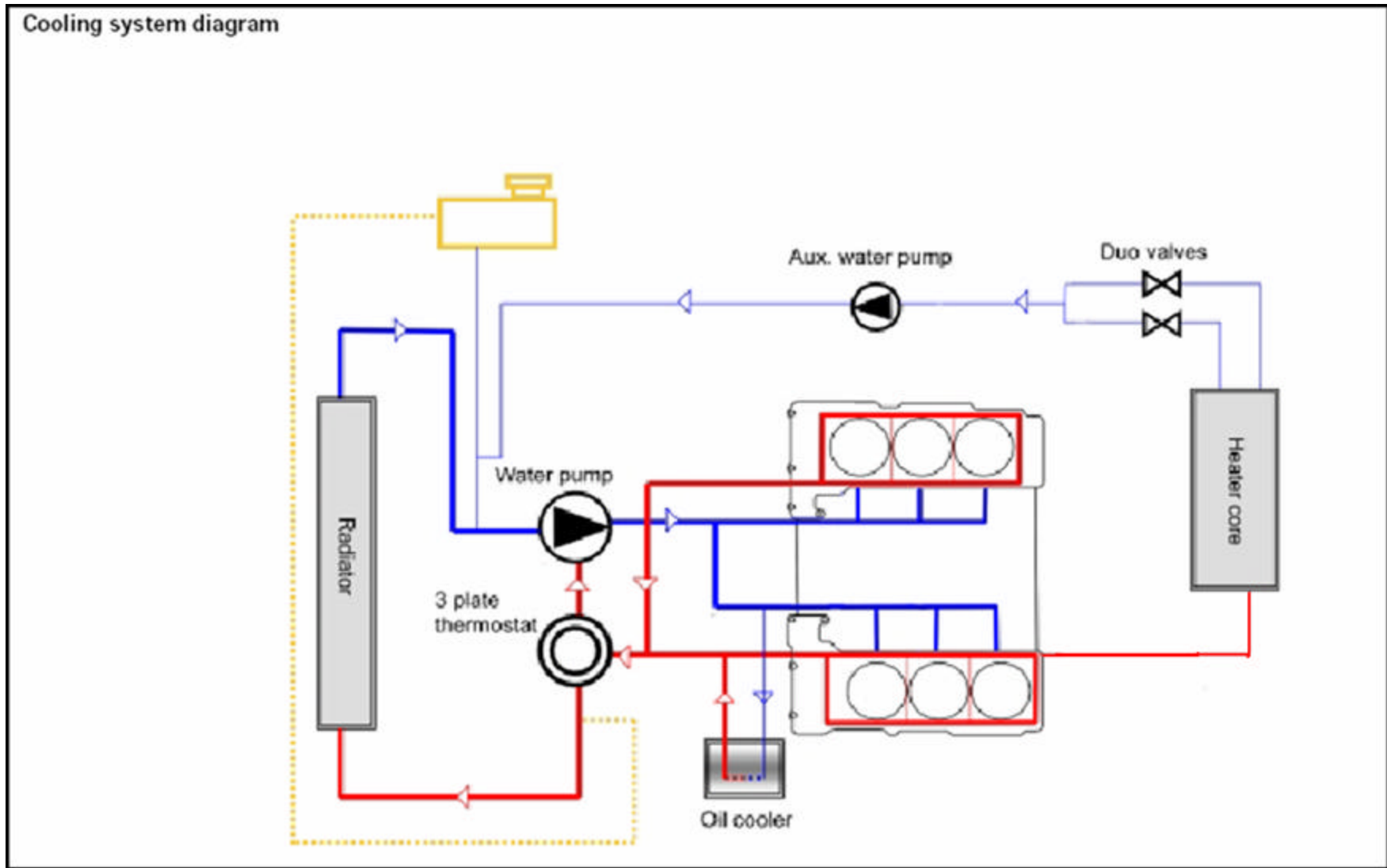


# Temperature Management



- |                 |   |
|-----------------|---|
| 1 – To radiator | A – Stationary coolant (cold start)   |
| 2 – From engine | B – Circuit for engine and heat exchanger                                     |
| 3 – To engine   | C – Active after 208°F (98°C), after start or ambient temp. above 82°F (28°C) |
|                 | D – Position for max radiator operation                                       |

