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Automatic Start/Stop (MSA)

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Automatic Start/Stop

Model: E89 sDrive28i (N20 MT), F10 528i/535i, F12 640i with the N20, N55 w/MT and AT

Production: 9/2010 and 9/2011

OBJECTIVES

After completion of this module you will be able to:

- Understand the operation of the MSA system used in BMW vehicles.
- Identify the components of the Automatic Start/Stop system.
- Understand the difference between MSA and MSA II and its updated features.
- Descibe the prerequisites to the operation of the system.

Introduction

The Automatic Start/Stop (MSA) system was first introduced on European E8x, E9x vehicles in conjunction with manual transmission and four-cylinder engines.

It is one more BMW Efficient Dynamics measure aimed at meeting the voluntary commitment of reducing CO2 emissions while enhancing fuel economy.

The MSA system lowers fuel consumption and emissions by automatically switching the engine off when the car is stationary. The engine is subsequently restarted automatically as well, as soon as the appropriate conditions for restarting are satisfied.

Although the F04 ActiveHybrid 7 uses the MSA function it was never offered in the US in a non hybrid model until its introduction on the E90 M3 (MT and DCT) in 9/2010.

With the introduction of the E89 Z4 sDrive28i (MT) and F10 528i in September 2011 to the US market MSA has been offered as standard equipment. This coincideds with the US launch of the N20 4 cylinder engines in these models.

The F10 535i and F12 640i with the N55 engine are also available with MSA as standard equipment at this time.

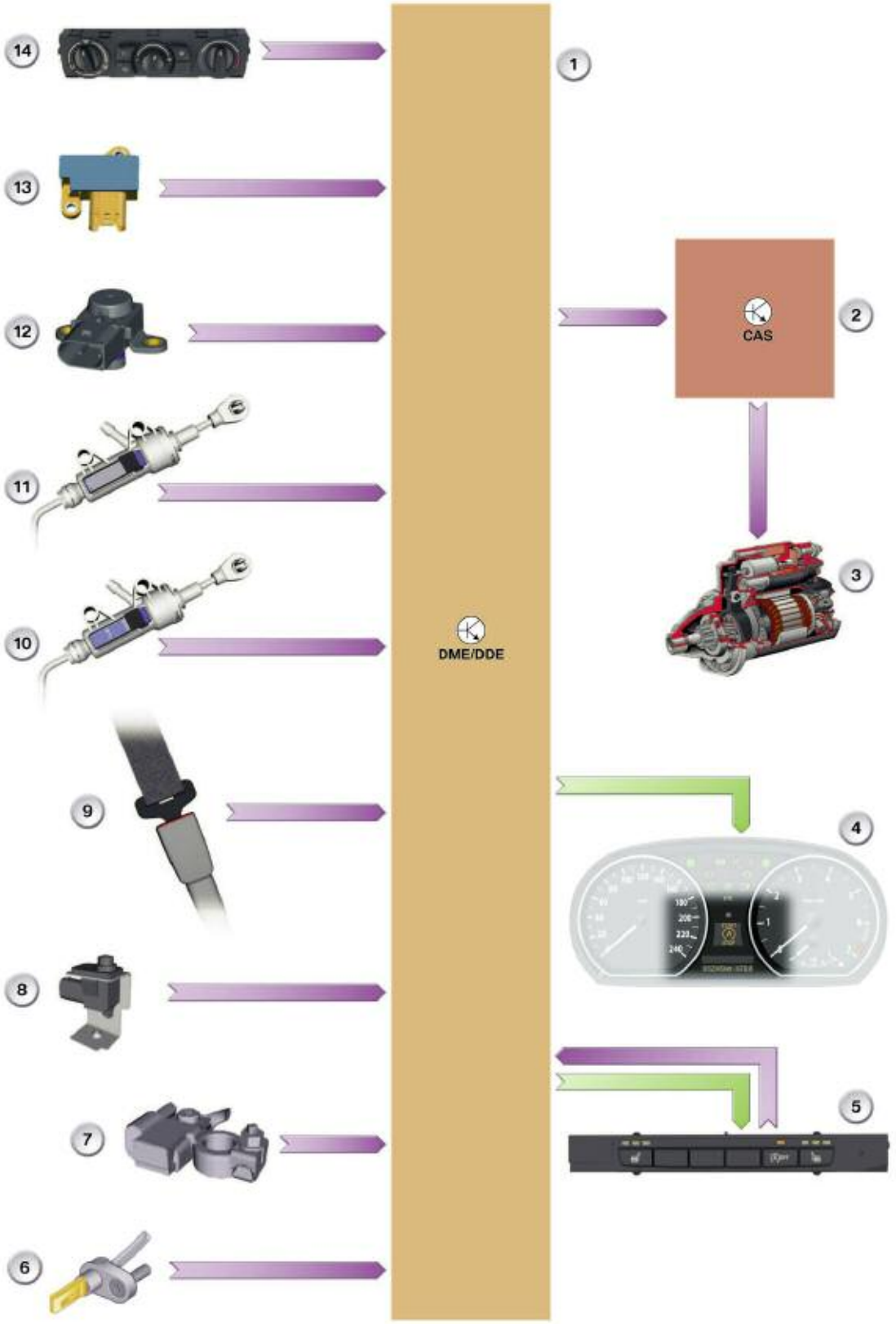
While MSA I is installed in BN2000 models Fxx vehicles use the second generation of MSA (MSA II) which has been further developed to operate in combination with automatic transmissions and the BN2020 electrical system.

Note: The following section describes the basic operation of MSA I on BN2000 vehicles. This material serves as reference information for the MSA II system on BN2020 vehicles as both systems share components and functions. See the MSA II section for more information regarding updated features and functions.

System Overview

The Automatic Start/Stop function is integrated in the engine management (DME). The MSA function makes use of a variety of existing data from the bus system. Various sensors are also required for proper functioning of the system. The input/output diagram in the “System Overview Section” provides a general view of the most important input and output signals.

Input output diagram for automatic start/stop (MSA I)



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2	Car access system
3	Starter
4	Instrument cluster
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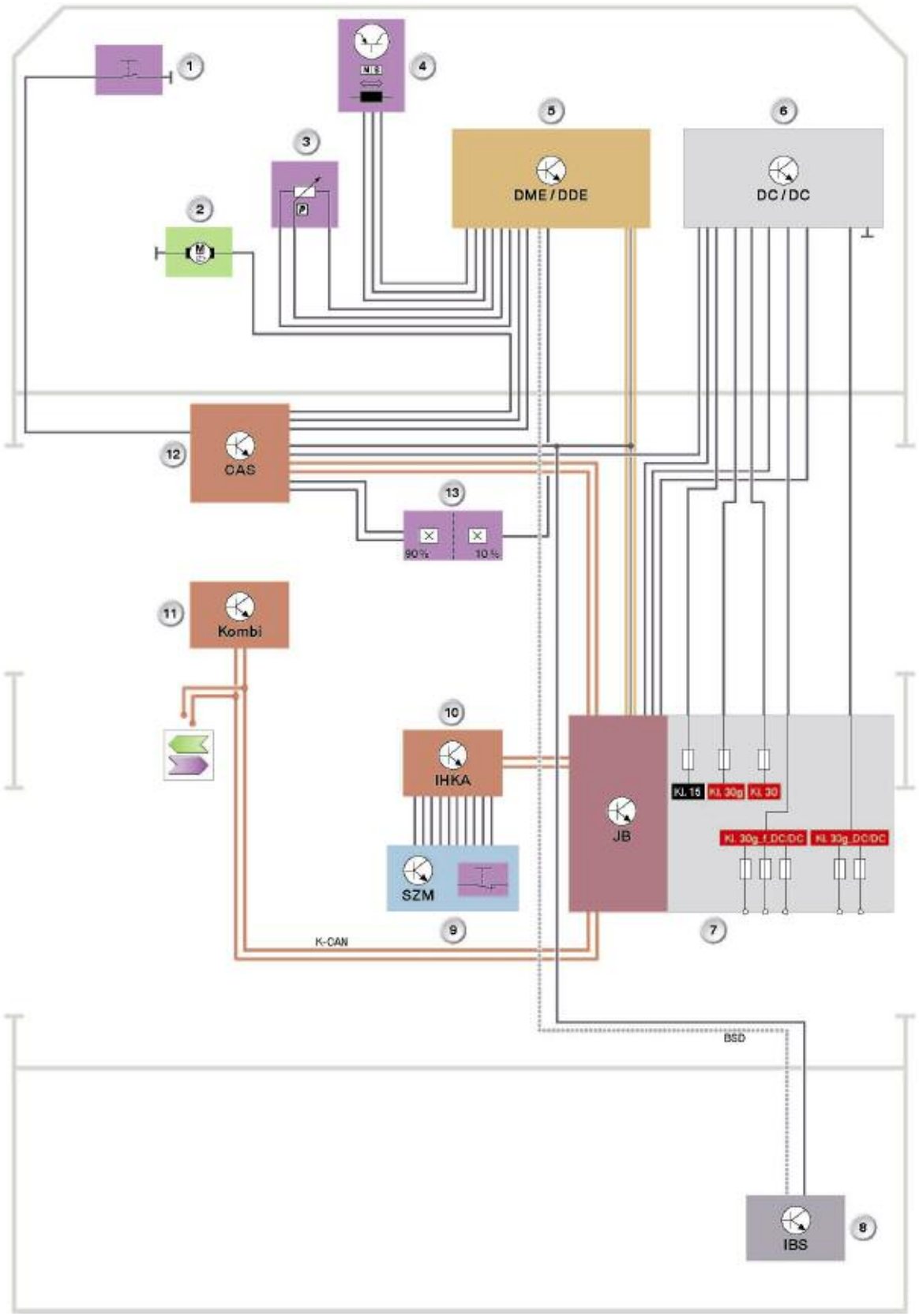
6	Wheel speed sensor
7	Intelligent battery sensor (IBS)
8	Hood contact switch
9	Seatbelt-buckle switch
10	Clutch switch, 90% position
11	Clutch switch, 10% position
12	Brake servo vacuum sensor
13	Gearbox neutral position sensor
14	Automatic climate control (IHKA)

System circuit diagram for automatic start/stop (BN2000)



Index	Explanation
1	Hood contact switch
2	Starter
3	Brake servo vacuum sensor
4	Gearbox neutral position sensor
5	Digital engine management module (DME)
6	DC/DC converter
7	Junction box (control unit with power distribution box)
8	Intelligent battery sensor (IBS)
9	Center console switch cluster with MSA button
10	Automatic climate control (IHKA)
11	Instrument cluster
12	Car access system
13	Gearbox neutral position sensor

K-CAN signals at the DME

In/Out	Signal	Source/Recipient	Function
In	Gearbox neutral position	Neutral position sensor => DME	Stop inhibitor and start inhibitor
In	Brake servo vacuum	Brake servo vacuum sensor => DME	Stop inhibitor and start enabler
In	Engine compartment open/closed	Hood contact microswitch => CAS	MSA deactivation
In	Change of steering angle	Steering-angle sensor => EPS/AL	Stop inhibitor
In	Clutch pedal position 10%	Clutch switch => DME	Start enabler when in neutral, stop inhibitor
In	Clutch pedal 90% position	Clutch switch => CAS	Start enabler when in extended neutral zone, stop inhibitor
In	Driver's seatbelt fastened/unfastened	Seatbelt-buckle switch => ACSM	MSA deactivation
In	MSA on/off	MSA button (center console) => IHKA	MSA activation/ deactivation
In	Battery status	IBS => DME	Stop inhibitor and start enabler
In	Road speed	Wheel speed sensor => DSC	Stop inhibitor and start enabler
In	Evaporator temperature	Evaporator temperature sensor => IHKA	Stop inhibitor and start enabler
In	Degree of misting	Misting sensor => IHKA	Stop inhibitor and start enabler
Out	Display	DME => Instrument cluster	Status indications and CC messages
Out	Start signal	CAS => starter motor	Engine starting

Preconditions

The MSA function can only be performed under certain conditions.

