

VIN: 3A56257 Vehicle: MINI/F56/HAT/Cooper/B38/AUTO/USA/LL/2014/09

System Version: 3.46.30.12832 Data Version: R3.46.30.12832

Knock control

A compression ratio of up to 11.0:1 is high for a turbocharged engine. Knock control monitors the combustion process. The knock control features extended functionality. The DME digital engine electronics system is also capable of detecting high-intensity "super-knocking" (a type of auto-ignition).

Brief component description

Knock sensor



Note!

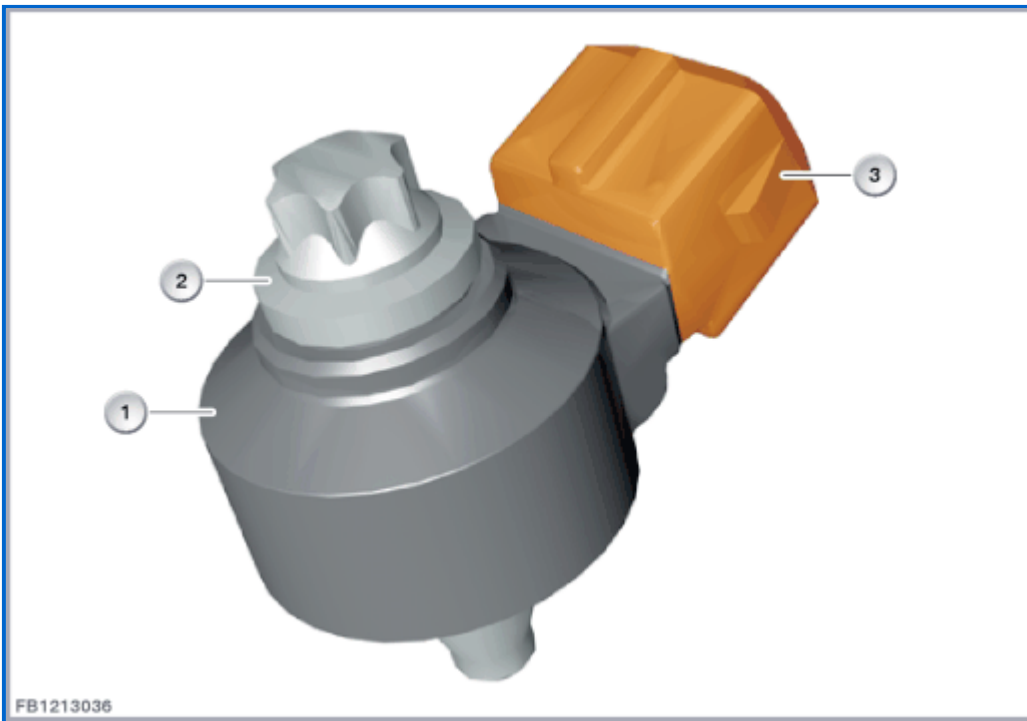
3-cylinder engines have 1 knock sensor. 4-cylinder engines have 2 knock sensors.

The knock sensors detect oscillations in the structure-borne noise from the engine block. Combustion events accompanied by knock generate structure-borne noise characterised by a specific oscillation pattern; this is registered by the knock sensors for subsequent processing in the DME engine-management system's module. The DME digital engine electronic system's knock control can then subdue the combustion knock with countermeasures such as adjusting the ignition timing.

The tendency for combustion knock to occur is influenced by the following factors:

- Pressure
- Temperature
- Fuel-air mixture
- Fuel grade (research octane number/motor octane number).

Combustion with knock contrasts with normal combustion in that portions of the air-fuel mixture ignite suddenly and spontaneously. These ignition events occur before the flame front initiated by the ignition spark during normal combustion reaches the affected portions of the air-fuel mixture. During these events the flame front propagates at velocities exceeding 300 m/s, while the comparable figure for normal combustion is approximately 30 m/s.



Item	Explanation	Item	Explanation
1	Knock sensor	2	Mounting bolt
3	two-pin plug connection		



Note!
 Compliance with the specified torque must be ensured when attaching the knock sensor. An incorrect torque could impact on the knock signal.