# Temperature Management

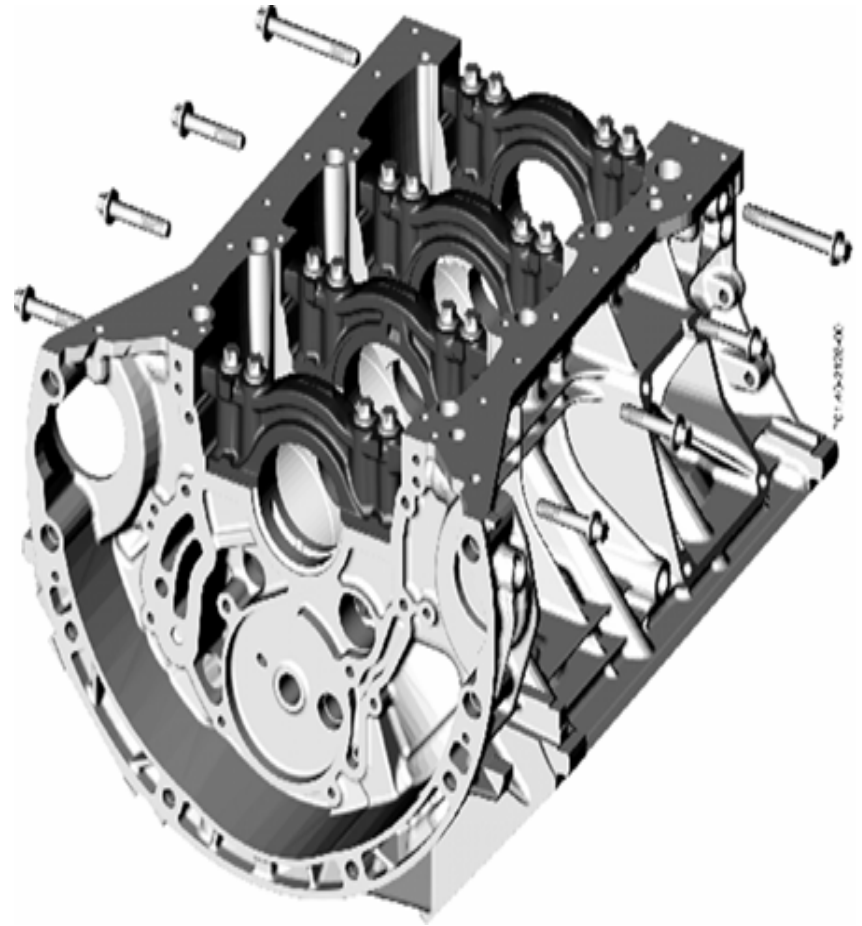


Fuel tank

Fuel pump control

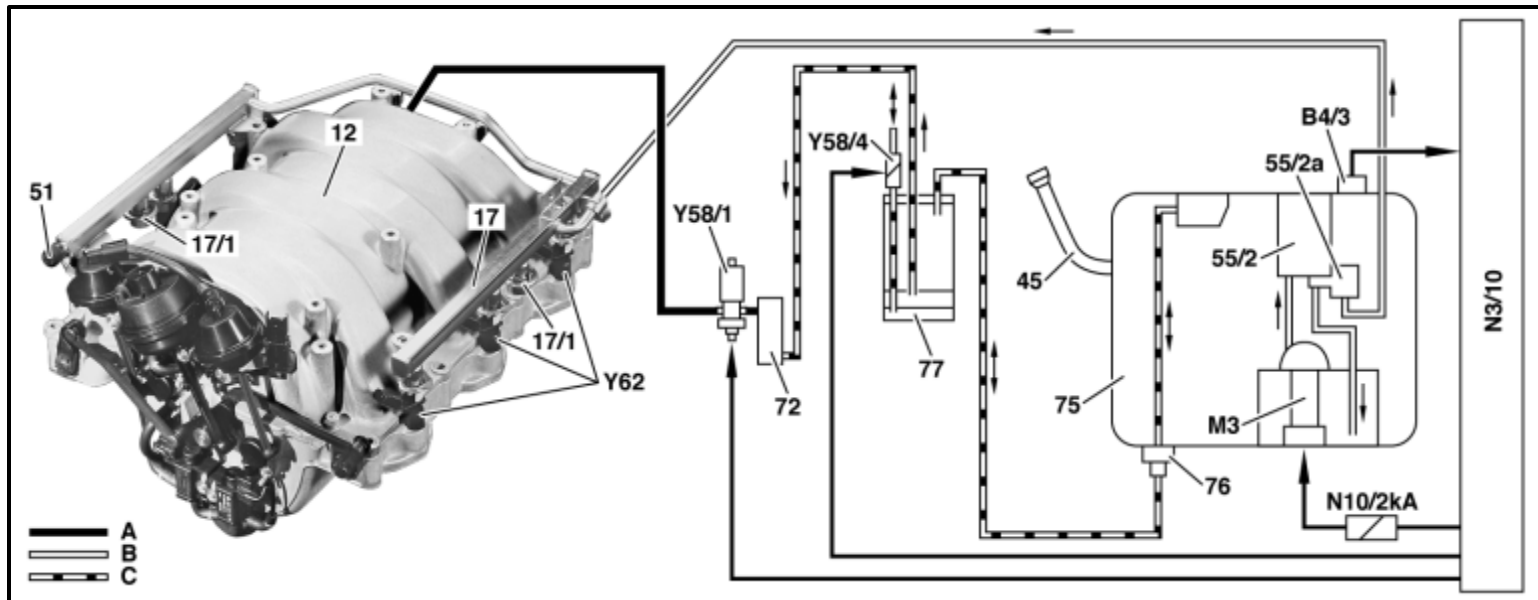
# Fuel Tank

- Magnesium cover helps protect tank
- Two layer steel tank with 18.4 gallon capacity
- In tank fuel supply system operates with 3.8 bar pressure
- Fuel filter with pressure regulator
- Returnless fuel system