The engine is switched off if:

- the vehicle is stationary (speed below 3 kph/2 mph)
- the vehicle has been driven at over >5 kph/3 mph since the last time the engine was stopped
- the vehicle has been driven at over >5 kph/3 mph since the last time terminal 15 was switched over
- the manual gearbox is in neutral
- the clutch pedal is not depressed
- the steering wheel is not being turned
- the engine speed is approximately idling speed

The engine is restarted in response to driver action if:

- the gearbox is in neutral (see section on neutral position sensor) and the clutch pedal is depressed (10%)
- the gear lever is in the extended neutral zone (see section on neutral position sensor) and the clutch pedal is depressed (90%)

The engine is restarted without action by the driver (only if switched off by MSA if:

- the vehicle starts rolling (5 kph/3 mph forwards or backwards)
- the brake system pressure falls below a defined threshold
- the battery charge level falls below a defined threshold
- the misting sensor detects misting on the windshield (IHKA)
- the evaporator temperature exceeds a certain threshold while the air-conditioning compressor is switched on

The basic condition for restarting the engine is that the manual gearbox is in neutral.

A precise description of all the conditions and exceptions that determine whether or not the MSA can operate is provided in the section "Stop inhibitors and start enablers".

External conditions such as the outside temperature (MSA only operates at temperatures ≤ +3 °C/37.4 °F) can result in the MSA function being unavailable for extended periods. The MSA function is always activated when the engine is not running, terminal 15 is switched on and a so-called "driving cycle" is initiated. The MSA can be switched off by means of the MSA button. The MSA is automatically switched on again the next time a driving cycle is initiated.

When the system is active, the console switch's LED is not illuminated. The following table is an overview of the operational situations when the system is active:

Transmission type	Engine automatically switches off when all of the following requirements are met:	Engine automatically restarts when any of the following items are detected:	Engine does not automatically switch off when any of the following items are detected:
Manual transmission	• After vehicle has been driven over at least 3 mph, but is now fully stopped • Transmission is in neutral and the clutch pedal is not depressed • Driver's safety belt is fastened • Driver's door is closed **Note: If the air conditioning system (A/C) is on, the airflow volume will be reduced.**	• Transmission is in neutral and clutch is depressed • Steering wheel movement	• Steering wheel is being moved, or is at maximum lock • Outside temperature is below 37.4 °F • Engine has not yet reached operating temperature • Vehicle battery is significantly discharged • Hood is unlocked • After driving in reverse • Condensation is detected on windows while A/C is on
M DCT	• After vehicle has been driven over at least 5 mph, but is now fully stopped • Vehicle comes to a full stop using the service brakes • Transmission is either in drive or sequential mode • Driver's safety belt is fastened • Driver's door is closed **Note: If the air conditioning system (A/C) is on, the airflow volume will be reduced.**	• Brake pedal is released • Accelerator pedal is pressed at same time the brake pedal is pressed • Steering wheel movement is detected • Selector lever moved from D or S to N or R	**Same as above, as well as:** • Excessively steep uphill or downhill gradient • Stop-and-go traffic • Brake pedal is released shortly after coming to a full stop

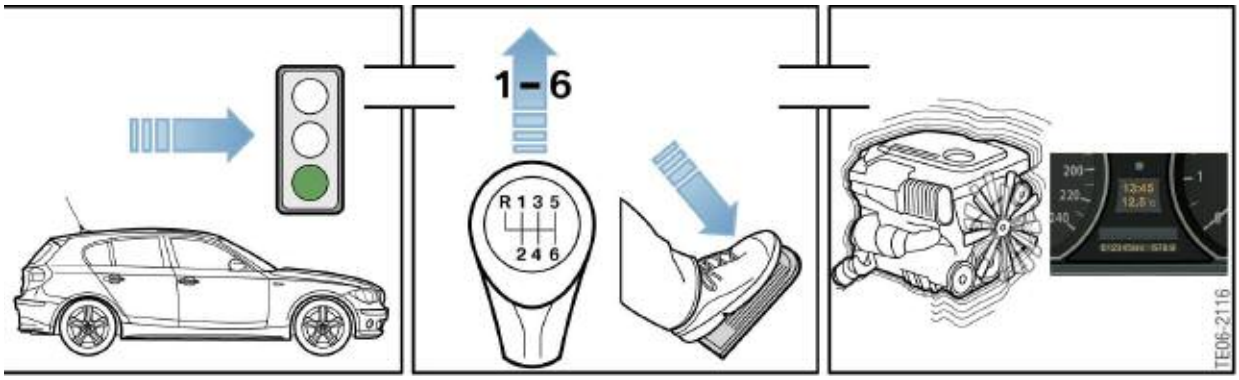
Note: On the M3 with the M DCT the clutch sensor is not monitored by MSA to start and shut down the engine. Instead the DME looks at brake pressure for this purpose.

Note: For information regarding the MSA System on Automatic vehicles refer to the MSA II section of this training material.

Principles of Operation

System Function

Provided all the preconditions are satisfied, the MSA functions as follows:



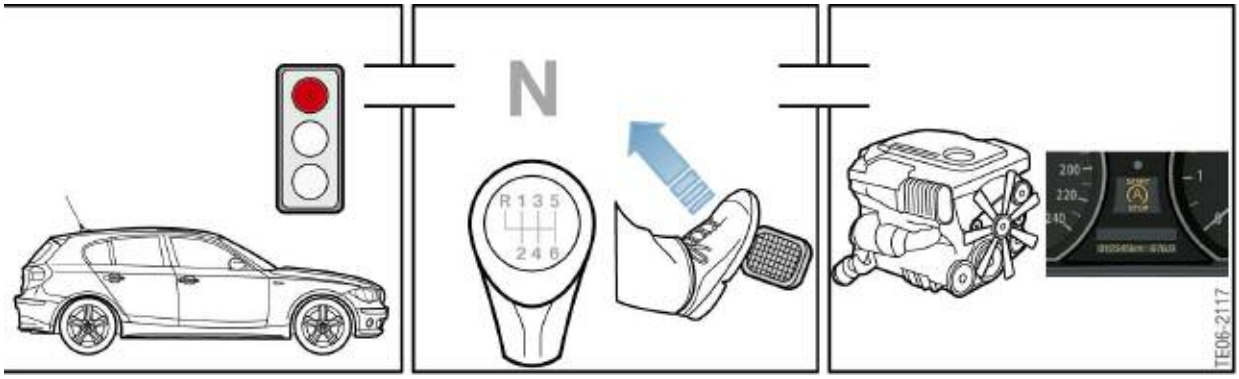
Vehicle is moving...

Gear is engaged...

Accelerator is depressed...

Engine is running...

Instrument cluster shows time and temperature.



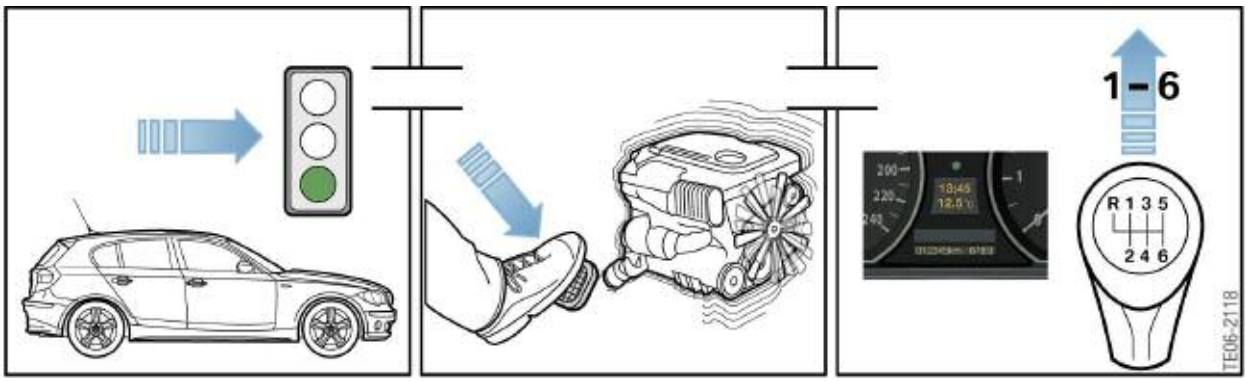
Driver brakes until vehicle comes to a stop...

Driver puts the gearbox in neutral...

and releases the clutch pedal ...

Engine stops...

The instrument cluster shows the "Start/Stop" symbol.



Driver wants to drive off again...

Driver depresses the clutch pedal...

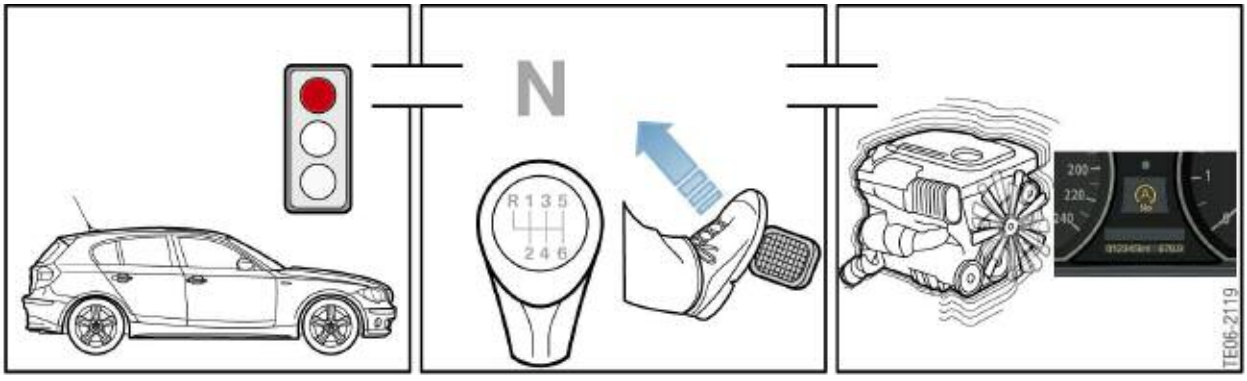
Engine starts...

The appropriate gear can be engaged and the car can drive off...

The "Start/Stop" symbol disappears and time and temperature reappear.

Stop inhibitors and start enablers

The MSA function has to be suppressed under certain conditions. The engine then continues running even though the gear lever is in the neutral position and the clutch pedal has been fully released. Example: stop inhibitor



Driver brakes until the vehicle comes to a stop...

Driver puts the gearbox in neutral...

and releases the clutch pedal...

Engine continues running...

A stop inhibitor is present and the instrument cluster displays the appropriate symbol.

Conversely, there are also situations in which the engine must be started even though the driver takes no active steps (e.g. pressing the Start/Stop button or depressing the clutch).

Note: We must point out that start enablers are conditions that require the engine to start automatically, without action by driver. And start inhibitors are conditions that do not allow the engine to stop.

The following are possible stop inhibitors and start enablers:

- Engine conditioning (stop inhibitor only)
- Battery status
- Electrical system power demand
- Climate control requirements
- Inadequate brake servo vacuum
- Inadequate power steering assistance (stop inhibitor only)
- Various safety requirements (reverse gear engaged, steering wheel movement and deceleration)
- Vehicle starting to roll

Engine conditioning
In addition to its primary function of providing the motive power for the vehicle, the engine also has to perform a number of ancillary functions. These functions are necessary for operational reliability, comfort/convenience and exhaust emissions compliance.

The following conditions prevent the engine from being switched off:

- Engine-coolant temperature below a certain level (dependent on engine model, approx. 20 - 50 °C/68 - 122 °F)
- Activated charcoal filter must have been purged
- Engine not running at idling speed i.e. > 900 rpm.

Alternator capacity utilization
Reduced alternator output capacity or a high level of power demand from the electrical system (I > 60 A) as an average immediately before the point at which the engine would be switched off and which can but must not be reduced or switched off by the APM results in a stop inhibitor.

Battery status

The battery status is a fundamental factor affecting the existence of stop-inhibiting and start-enabling conditions. Computation of the battery status is performed by the Advanced Power Management (APM). That function is integrated in the engine management (see Energy management) and has been extended specifically for the MSA.

The aim is to ensure reliable engine starting from an electrical system viewpoint after the engine has not been running for a defined period. Before the engine is switched off, a reliable prediction of the minimum absolute remaining usable capacity and the minimum voltage level when subsequently restarting the engine from warm is made.