When knock persists over an extended period, the pressure waves from this violent combustion of the air-fuel mixture can cause mechanical and thermal damage to the head gasket, the pistons and the cylinder head itself. The knock sensors register the characteristic oscillations from combustion knock and convert them into electrical signals for transmission to the DME digital engine electronics system module. Within the DME module the signals are processed according to firing order to allow correlation with specific individual cylinders.

The knock sensor detects structure-borne noise within a frequency range extending from 5 to roughly 20 kHz. Engine knock generally occurs within an approximate frequency range of 7 to 16 kHz. The DME digital engine electronics system selects the ideal processing frequency for detecting combustion knock with reference to the following factors:

- Engine speed
- Load
- Cylinder

System functions

The following system functions are described:

- Knock control
- Super-knocking

Knock control

The engine is equipped with a cylinder-specific, adaptive knock control system. Knocking tendency is increased by:

- Increased compression ratio
- High cylinder filling
- Low fuel grade/quality (research octane number/motor octane number)
- High intake-air and engine temperatures.

The value of the compression ratio can also become too high due to spread due to deposits or the manufacturing process. For engines without knock control, these unfavourable effects must be taken into consideration when designing the ignition system by applying a safety margin to the anti-knock limit. However, this results in unavoidable losses in efficiency in the upper load range. The knock control prevents knock. It retards the ignition point of the affected cylinder(s) (cylinder-specific) only as far as necessary and only if there is an actual risk of knocking. In this way, the ignition timing map can be adapted to the optimum consumption values (without having to take the knock limit into consideration). A safety distance is no longer necessary. The knock-control system adopts all of the corrections to ignition timing required to prevent knock and also allows completely satisfactory operation on regular petrol (minimum research octane number of 91). The knock control provides:

- Protection against damage resulting from engine knock (also under unfavourable conditions)
- adaptive functionality that allows the system to respond immediately to knock hazards by instantaneously dialing in the correct ignition timing, even under rapidly changing conditions
- Lower fuel consumption and higher torque throughout the entire upper end of the load range (variable according to the fuel grade being used)
- High levels of economy thanks to optimal exploitation of the available fuel grade (octane) and the ability to compensate for variations in the engine's condition.

Self-diagnosis of the knock control system includes the following checks:

- Checks for signal-related malfunctions, such as those stemming from open wires and plug connections
- Self-test of evaluation circuit
- Check of the level of engine-generated noise registered by the knock sensors.

The knock control system is switched off if a fault is found during the course of one of these checks. An emergency program assumes control of the ignition timing while simultaneously imposing a limit on torque generation. At the same time, the relevant fault is entered in the DME fault memory. The emergency program ensures damage-free operation on fuels with a Research Octane Number of 91 or above. The emergency program's response varies according to load factor, engine speed and coolant temperature.



Note!

When multiple knock sensors are installed, the diagnostic function is not able to detect inadvertent reversal of the installation positions for the two knock sensors. Installation of the knock sensors in the correct respective positions is of decisive importance for their correct operation. The length of the connecting cable and the distance to the cable connection identify the correct positions for the individual knock sensors. Ensure that the knock sensors are in the correct positions during installation!

Super-knocking

Super-knocking designates irregular combustion that occurs in engines operating with high-boost forced induction. When this condition occurs the combustion pressure rises from a normal level of roughly 100 bar up to levels as high as 200 bar. This phenomenon is caused by contaminants in particulate form within the combustion chamber that initiate combustion of the air-fuel mixture before the actual ignition firing point. For this reason it is not possible to prevent super-knocking by adjusting the ignition timing. When the DME digital engine electronics system detects super-knock it responds by reducing output to protect the engine. Super-knocking results in deactivation of the injection (for 3 to 6 cycles) on the affected cylinder. A fault (DTC) is also entered in the fault memory in response to recurring super-knock at high engine speeds. Under these conditions a damaged spark plug can be considered as a potential problem source.

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