# Fuel Networking

A Electrical line  
B Fuel pipe  
C Purge line



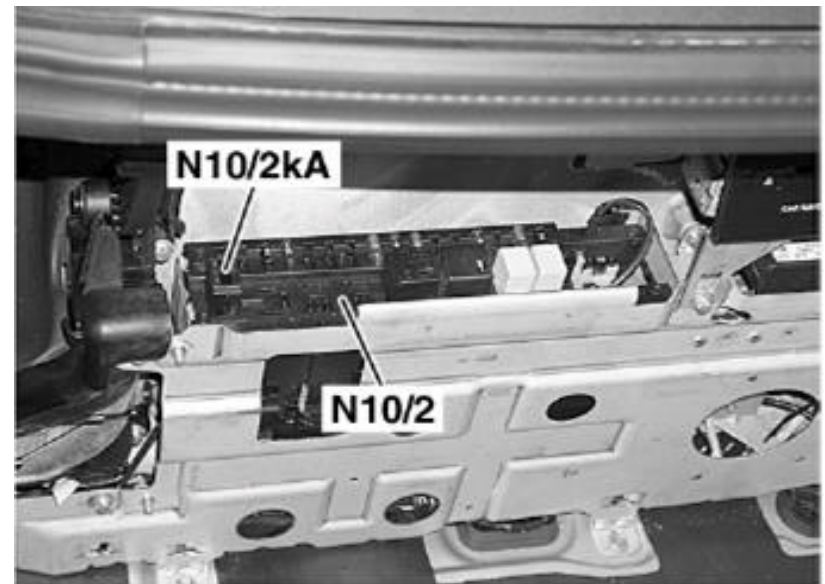
12 Intake manifold  
17 Fuel rail  
17/1 Fuel pressure reservoir  
45 Fuel filler neck, with ORVR  
51 Pressure gauge connection  
55/2 Fuel filter  
55/2a Fuel pressure regulator 3.8 bar

75 Fuel tank  
76 Vent valve, except USA  
77 Activated charcoal canister  
B4/3 Fuel tank pressure sensor  
M3 Fuel pump assembly (with integral fuel pump (FP))

N10/2kA Fuel pump relay  
N3/10 ME-SFI control unit  
Y58/1 Purge control valve  
Y58/4 Activated charcoal filter shutoff valve  
Y62 Fuel injection valves