The APM calculates the status of the electrical system on the basis of the following data:

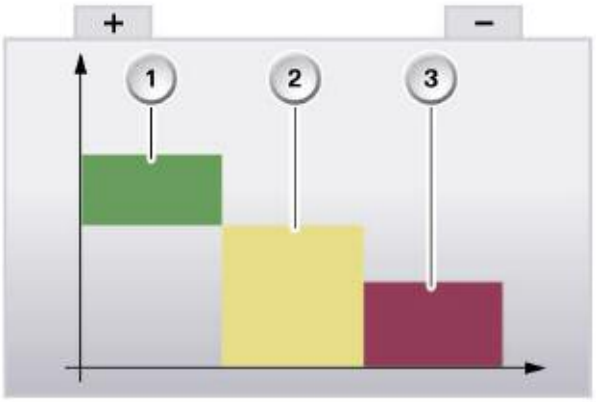
- Battery status
  - – Charge level too low
  - – Charge level implausible
  - – Battery temperature too high
  - – Starting voltage dip too low on previous MSA start
- Power demand from electrical equipment in use

The result can be either prevention or requirement of MSA function.

The following information may be signalled:

- Stop-inhibiting condition
- Start-enabling condition

The MSA responds to battery charge level in the following manner:



Index	Explanation
1	In the green zone, the MSA can function fully
2	In the yellow zone, the engine is not switched off
3	In the red zone, the engine is started

Note: If the battery charge level drops into the red zone after the MSA has switched the engine off, the MSA restarts the engine.

Climate control requirements

Heating mode

If the engine coolant temperature is significantly below the required temperature for heater fan operation, this is treated as a stop inhibitor. In heating mode (while the engine is not running) the electric auxiliary water pump or main electric water pump is activated. The demand is signalled by the climate control panel via the bus system.

Air-conditioning mode

In certain situations it is necessary to ensure that the air conditioning compressor continues to provide cooling capacity so as to dehumidify and lower the temperature in the vehicle's interior.

Depending on equipment the following stop inhibitors may apply:

- Automatic air conditioning: MAX AC button pressed
- Air conditioning: high fan setting and low fan output temperature and compressor button pressed.

The MSA system has to be inhibited if there is a demand for windshield defrosting.

Depending on equipment this is detected by:

- Automatic air conditioning:

  Defrost button pressed and compressor activated

- Air conditioning:

  High fan setting and air flow directed onto windshield and compressor activated

If the misting sensor signal indicates that the windshield is misting, MSA is inhibited if the air conditioning is switched on (stop-inhibiting condition). If this occurs when the engine is switched off, a start command is issued.

If the evaporator temperature rises above a defined threshold when the engine has been switched off by the MSA and the air conditioning is on, this constitutes a start enabling condition which will prompt the engine to start automatically.

If the evaporator temperature is above a defined threshold when the air conditioning is on, this constitutes a stop-inhibiting or start enabling condition.

If the engine has been switched off by the MSA, a less comfortable interior climate may result (dampness/odor).

Note: For further information regarding climate control refer to the MSA II System Components section of this training material.

Inadequate brake servo vacuum
In order to ensure there is always sufficient braking power (even when the engine is switched off) the vacuum in the brake servo has to be continuously monitored.
If required, the engine is automatically restarted, i.e. if the vacuum drops below 500 hPa (0.5 Bar) while the engine has been stopped by MSA.

Power steering
Regardless of the power steering used (EPS or hydraulic) the engine can not be switched off as long as the steering wheel is being turned. In such situations, there must always be power steering assistance available. The MSA system detects steering wheel movement based on the signals from the steering column switch cluster (via the bus system) to determine if the engine can be switched off.

Safety requirements
If the hood is opened, the MSA is deactivated in order to prevent the engine being started automatically when work is being carried out in the engine compartment. The engine compartment lid contact switch is monitored for this purpose. It is always possible to start the engine with the Start/Stop button.

Reactivation of the MSA is possible once the hood has been closed and either the engine has been started or the vehicle speed has reached 5 kph/3 mph.

If the driver gets out of the vehicle, the MSA is deactivated in order to prevent the engine being started automatically.

The driver's seatbelt buckle is monitored for that purpose.

- If the driver's seatbelt buckle is unfastened, the MSA is deactivated. The engine can not be switched off by the MSA until the seatbelt buckle is fastened again and the vehicle has reached a speed of > 5 kph/3 mph once (stop inhibitor only).

CAUTION!!! **The engine may be started despite the seatbelt being unfastened and the hood being open if the vehicle speed exceeds 5 kph/3 mph.**

- If an automatic start demand is issued, a CC message is generated.
- Reactivation of the MSA is possible once the driver's seatbelt has been fastened and either the engine has been started or the vehicle speed has reached 5 kph/3 mph.

The signal indicating the status of the seatbelt-buckle switch is provided by the safety system via the bus system.

Preventing the engine being switched off if the vehicle is moving
On no account must the engine be switched off if the vehicle is moving. The engine can not be switched off until the vehicle speed is below 3 kph/2 mph.

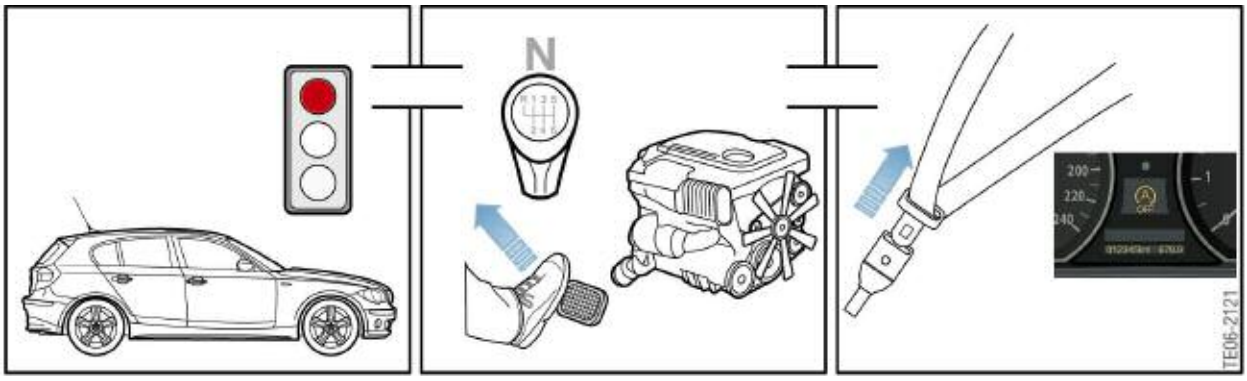
Preventing automatic engine starting when a gear is engaged
If a gear is engaged on a vehicle with manual transmission, automatic engine starting must be prevented.

Detection of when the drive is disengaged is performed by means of the gearbox neutral position sensor.

System-related deactivation
The MSA can also be deactivated for system related reasons. A CC message is displayed to the driver on the instrument cluster if a start request is received.

The following deactivators can be responsible for system-related deactivation:

- Seatbelt-buckle signal
- Hood contact switch
- Engine emergency mode
- Implausible sensor or bus signals
- Vehicle being towed
- Key not detected (Comfort Access)



Driver brakes until vehicle comes to a stop...

Driver puts the gearbox in neutral...

and releases the clutch pedal...

Engine stops...

Driver unfastens seatbelt...

The MSA function is deactivated, the engine remains off...

The engine only restarts if the driver presses the Start/Stop button.

Response to deactivation by a safety function

If the MSA is deactivated by a safety function after the engine has been switched off by the MSA, the engine can only be restarted by the Start/Stop button and if the road speed exceeds 5 kph/3 mph.

Response to deactivation by system faults (emergency mode concept)

If a fault in the MSA system complex (signal inputs, actuator systems, bus signals ...) is detected, a stop inhibitor is set or the MSA deactivated.

Thus, detection of a fault while the engine is running prevents the MSA subsequently switching the engine off at any time. If the engine detects a fault after it has been switched off by the MSA, the following scenarios are distinguished:

1. If a safety-related fault is detected (fault on neutral-position sensor, brake servo vacuum sensor, clutch sensor, enable signal line, hood switch or driver's seatbelt-buckle switch), the MSA is immediately deactivated and automatic restarting of the engine is no longer possible.
2. If other types of fault are detected (DME emergency mode, etc.) which are not safety-critical, the MSA is allowed to start the engine once more. Subsequently, however, the MSA is no longer permitted to switch the engine off.
3. If faults in bus communication with the DME engine management module are encountered, the MSA is deactivated.

If the MSA is deactivated due to a system fault, the instrument cluster displays a CC message (ID397).

Instruction as to further action required (take car to dealer) ID397.

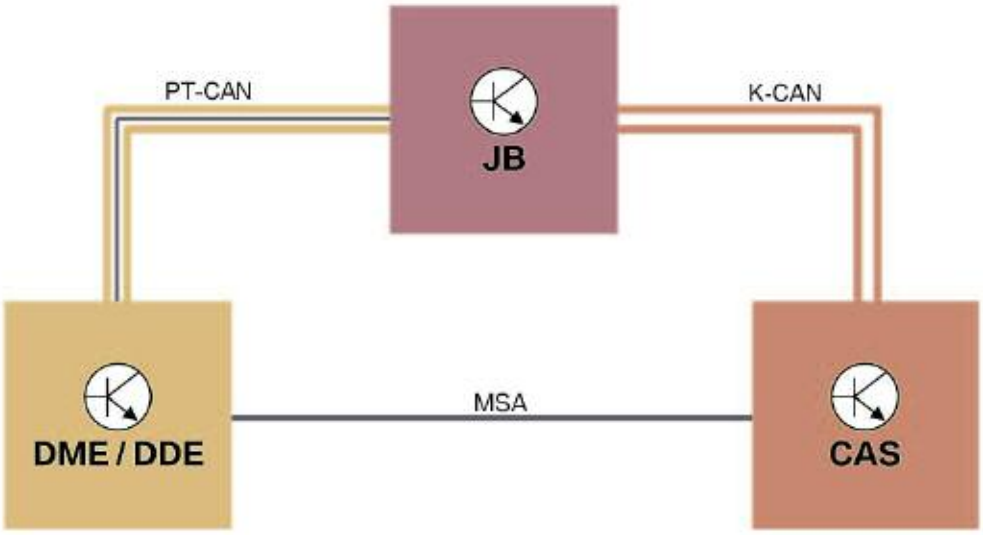
Deactivation due to external conditions

If the seatbelt is unfastened or the hood opened after the engine has been switched off by the MSA, the MSA is deactivated and the engine can only be restarted by the Start/Stop button or if the road speed exceeds 5 kph/3 mph. If the driver attempts to start the car by depressing the clutch, CC message ID450 is displayed after 1-2 seconds.

Signal path in electrical system
The Car Access System (CAS) is only a subordinate control unit in this situation and does not perform any calculations of its own regarding automatic engine starting.

The information for engine starting clearance is transmitted via the bus system in the first instance:

- DME
- PT-CAN
- Junction-box
- K-CAN
- CAS



In addition, clearance for starting is also signalled via a separate line. The CAS compares the two signals. If the time lag between the two signals exceeds a certain limit, the MSA is not allowed to start the engine. A fault memory entry is registered.

Deactivation by MSA button
The MSA function can be manually deactivated by means of the MSA button, in which case the LED in the button lights up.

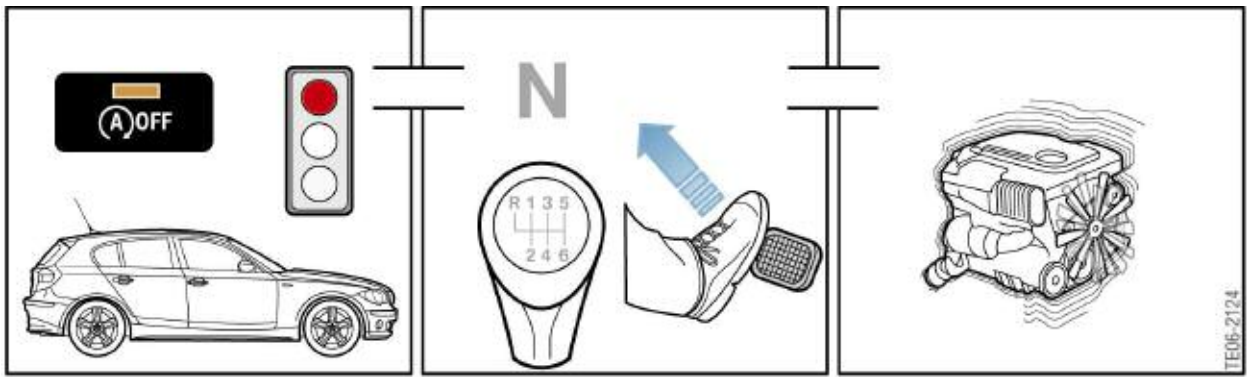
Every time the engine is restarted, the MSA function is reactivated.