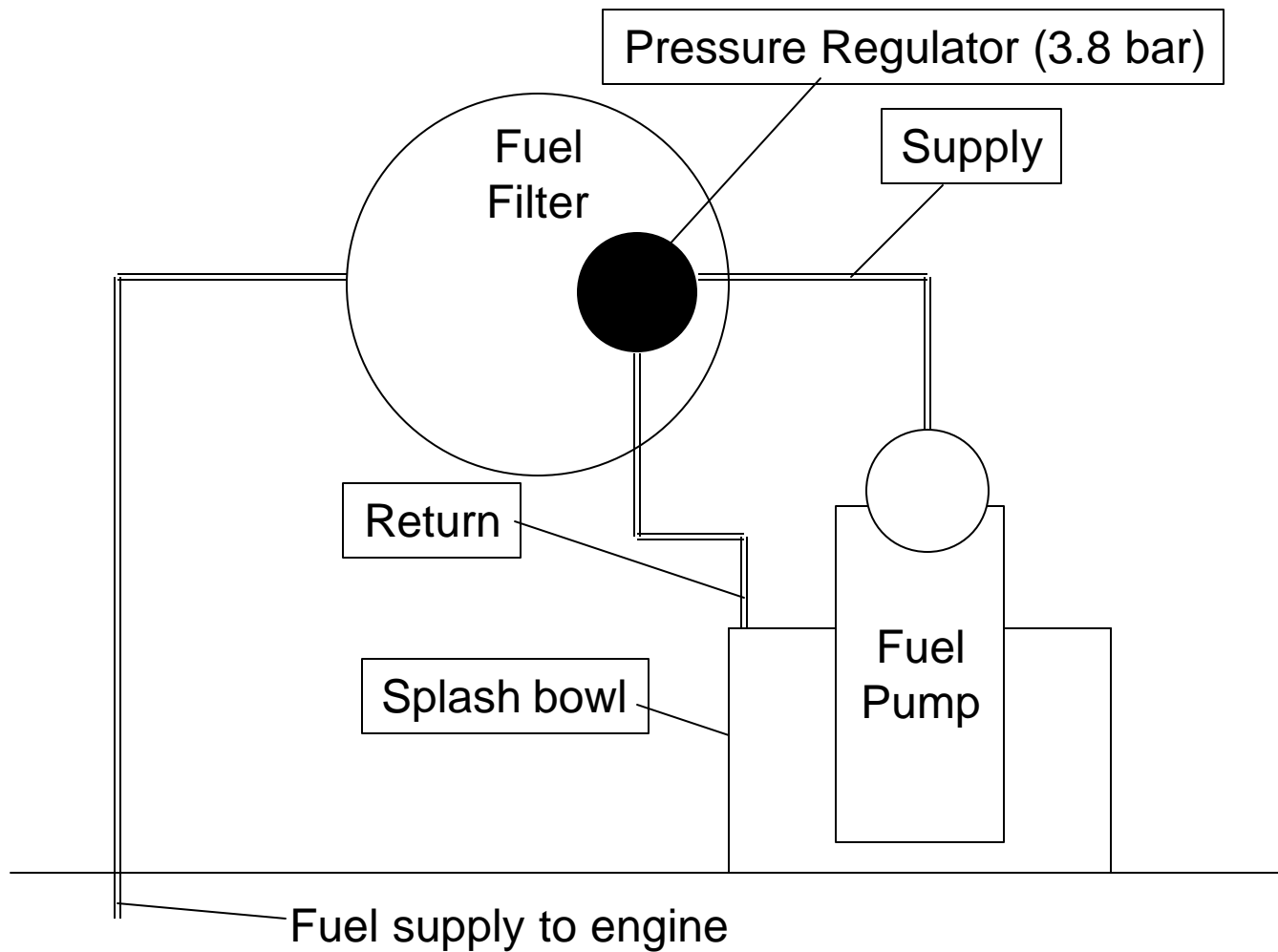
# Fuel Pump Control

- Fuel pump controlled via fuel pump relay (N10/2kA)
- Fuel pump Relay located in rear SAM (N10/2)
- Fuel pump relay energized via ME
- Fuel pump runs ~ 1 second after ignition on

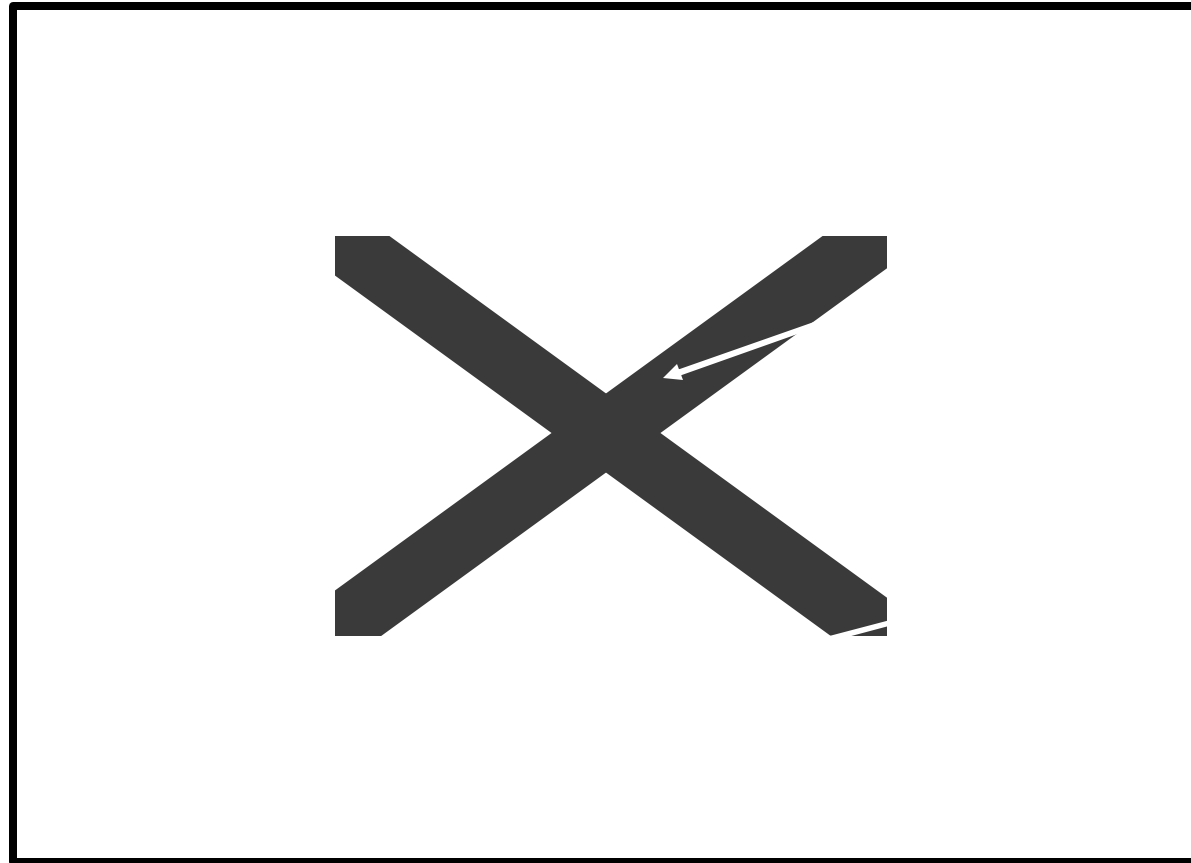


N10/2 – Rear SAM  
N10/2kA – Fuel pump relay

# Fuel Supply Circuit In Tank



# Access Point To Fuel Filter and Pump

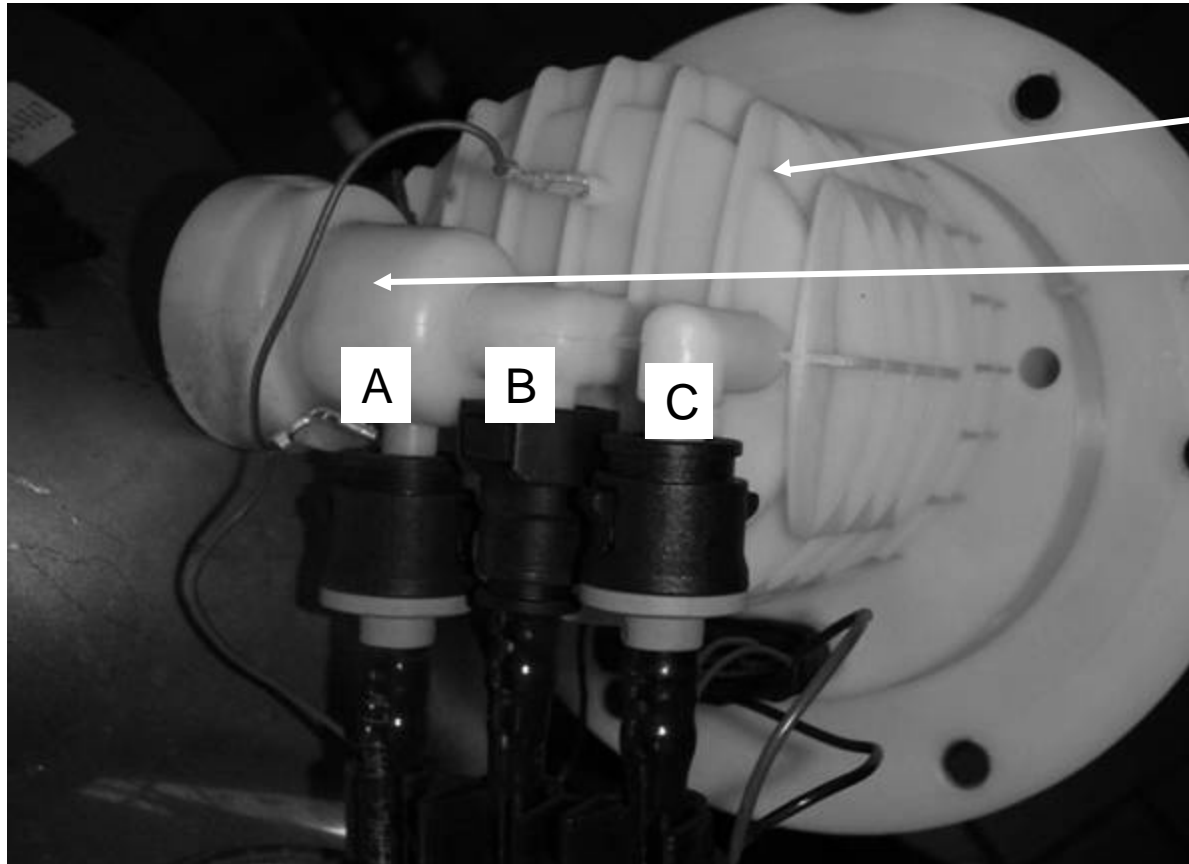


Tank  
Pressure  
Sensor

Connector  
For pump  
And level  
sensor



# Fuel Pressure Regulator



Filter

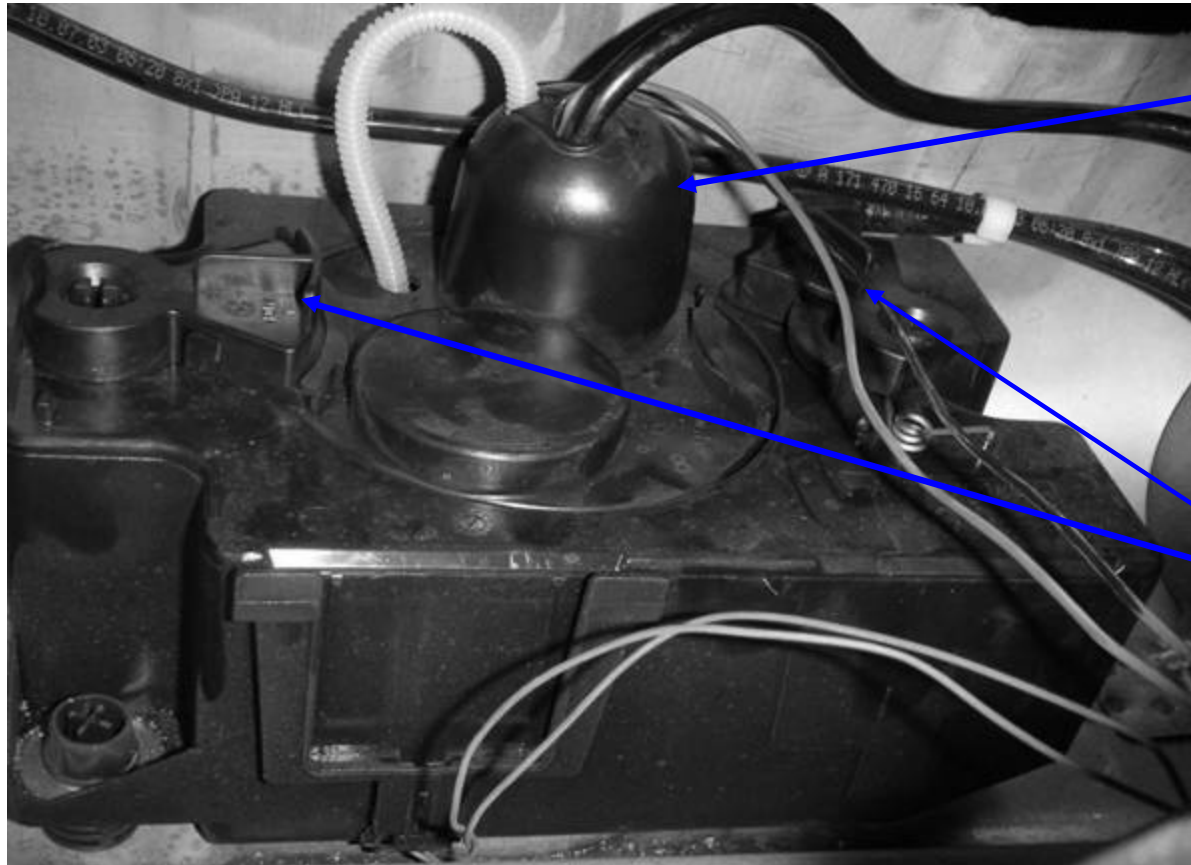
Pressure  
regulator

A-from pump  
B-return to  
splash bowl  