Button not pressed

-> LED off

Button pressed; driver wants MSA deactivated

-> LED on



Driver brakes until vehicle comes to a stop...

Driver puts the gearbox in neutral...

and releases the clutch pedal ...

Engine continues running.

Energy management

Availability when engine switched off by MSA

When the engine has been switched off by the MSA, excessive power consumption must be avoided. Therefore, all large consumers of electricity are switched off, or their consumption reduced. The displays remain active.

The following are switched off:

- Rear window heater
- Mirror heaters
- Seat heaters

The following are adjusted to the situation:

- Heater fan

The automatic climate control (IHKA) is responsible for adjusting the heater fan.

Availability while engine is started by MSA

There are restrictions to the following functions while the engine is being started by the MSA:

- Power windows
- Windshield wipers
- Sliding sunroof
- Interior and exterior lights

After the engine has been started, automatic sequences are continued.

If the power windows or sunroof are in the middle of an automatic sequence when the engine is started, the sequence is interrupted.

Once the engine has been started, the automatic sequence is continued. The windshield wipers are also briefly halted while the engine is started.

Multimedia, CD or radio playback is not restricted in any way.

System Components

As already mentioned in the system overview, the MSA function involves a complex system of interactions across the entire bus system. However, the information required is provided by existing signals from other systems.

The following components are necessary for the MSA:

- System's own sensors
  - – Brake servo vacuum sensor
  - – Manual gearbox neutral position sensor
  - – MSA button
- External sensors, e.g.
  - – Clutch switch
  - – Hood contact switch
  - – Seatbelt-buckle switch (driver)

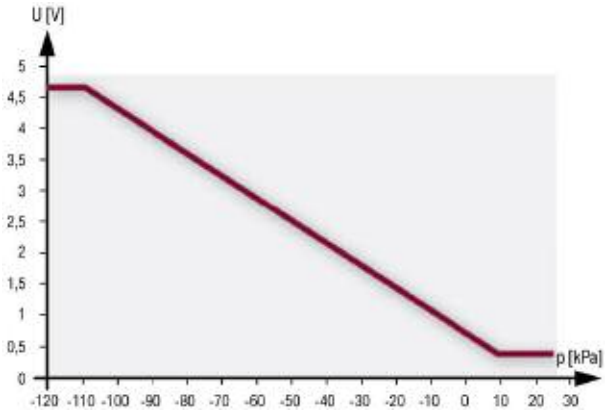
Brake Servo Vacuum Sensor

In order to ensure that there is sufficient vacuum for brake servo assistance at all times, the brake servo is fitted with a vacuum sensor.

The brake servo vacuum sensor is located next to the brake servo and is connected via a separate lead.

Vacuum sensor

Voltage proportional to vacuum



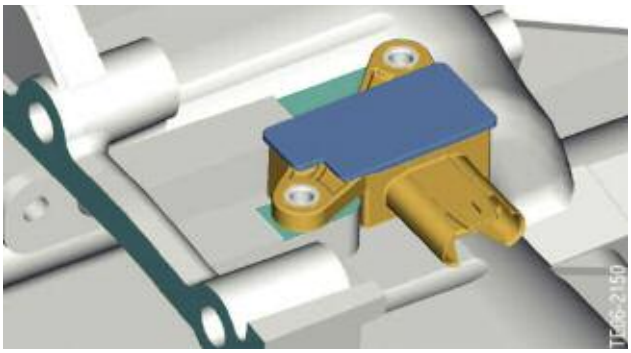
The brake servo vacuum sensor supplies voltage signals proportional to the vacuum present (see graph).

Note: If there is insufficient vacuum, the MSA starts the engine even without action by the driver.

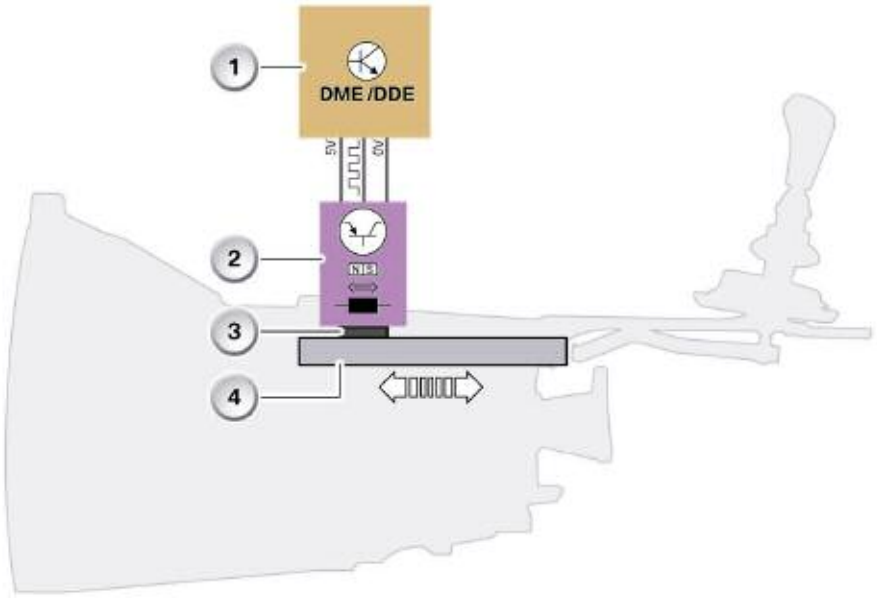
Manual Gearbox Neutral Position Sensor

The neutral position sensor is mounted on top of the gearbox housing and its purpose is to detect when the gear lever is in the neutral position. The neutral position sensor is a PLCD (permanent-magnet linear contactless displacement) sensor.

Manual gearbox neutral position sensor



Method of operation of neutral position sensor

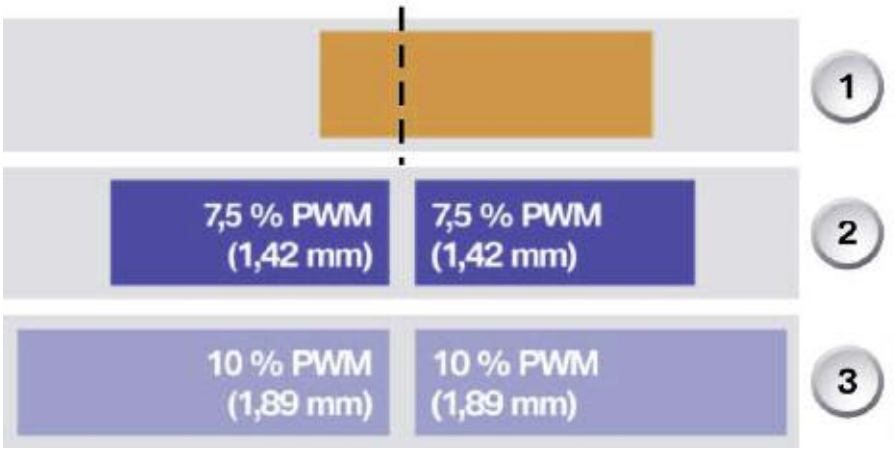


Index	Explanation	Index	Explanation
1	Digital engine management module (DME)	3	Magnet
2	PLCD sensor	4	Gear-shift linkage rod

Moving the gear lever moves the gear-shift linkage rod and, therefore, the magnet. The DME is able to detect the position of the gear lever by means of the PLCD sensor.

The following distinctions have to be made for the purposes of the MSA function:

- Gear engaged - MSA function disabled
- Gear lever in neutral position - MSA starts engine if clutch is depressed by 10%
- Gear lever moved slightly out of neutral position - engine is started if clutch depressed by 90%



Index	Explanation	Index	Explanation
1	PLCD sensor learning zone	3	Engine started if clutch depressed by 90%
2	Engine started if clutch depressed by 10%		

The learning sequence (orange) is necessary to compensate for tolerances in the mechanical and electrical systems.

The DME then calculates the maximum ranges relative to the learned gear-lever neutral position within which the engine can be started if the clutch is depressed.

When the clutch is fully depressed, the engine can still be started when the gear lever is deflected by up to 1.89 mm (10% PWM).

The PLCD sensor is provided with a 5 V power supply. The output voltage is a PWM signal whose pulse duty factor changes according to the position of the gear lever (10 - 90%).

The neutral position sensor has to complete a learning phase. If the DME is replaced, the learned data can be copied by reading the learned position using the diagnosis system (provided the old DME can be read) before the unit is replaced and then writing it to the new unit.

The learning sequence is described in the BMW diagnosis system.

MSA Button

In all models, except the E90 M3, the MSA button is used to deactivate the MSA system. If the terminal 15 signal changes to **on** when the engine is not running or if the MSA button is pressed again, the MSA is reactivated.

The signal from the MSA button is received by the IHKA and passed on to the engine management. The indicator lamp is controlled by the IHKA.

Note: In the E90 M3 the MSA system is OFF by default and is activated by pressing the button in the center console.

Clutch Switch

Index	Explanation
1	10% clutch pedal depression detected
2	90% clutch pedal depression detected

The existing clutch switch signal is used as an input variable for the MSA.

Two statuses are registered:

- 10% clutch pedal depression
- 90% clutch pedal depression

Note: In the M3 the clutch sensor signal is not monitored in the M DCT transmission for the MSA function. Instead the DME monitors brake pressure to determine when to start the engine as the driver wishes to drive off.

Hood Contact Switch

The hood contact switch signal is taken into account as a determining factor in the MSA calculations. If the hood is open, the engine must not be started or stopped by the MSA for safety reasons.

Note: If the hood switch is defective (continuously signals "open"), all MSA functions are suppressed.

CAUTION!!! **If the top of the hood switch is covered over (workshop mode), it signals "Switch closed". The MSA function is active. Caution: the engine may start automatically.**

Seatbelt-buckle Switch

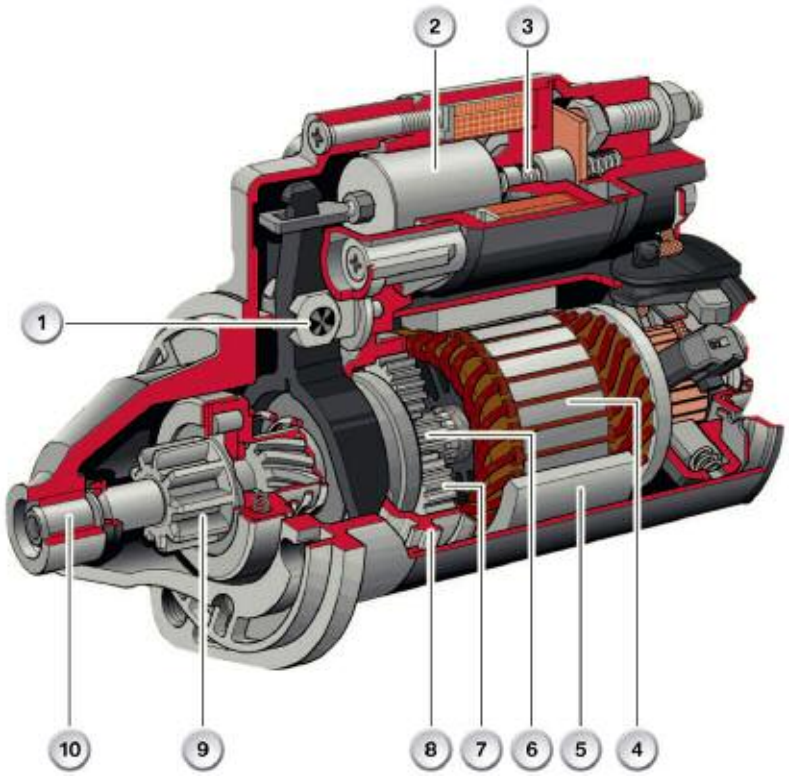
The seatbelt-buckle switch enables the MSA to detect if the driver's seatbelt is fastened. If the driver's seatbelt is not fastened, the MSA responds in different ways depending on the vehicle status.