C-filtered fuel  
to engine

# Fuel Level Sensor



# Splash Bowl

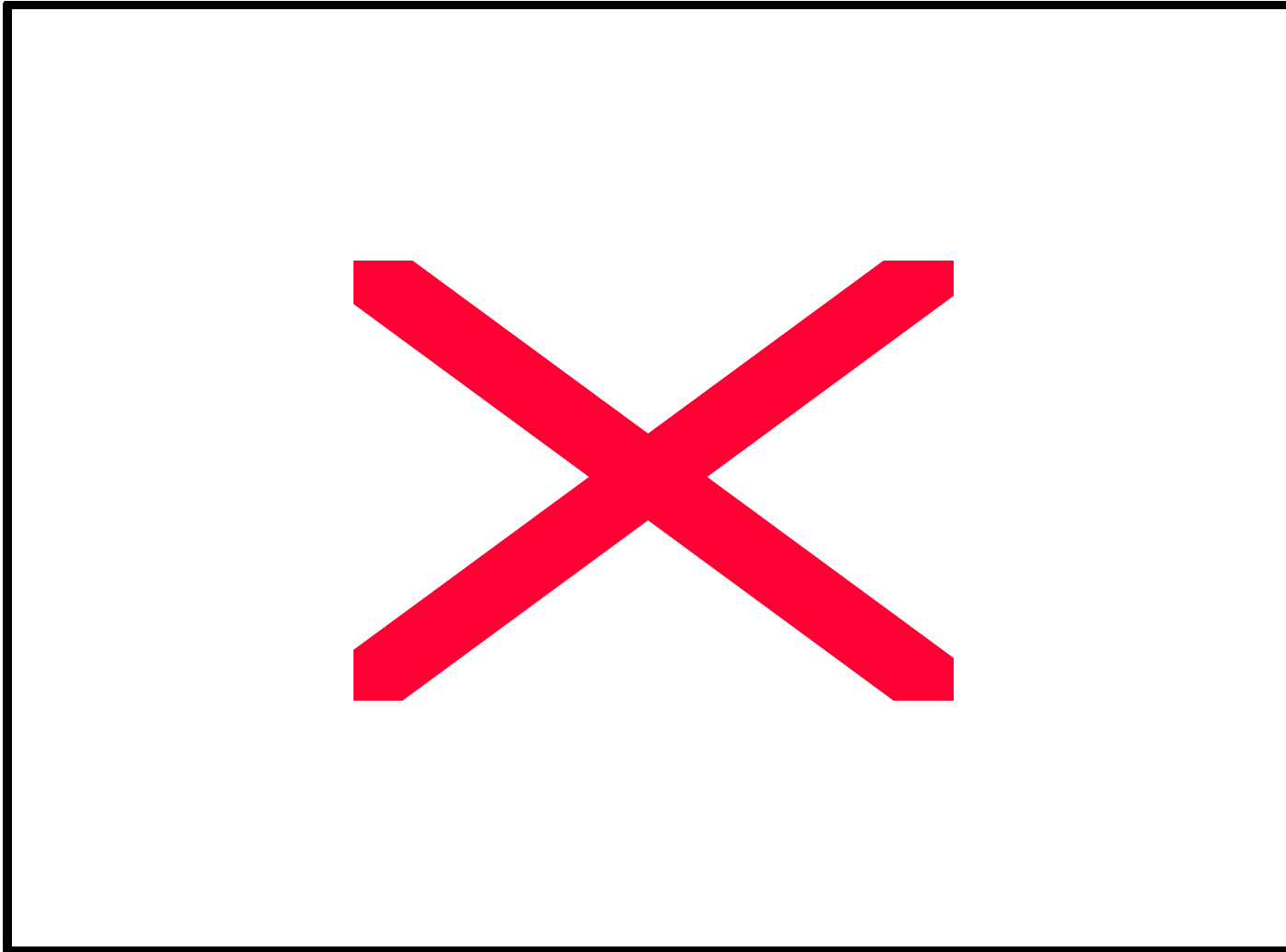


pump

Swivel  
2 retainers  
to remove  
pump

# Fuel Pump





N3/10 – ME 9.7  
A1 – Instrument cluster  
N10/2 – Rear SAM

B4 – Fuel level sensor  
75 – Fuel tank

# Speed Sensitive Power Steering

# Speed Sensitive Power Steering

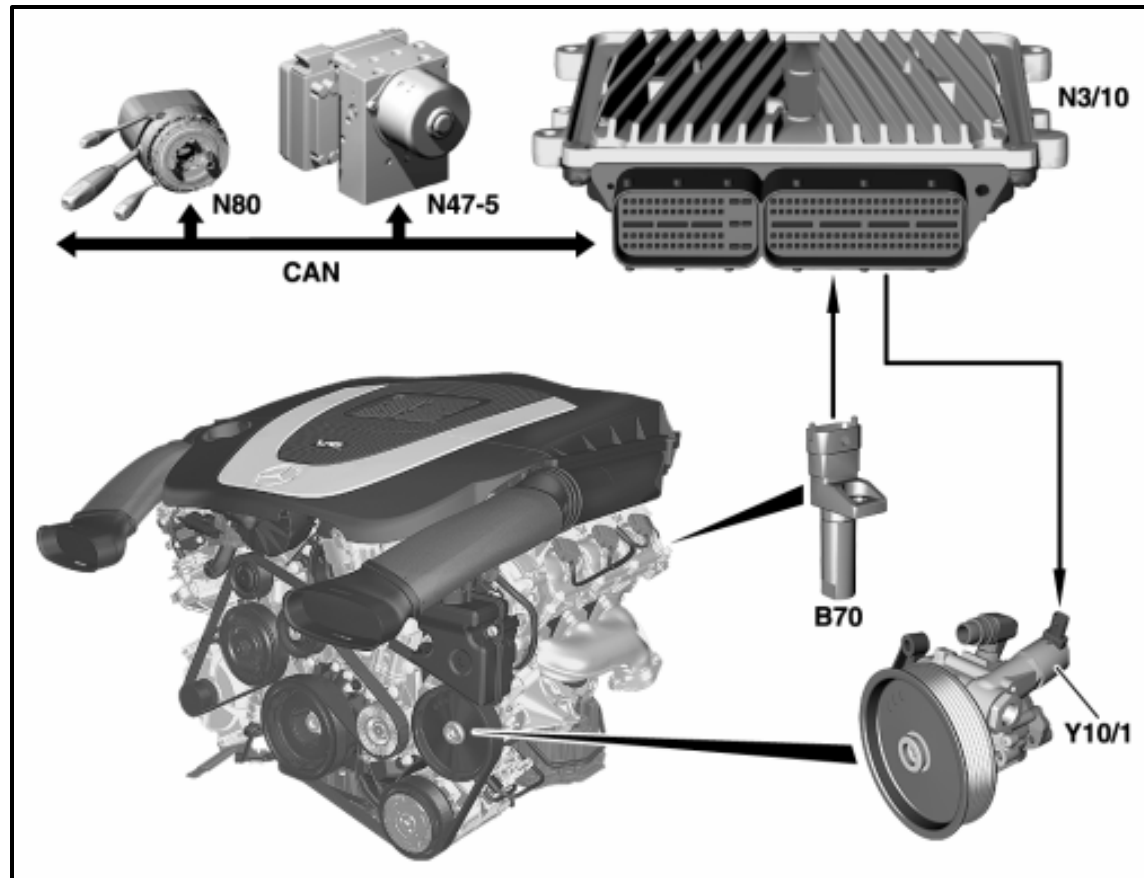
- Gives the customer firmer feel in steering at higher speeds and more assist for parking maneuvers at slower speeds
- ME 9.7 now controls functions of the Speed Sensitive Power Steering system
- The valve port is adjusted for steering support required for the current driving condition and is dependent on the following input signals:
  - Engine speed
  - Vehicle speed (Via CAN)
  - Steering angle (Via CAN)
  - Steering angle speed (Via CAN)

# Speed Sensitive Power Steering

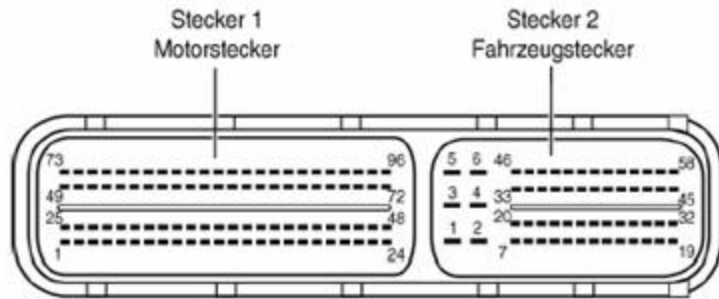
- The pressure regulator valve controls the valve port and is rigidly connected to the power steering pump
- It is actuated according to a performance map with a duty cycle of 10 to 90% and regulates the amount delivered to the power steering pump at between 2 and 9 liters/minute
- The pressure regulator valve is opened wide for ignition ON and during engine start
- In the case of faults on the input signals or on the pressure regulator valve, actuation is interrupted immediately and the maximum support is available from the power steering pump



# Speed Sensitive Power Steering Networking



- B70 Crankshaft Hall sensor
- N3/10 ME-SFI control unit
- N47-5 ESP and BAS control unit
- N80 Steering column module
- Y10/1 Power steering pump pressure regulator valve



Connector 1 Motor connector (M) Connector 2 Vehicle connector (F)

Pin	Signal/Signal info
1	Camshaft timing adjuster intake, right bank
2	Not used
3	Injection valve end stage, cyl.6
4	Not used
5	Pressure control valve steering assist pump
6	Ignition signal 1 ignition coil cyl.1
7	Ignition signal 3 ignition coil cyl.3
8	Ignition signal 5 ignition coil cyl.2
9	Not used
10	Camshaft sensor exhaust right bank
11	Lambda sensor before CAT right bank (Nernst voltage)
12	Lambda sensor before CAT left bank (trim resistor)
13	Signal lambda sensor in CAT left bank
14	Lambda sensor before CAT right bank (virtual ground)
15	Sensor ground 1
16	Sensor ground 2
17	(Sensor ground)
18	Not used
19	Switch over solenoid valve (EUV) turbulence flap
20	Not used
21	Variable intake manifold valve
22	Injection valve end stage, cyl.4
23	Injection valve end stage, cyl.1

24	Camshaft sensor exhaust right bank
25	Heater lambda sensor in CAT left bank
26	Injection valve end stage, cyl.5
27	Heater lambda sensor in CAT right bank
28	Not used
29	Not used
30	Ignition signal 2 ignition coil cyl.4
31	Ignition signal 4 ignition coil cyl.6
32	Ignition signal 6 ignition coil cyl.5
33	Not used
34	Camshaft sensor exhaust left bank
35	Lambda sensor before CAT left bank (Nernst voltage)
36	Lambda sensor before CAT left bank (pump voltage)
37	HFM - Signal secondary air pump (SULEV - not USA)
38	Lambda sensor before CAT left bank (virtual Ground)
39	Sensor ground throttle plate potentiometer
40	Sensor ground lambda sensor in CAT left bank
41	Signal lambda sensor in CAT right bank
42	5V Sensor power supply 1
43	5V Sensor power supply throttle plate potentiometer
44	5V Sensor power supply 2
45	LIN - interface
46	Not used
47	Injection valve end stage, Cyl.3
48	Camshaft timing adjuster intake left bank
49	Heater lambda sensor before CAT right bank
50	Not used
51	Injection valve end stage, Cyl.2
52	Not used
53	Secondary air valve
54	3-plate thermostat
55	Not used
56	Camshaft sensor intake left bank
57	Camshaft sensor intake right bank
58	Not used
59	Signal A knock sensor left bank
60	Signal A knock sensor right bank
61	Lambda sensor before CAT right bank (trim resistor)
62	Not used

63	Position sensor turbulence flap left bank
64	Not used
65	Not used
66	Signal coolant temperature sensor
67	Not used
68	Not used
69	Signal hot film MAF
70	Not used
71	Heater shut off valve
72	Not used
73	Heater lambda sensor before CAT left bank
74	Motor (plus) throttle plate motor
75	Motor (minus) throttle plate motor
76	Not used
77	Not used
78	Not used
79	Not used
80	Ground crankshaft sensor
81	Signal crankshaft sensor
82	Not used
83	Signal B knock sensor left bank
84	Signal B knock sensor right bank
85	Lambda sensor before CAT right bank (pump current)
86	Signal manifold absolute pressure sensor
87	Oil pressure switch
88	Signal throttle plate potentiometer 1
89	Position sensor turbulence flap left bank
90	Not used
91	Not used
92	Not used
93	Reference signal (temperature) hot film MAF
94	Oil level switch
95	Camshaft timing adjuster exhaust left bank
96	Not used

# Questions?