- If the engine is running, a stop inhibitor is set
- If the engine has been switched off by the MSA, the MSA is deactivated. The engine can only be restarted by means of the Start/Stop button.

Actuators

The MSA indirectly operates the starter motor and indicator lamps/CC or display messages on the instrument cluster.

Starter



Index	Explanation	Index	Explanation
1	Forked lever: reinforced	6	Planetary gears: more direct transmission
2	Relay armature: lubricant coated	7	Planetary gears: needle roller bearings
3	Relay springs: greater number of cycles	8	Planetary gears: sintered internal gear with damper
4	Starter motor (+electrical system): updated, higher power	9	Pinion: number of teeth increased
5	Magnets: higher flux/demagnetization resistance (high torque)	10	Drive shaft bearing: needle roller bearing

With the MSA, the starter motor has significantly more work to do. Therefore, it has been designed for substantially more (approx. 8 times as many) starting cycles.

The components of the starter motor have been adapted to the higher demands (see legend).

Alternator

Due to battery discharge while the engine has been switched off by the MSA, a more powerful alternator is fitted.

Battery

The MSA always comes together with intelligent alternator control (IGR). Due to the substantially more frequent charging and discharging cycles, the load on the battery is very high. AGM batteries provide the possibility of achieving a similar service life despite the high loadings because they have a higher recharging capacity.

AGM batteries with a minimum capacity of 90 Ah are fitted, depending on the vehicle and equipment levels.

As of the introduction of the F10, the intelligent battery sensor IBS is used to improve the battery condition detection. In BN2020 vehicles the following criteria are used to establish whether or not the battery is defective and needs to be replaced:

- Identification of faulty battery cells in the vehicle battery
- Establishing the remaining capacity of the vehicle battery
- Battery water loss detected
- Long immobilization period with low state of charge
- Charge capacity
- Charge balance when the vehicle is at a standstill
- Charge balance when the vehicle is moving
- Lowest permitted discharging
- Discharge via the automatic start/stop function (MSA).

These criteria are recorded using the measured values obtained from the intelligent battery sensor and other measured variables of the voltage supply. Only specific criteria may be used to determine the battery condition, depending on the powertrain and equipment used in the vehicle.

The battery condition detection determines whether the battery needs to be replaced based on the severity and number of defects detected. Furthermore, the vehicle user is notified via the "Check power supply" check control message that a problem may exist. The fault entry can only be deleted once the vehicle battery change service function has been carried out.

The condition of the battery can be read out in Service via the "battery condition" or "energy diagnosis" procedures ("General information “battery" menu) in order to determine whether it needs to be replaced.

Indicator Lamp

There are a number of new indications that provide feedback from the MSA for the driver.

The possible MSA indications are detailed in the next chapter.

Indication concept

The following indications are used in conjunction with the MSA:

If the engine can be started by the MSA, that status is continuously indicated on the instrument cluster. If the driver wants to see the time and temperature, the indication can be suppressed by pressing the computer roller.

If there is a fault on the MSA hardware that causes the MSA to be deactivated, a CC message is displayed.

Text of CC message: "Automatic start/stop has failed."

If the MSA is deactivated to ensure functional safety ("Seatbelt buckle unfastened"), another CC message is displayed as soon as a start compeller is present:

Text: "Automatic start/stop deactivated."

Electrical system stabilization

As a result of the substantially more frequent starting cycles, there are correspondingly more voltage dips in the electrical system due to the electrical load.

In order to stabilize the supply voltage for particularly voltage-sensitive electrical components and thereby protect them, a DC/DC converter is used in conjunction with the MSA.

The DC/DC converter supplies the terminal 30g_DC/DC and terminal 30g_f_DC/DC relays with a constant voltage even during a starting cycle.

The DC/DC converter requires the following control signals:

- Terminal 50
- Terminal 15
- Terminal 30g
- Terminal 30g_f ON
- Terminal 30g_f OFF

The terminal 50 signal is provided by the CAS, the terminal 15 and terminal 30g signals by the junction-box control unit.

The DC/DC converter has a diagnosis output (PWM signal) that provides the following coded information:

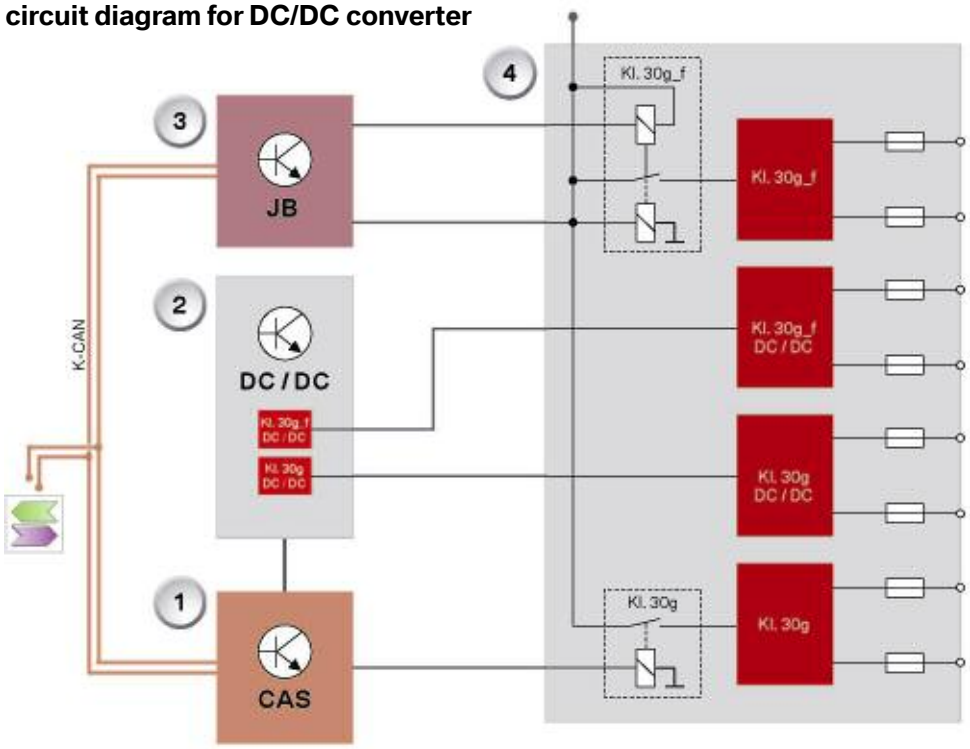
- Converter OK
- Converter defective
- Converter overheated

The diagnosis lead is read and analyzed by the JB.

The DC/DC control unit is located in the electronics box in the engine compartment.

The DC/DC control unit contains the electronic circuitry for converting the voltage and the terminal 30g_f_DC/DC and terminal 30g_DC/DC relays.

System circuit diagram for DC/DC converter

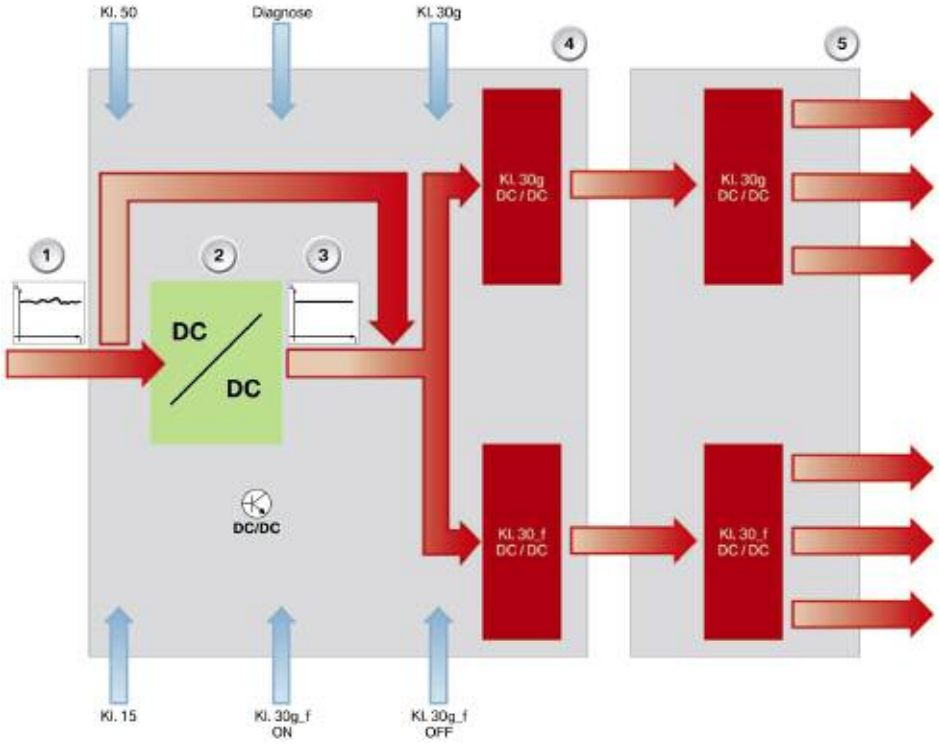


Index	Explanation	Index	Explanation
1	Car access system	3	Junction-box
2	DC/DC control unit	4	Junction-box power distributor

In addition to terminals 30g_DC/DC and 30g_f_DC/DC, the terminals 30g and 30g_f, and therefore the terminal relays, are retained.

Terminal management

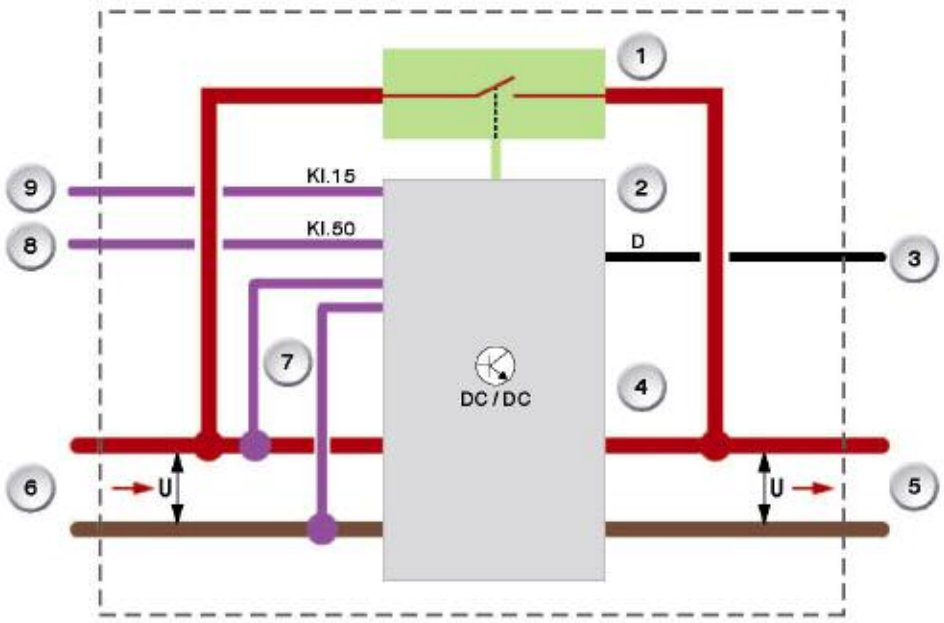
Voltage-sensitive electrical components are supplied with a matched voltage when necessary. That supply is only provided under certain conditions (starting cycle and voltage below 10.5 V). Otherwise, the connected control units are supplied with the normal electrical system power supply diverted through the DC/DC converter.



Index	Explanation	Index	Explanation
1	Electrical system power supply under various loads before DC/DC converter	4	DC/DC control unit
2	DC/DC converter	5	Junction-box power distributor
3	Electrical system power supply under various loads after DC/DC converter		

DC/DC control unit

Inside the DC/DC converter is the actual converter module that, depending on conditions, provides either a matched voltage or the normal electrical system power supply voltage for the terminals 30g_DC/DC and 30g_f_DC/DC.



Index	Explanation	Index	Explanation
1	Bypass switch	6	Input voltage subject to electrical system fluctuations
2	DC/DC module	7	Input voltage testing leads
3	Diagnosis lead	8	Terminal 50 data lead
4	DC/DC converter	9	DC/DC module power supply
5	Stabilized electrical system voltage		

The DC/DC module uses the input voltage testing leads and terminal 50 to decide whether to supply the DC/DC terminals via the bypass or the DC/DC converter.

The relays 30g_DC/DC and 30g_f_DC/DC are also accommodated in the DC/DC control unit.

The terminal 30g and terminal 30g_f relays are retained in the power distributor.

The DC/DC control unit basically operates in the following modes:

- Boost mode
- Bypass mode

Bypass mode

In bypass mode, the electrical system power supply is not fed through the DC/DC converter. A bypass passes it straight through to the outputs of the DC/DC converter.

Boost mode

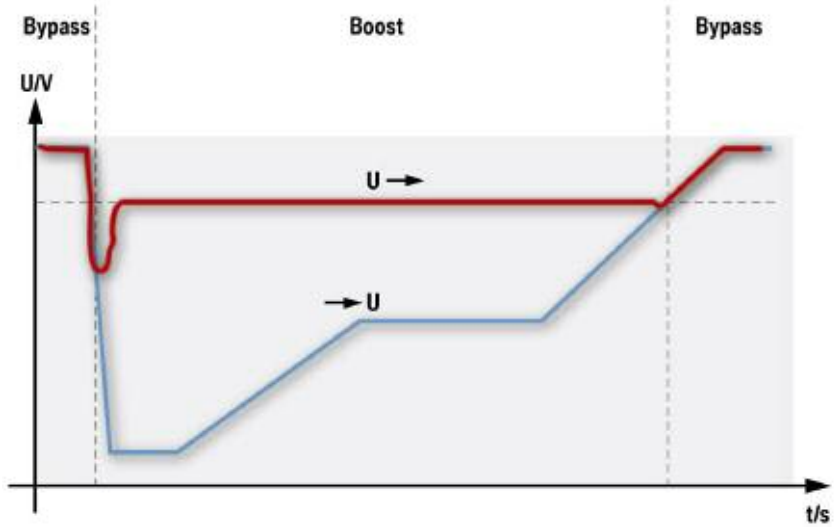
In boost mode, the electrical system voltage is adjusted. The decision as to when stabilization is necessary/possible is dependent on the following factors:

- Terminal 50 on/off
- and input voltage at the DC/DC converter.

Terminal 50

Boost mode is activated if terminal 50 is on and the voltage drops below 10.5 V. As soon as terminal 50 is active, the DC/DC converter goes into a standby mode in order to improve response characteristics. Not until the voltage drops below the defined threshold of 10.5 V is boost mode activated and the matched voltage supplied to the terminal 30g and 30g_f relays.

Typical voltage progression when engine is started



The blue line represents a typical voltage progression when the engine is started. Depending on external factors, the voltage may drop as low as 7.5 V.

The red line shows the voltage provided by the DC/DC control unit.

Automatic Start/Stop II (MSA II)

Originally the MSA system was only available for manual transmission European BMW models. (This system is described in the previous section of this training manual). MSA II however, is the second generation of the system that was especially adapted to operate with automatic transmissions and BN2020 vehicles.

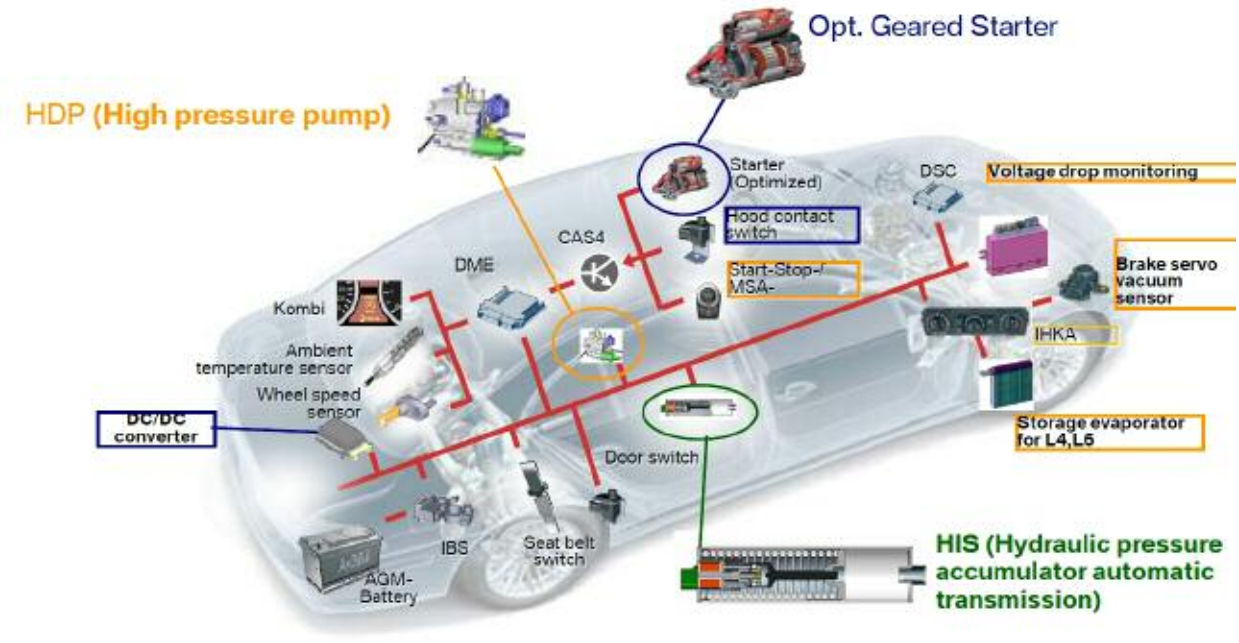
The F04 ActiveHybrid 7 was the first BMW in the US market (as of 3/2010) to use the MSA function in combination with an automatic transmission. That system uses the E Machine to start the combustion engine instead of a conventional type starter.

The F10 528i (N20), 535i (N55) and F12 640i (N55) are available as of 9/2011 with the MSA II system (as standard equipment) with both the manual and automatic 8 speed transmission while the E89 sDrive28i (N20) is currently only available with MSA if combined with the manual transmission.

MSA II system highlights:

- Air conditioning function is enhanced with the cold storage evaporator
- The hydraulic pressure accumulator allows MSA II to operate with automatic transmissions.
- Driver presence detection via driver's seat belt and driver's door switch.

MSA II System Components



F10,F12/ N55 / N20 AT

System Overview

Automatic start/stop function - Manual transmission

The operating logic of the automatic start/stop function in vehicles with manual gearbox has already been discussed in the MSA I section of this training material.

When the car is stopped and the driver engages neutral and releases the clutch pedal, the automatic start/stop function switches the engine off. This means that the vehicle does not use any fuel when it is at a standstill. When the driver depresses the clutch pedal again, the engine is automatically restarted and the driver can continue driving.

Automatic start/stop function - Automatic transmission

The description that follows therefore deals specifically with the automatic start/stop function in conjunction with the automatic transmission.

The engine will **NOT** automatically turn OFF if:

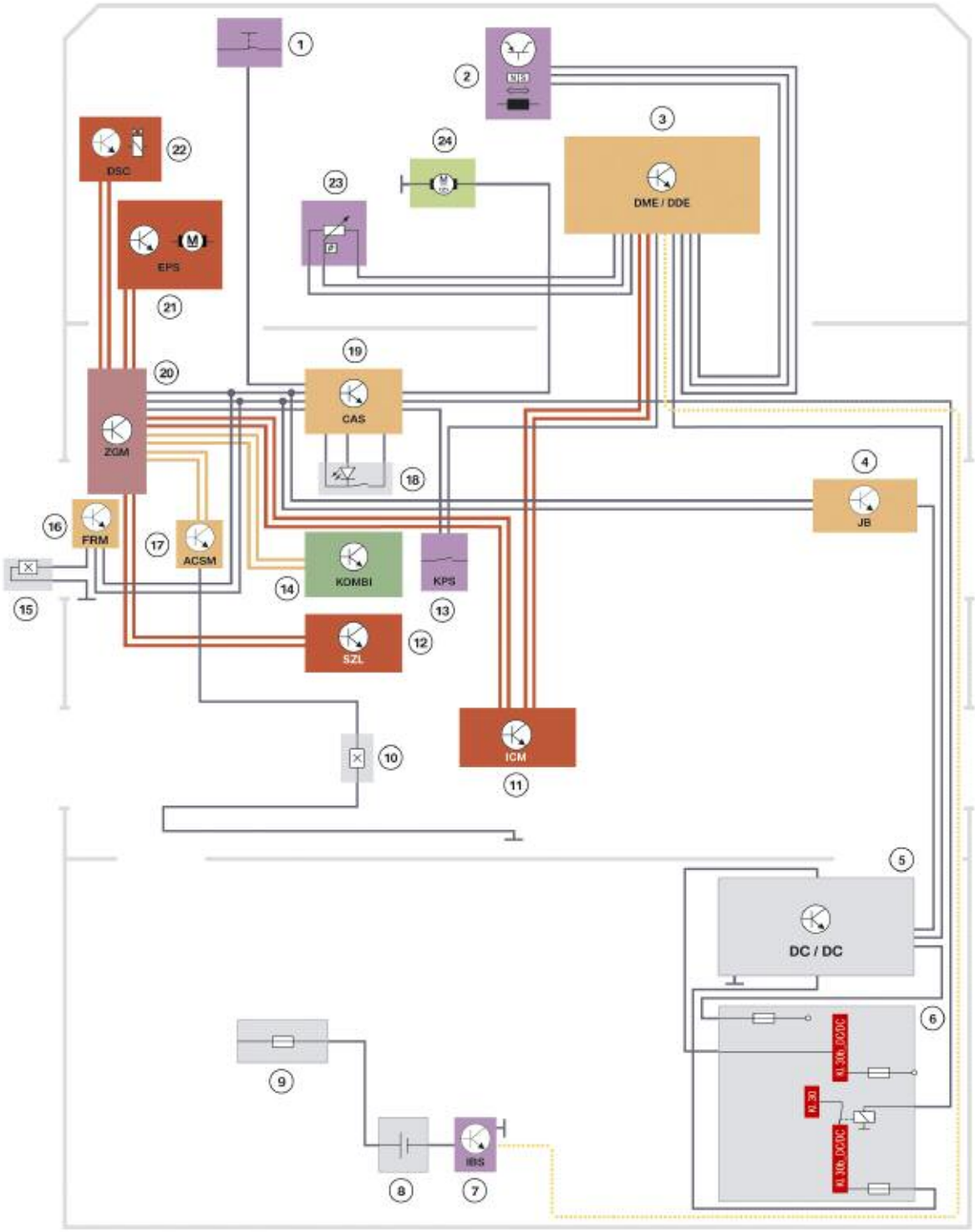
- Outside temperature below 37.4˚F.
- Outside temperature above 86˚F.
- Vehicle interior is not yet warmed up or cooled down.
- Engine is not yet warmed up.
- Vehicle battery state of charge very low.
- After vehicle was driven in reverse.
- Steering wheel operated after vehicle stopped.
- Stop&Go-Traffic.

If MSA is active (ENGINE OFF), the engine will be turned ON automatically if:

- Interior temperature cannot be maintained (cooling and heating).
- Windshield fogging.
- Vehicle battery state of charge drops below a threshold.
- Steering wheel input is detected.
- Change gear lever position from D to N; D to M/S; P to D.
- The accelerator and the brake pedal are pressed at the same time.

MSA II Wiring Diagrams

F10 Automatic start/stop MSA II wiring diagram



Index	Explanation
1	Hood contact switch
2	Zero-gear sensor (vehicles with manual transmission only)
3	Digital Motor Electronics DME
4	Junction box electronics with front power distribution box
5	DC/DC converter
6	Rear right power distribution box
7	Intelligent battery sensor (IBS)
8	Battery
9	Battery power distribution box
10	Seat belt buckle contact, driver's seat
11	Chassis Management, ICM
12	Steering column switch cluster (SZL)
13	Clutch switch (vehicles with manual transmission only)
14	Instrument cluster KOMBI
15	Driver's side door contact
16	Footwell module FRM
17	Crash safety module, ACSM
18	Start/Stop button
19	Car Access System CAS
20	Central Gateway Module
21	Electromechanical Power Steering EPS
22	Dynamic Stability Control (DSC)
23	Brake vacuum-sensor (vehicles with manual transmission only)
24	Starter

DC/DC converter

The higher frequency of starting operations in vehicles with the automatic start/stop function can lead to voltage dips in the vehicle electrical system. One or two DC/DC converters are installed in order to protect specific voltage-sensitive components (depending on the vehicle equipment).

The DC/DC converters supply a constant voltage to the 30B_DC/DC terminals, also during the starting operation.

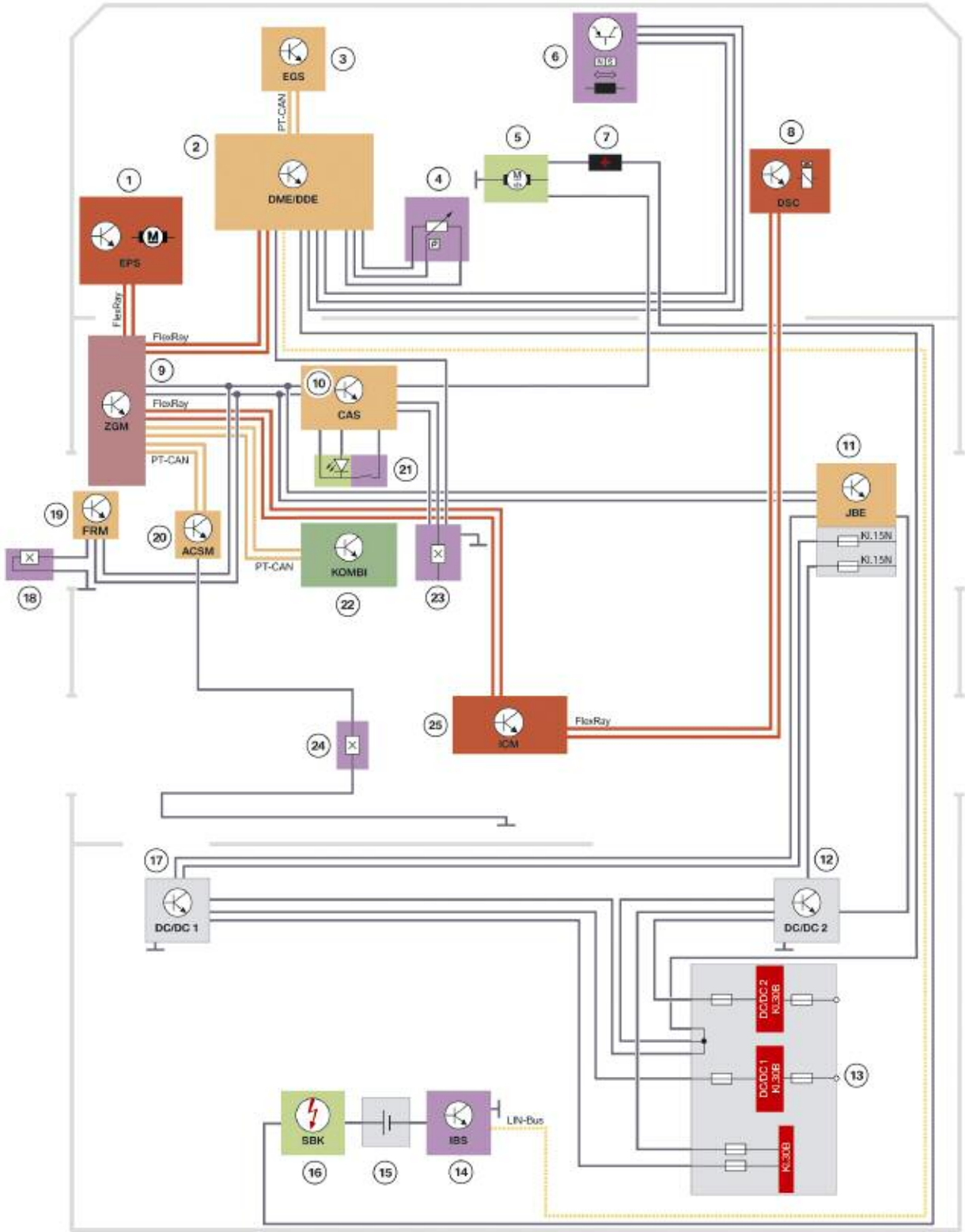
A DC/DC converter is installed if the speakers are activated by a radio or additional amplifier. Two DC/DC converters are installed if the speakers are activated by one of the headunits, due to the high power consumption of the headunit. This applies for vehicles without the HiFi speaker system (SA 676) or the HiFi system (SA 677) but with one of the following items of optional equipment:

- Radio Professional (SA 663)
- Navigation system (optional extra 609)

As a basic rule, only one DC/DC converter is installed in vehicles with the HiFi speaker system (SA 676) or HiFi system Professional (SA 677).

Note: For a detailed explanation of how the DC/DC converter operates refer to the MSA I section of this training material.

MSA II Wiring Diagram with Double DC/DC Converter



Index	Explanation
1	Electronic Power Steering (EPS)
2	Digital Motor Electronics (DME)
3	Electronic transmission control (EGS)
4	vacuum sensor (vehicles with manual transmission only)
5	Starter motor
6	Zero-gear sensor (vehicles with manual transmission only)
7	Power distribution box, engine compartment
8	Dynamic Stability Control (DSC)
9	Central gateway module
10	Car Access System (CAS)
11	Junction box power distribution box
12	**DC/DC converter 2**
13	Luggage compartment power distribution box
14	Intelligent battery sensor (IBS)
15	Battery
16	safety battery terminal (SBK)
17	**DC/DC converter 1**
18	Door contact, driver
19	FRM
20	Crash Safety Module (ACSM)
21	Start/Stop button
22	Instrument panel (KOMBI)
23	Clutch switch (vehicles with manual transmission only)
24	Seat belt buckle contact, driver
25	Integrated Chassis Management
Terminal 15N	Ignition (after-run)
Terminal 30B	Terminal 30, time-dependent

Automatic Mode

The automatic start/stop function is ready for operation following every engine start.

The function is activated once the vehicle reaches a specific speed:

- Vehicles with manual transmission: > 5 km/h/3 mph.
- Vehicles with automatic transmission: > 9 km/h/5 mph.

The driver presence detection via the seat belt buckle switch and also via the door contact has been introduced as a new feature of MSA II.

When the driver leaves the vehicle, the automatic start/stop function is deactivated, in order to prevent the engine from starting automatically.

The MSA function is always reactivated if:

- the driver's seat belt is fastened and the vehicle is travelling at a speed of > 5 km/h
- the driver's door is closed and the vehicle is travelling at a speed of > 5 km/h/3 mph*.

* > 9 km/h/5 mph - vehicles with automatic transmission

The prerequisites for deactivation of the automatic start/stop function vary, depending on which switching mode the seatbelt buckle switch and door contact are in when the automatic start/stop function is activated:

Status during activation of automatic start/stop function	Prerequisites for deactivation of automatic start/stop function
• The driver's seat belt is fastened. • The driver's door is closed.	The driver unfastens the seat belt buckle and opens driver's door.
• The driver's seat belt is **not** fastened. • The driver's door is closed.	The driver opens the driver's door.
• The driver's seat belt is fastened. • The driver's door is opened.	The driver unfastens the seat belt buckle.

The automatic start/stop function is reactivated if:

- the seat belt buckle is fastened and/or the driver's door is closed and the engine has been started
- the seat belt buckle is fastened and/or the driver's door is closed and the vehicle is travelling at a speed of > 5 km/h/3mph*.

* > 9 km/h/5mph - vehicles with automatic transmission

Driving

The purpose of the automatic start/stop function is to switch the engine off when the vehicle is at a standstill. As long as the vehicle is in motion the driver will not be aware of the automatic start/stop function.

Index	Explanation
1	Vehicle moving
2	Selector lever in drive position D, driver operates accelerator pedal
3	Engine running, the driving situation is reflected by the engine speed display and fuel consumption display

Stopping

From the driver's point of view, the stopping process with subsequent engine stop is as follows:

Index	Explanation
1	Vehicle slows to a standstill, e.g. at a red light
2	Selector lever remains in the "D" drive position, driver depresses the brake pedal to decelerate and hold the vehicle at a standstill
3	The engine is switched off after roughly 1 second, "0" engine speed will be displayed on the tachometer

In the situation depicted above the driver holds the car at a standstill by depressing the brake pedal.

Alternatively, the driver can select selector lever position "P" and release the brake pedal. The engine remains switched off. If then the drive position "D" is subsequently engaged, the engine starts without delay.

Driving off

The driver indicates his intention to drive off by releasing the brake pedal.

If the driver previously held the car at a standstill by depressing the brake pedal, the engine starts as soon as the driver releases the brake pedal.

Index	Explanation
1	Driver wishes to continue the journey (e.g. green light)
2	The selector lever remains in drive position "D", driver releases the brake pedal
3	Engine is started, revolution counter and fuel consumption display revert back to normal to reflect the driving situation

If the driver moves the selector lever into position "P" after the engine was switched off automatically, the engine starts automatically if the selector lever is now moved to position "D".

During this process, the automatic engine start is not activated automatically via a signal from the brake light switch, but by the DSC control unit that monitors the brake pressure.

Establishing start-up readiness

If the driver wants to start the engine but not yet drive off, he can establish start-up readiness by:

- Pressing the brake pedal briefly, applying more force
- Releasing the brake pedal slightly

Both of these actions will prompt the engine to start automatically.

Automatic hold

If the driver has activated the "Automatic Hold" function, he/she can also release the brake pedal once the vehicle has come to a standstill. The automatic start/stop function also switches the engine off in this case. The car is held at a standstill by the DSC hydraulics. The engine only starts if the driver operates the accelerator pedal.

Preventing automatic engine shutdown

In order to be able to drive off quickly, e.g. at a crossing, the automatic engine shutdown can be actively prevented if within one second after the vehicle comes to a standstill the brake pedal is pressed briefly, applying more force than usual, then immediately held with the usual brake pedal force.

Index	Explanation
1	Vehicle slows to a standstill, e.g. at a red light
2	Immediately after the vehicle comes to a standstill (within one second) the brake pedal is pressed briefly, applying more force than usual, then immediately held with the usual brake pedal force
3	The engine continues running

Switch-off Inhibitors

Under certain conditions it is necessary to suppress the MSA function:

- the vehicle is coasting (vehicles with manual transmission only)
- the brake vacuum is too low (vehicles with manual transmission only)
- the brake pedal is not pressed firmly enough which means the vehicle is detected as not being held sufficiently (vehicles with automatic transmission only)
- the vehicle stops on uphill/downhill gradients > 12%
- the steering angle is > 6°
- the steering wheel movement is not yet complete (as otherwise insufficient support will be provided by the power steering as a consequence)
- the vehicle was not driven at a speed of > 5 km/h/3 mph* following the previous engine shutdown
- the engine is not running at idle speed (accelerator pedal is being pressed)
- the vehicle is being driven in reverse
- the Hill Descent Control (HDC) has been activated
- the operating temperature of the engine is too low
- the carbon canister is being purged
- the fuel grade is insufficient
- the gearbox adaptation is active (vehicles with automatic transmission only)
- the hydraulic pressure accumulator is not charged yet (vehicles with automatic transmission only)
- stop-and-go traffic
- the state of charge is too low
- the ambient temperature is below +3 °C/ 37.4 °F (ice warning)
- the ambient temperature is above +30 °C/ 86 °F (with heating and air conditioning system switched on)
- the condensation sensor of the IHKA detects fogging of the windshield
- the heating and air conditioning system is switched on but the passenger compartment has not yet warmed up or cooled down to the required temperature
- the brakes have been applied via ABS.

* > 9 km/h/5 mph - vehicles with automatic transmission

Switch-on Prompts

Conversely, it may be necessary to start the engine under the following conditions:

- the vehicle is not sufficiently held by the released brake pedal (vehicles with automatic transmission only)
- the steering wheel is moved
- the engine is not running at idle speed (accelerator pedal is being pressed)
- the transmission changes from "P" to "D"; the driver previously shifted from "D" to "P" when the engine was automatically switched off (vehicles with automatic transmission only)
- the transmission changes from "D" to "N" or "R" (vehicles with automatic transmission only)
- the brake vacuum is too low (vehicles with manual transmission only)
- the state of charge is too low
- the ambient temperature is above +30 °C/86 °F (with heating and air conditioning system switched on)
- the condensation sensor of the IHKA detects fogging of the windshield
- the evaporator temperature is too low to ensure sufficient climate control.

Deactivation

If a deactivation condition exists, the automatic start/stop function is deactivated.

The following scenarios arise, depending on when the deactivation condition for the automatic start/stop function occurred:

- the engine continues running and is no longer stopped automatically
- the engine was stopped automatically and starts once again automatically
- the engine was stopped automatically and no longer starts automatically (the Check Control message "MSA off" appears - the start/stop button must be operated in order to the start the engine).

The following deactivation conditions may occur:

- the driver's absence has been detected
- the engine did not start when starting
- the engine compartment lid is unlocked
- a fault related to the automatic start/stop function has been detected at the engine, transmission or components involved in the automatic start/stop function
- the bus communication is faulty
- the automatic start/stop function has been deactivated via the automatic start/stop function button
- the automatic start/stop function was deactivated via the diagnosis system
- the vehicle is in transport mode
- the engine was stalled.

The individual statuses can be read out using the diagnosis system.

An easy-to-follow example of a deactivation with subsequent switch-on request:

- the automatic start/stop function is deactivated via the automatic start/stop function button in the automatic engine shutdown phase
- as a consequence, the engine starts automatically
- after this, no further automatic engine shutdowns occur, the automatic start/stop function remains deactivated.

Deactivation via automatic start/stop function button

F10 automatic start/stop function button location

The automatic start/stop function can be deactivated manually via the automatic start/stop function button (1). The LED in the button lights up when the function is deactivated. The automatic start/stop function is reactivated each time the engine is restarted.

System Components

Storage Evaporator

To maintain the climate control of the passenger compartment when the engine is off, for vehicles with automatic start/stop function, a cold accumulator, known as the storage evaporator, is installed.

Function of the conventional air-conditioning evaporator
The warm air flow is drawn across the air-conditioning evaporator as the refrigerant evaporates. The evaporation process extracts heat and moisture from the air as it flows across it.

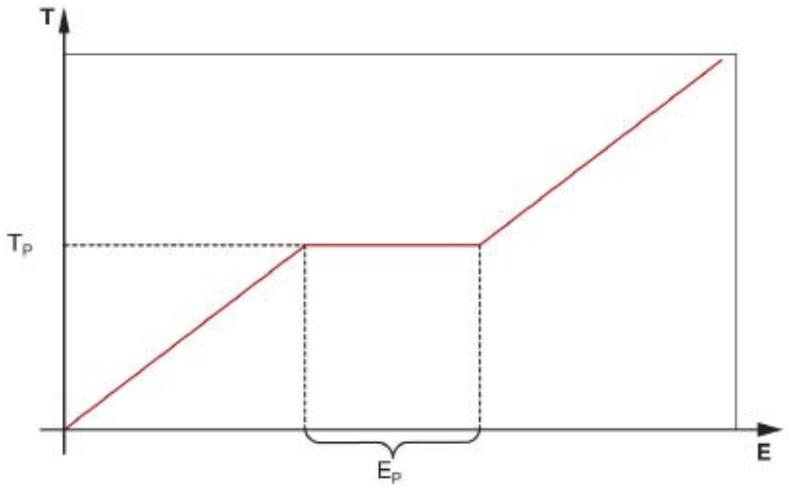
The heat is transfered to the refrigerant and sent to the AC system condenser. There it is extracted out of the vehicle through the process of convection as fresh air flows across the core of the condenser.

Function of the storage evaporator
The “cold” storage evaporator uses a cold accumulator that is installed behind a conventional air-conditioning evaporator.

Index	Explanation
1	Storage evaporator
2	Refrigerant passages
3	Line for storage medium

As with a conventional air-conditioning evaporator, the storage evaporator also evaporates the refrigerant. In addition, the refrigerant passages are surrounded with a storage medium. As the evaporation process draws heat out of the storage medium it freezes and becomes rigid, this is refered to as the “transition phase” from liquid to solid.

Latent heat stored by storage medium in the storage evaporator



Index	Explanation
T	Temperature
Tp	Temperature of the transition phase
E	Stored quantity of heat
Ep	Quantity of heat of the transition phase

If the engine is off, e.g. at a red light, the air conditioning compressor is also off.

The refrigerant is no longer able to evaporate, thus the storage medium is no longer being cooled.

When the transition phase temperature is reached, the storage medium starts to melt and thus draws heat from the air flowing across it.

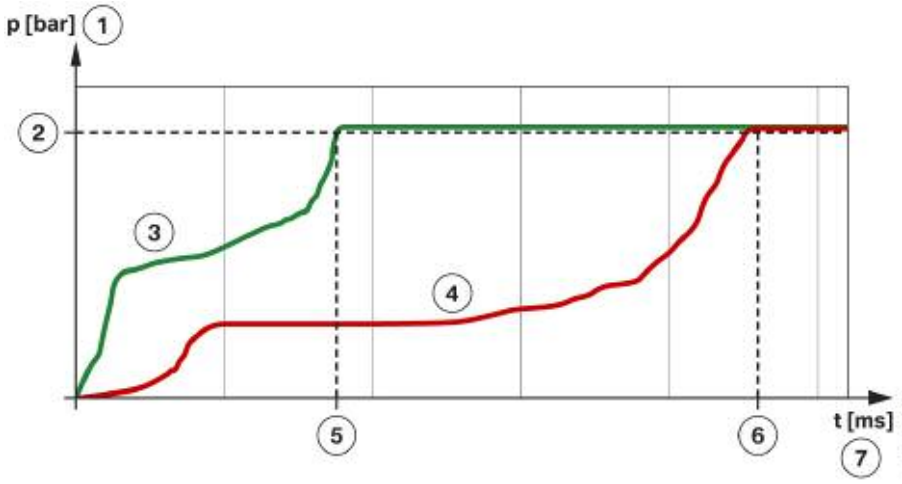
Hydraulic Pressure Accumulator

When the automatic start/stop function is activated the engine may shut off once the vehicle is at a standstill, the engine restarts automatically as the driver releases the brake to drive off.

In these engine stop phases the transmission oil pump is not driven, thus the fluid pressure supply ceases, the gearshift elements open, and there is no longer a transfer of power in the transmission. Maximum transmission oil pressure is required in order for the drive off process to take place dynamically without a noticeable delay when the automatic start/stop function is activated. However, the mechanically driven transmission oil pump cannot build up pressure quickly enough while the engine is starting.

A hydraulic pressure accumulator is therefore used in the automatic transmission for this purpose (as with F04). With the volume of transmission fluid stored in the hydraulic pressure accumulator, the shift elements can be filled as soon as the engine is started, even before the transmission oil pump has built up the necessary pressure to drive off.

Variation in transmission oil pressure over time at engine start



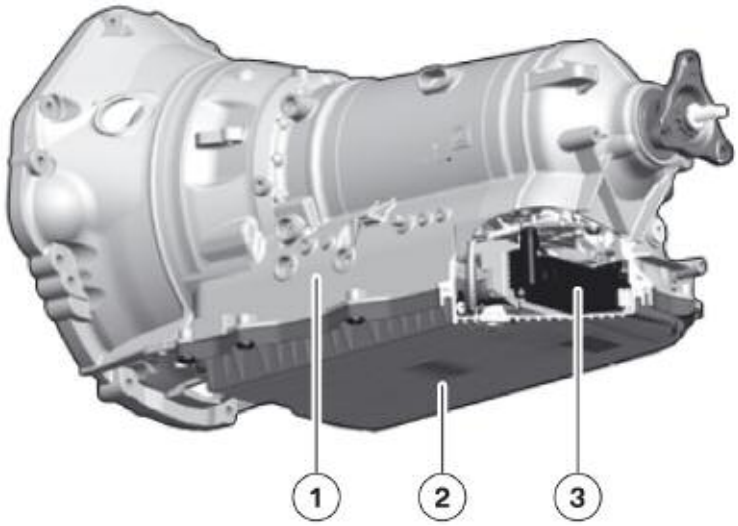
Index	Explanation
1	Transmission oil pressure
2	Nominal value of the transmission oil pressure which is required to hydraulically actuate the shift elements
3	Characteristic of the transmission oil pressure **with** hydraulic pressure accumulator
4	Characteristic of the transmission oil pressure **without** hydraulic pressure accumulator
5	Point at which the automatic transmission **with** hydraulic pressure accumulator is ready to drive off
6	Point at which the automatic transmission **without** hydraulic pressure accumulator is ready to drive off
7	Time

Installation location

The hydraulic pressure accumulator is integrated in the automatic transmission. It is located in the transmission oil sump, in the direction of travel behind the mechatronics module.

The hydraulic pressure accumulator can be replaced as a separate component.

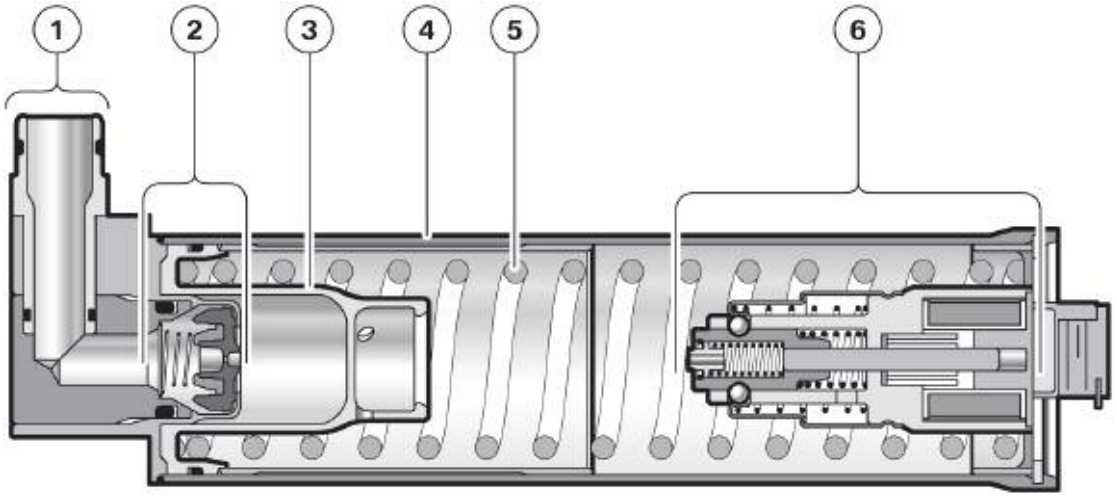
8 Speed Automatic Transmission cutaway



Index	Explanation
1	Transmission housing
2	Transmission oil sump
3	Hydraulic pressure accumulator

Design

Design of hydraulic pressure accumulator



Index	Explanation
1	Connection to hydraulic system of automatic transmission
2	Throttle and non-return valve
3	Hydraulic piston
4	Hydraulic cylinder
5	Coil spring
6	Electromechanical latch mechanism

The hydraulic pressure accumulator consists of a hydraulic cylinder. This cylinder contains a piston that moves against the force of a spring. The piston can be electromechanically locked in the tensioned end position. The electromechanical latch mechanism incorporates locking balls, a tension spring, a release spring, and a solenoid.

The solenoid is activated and deactivated by the EGS. A corresponding wiring harness to the hydraulic pressure accumulator is laid inside the transmission housing.

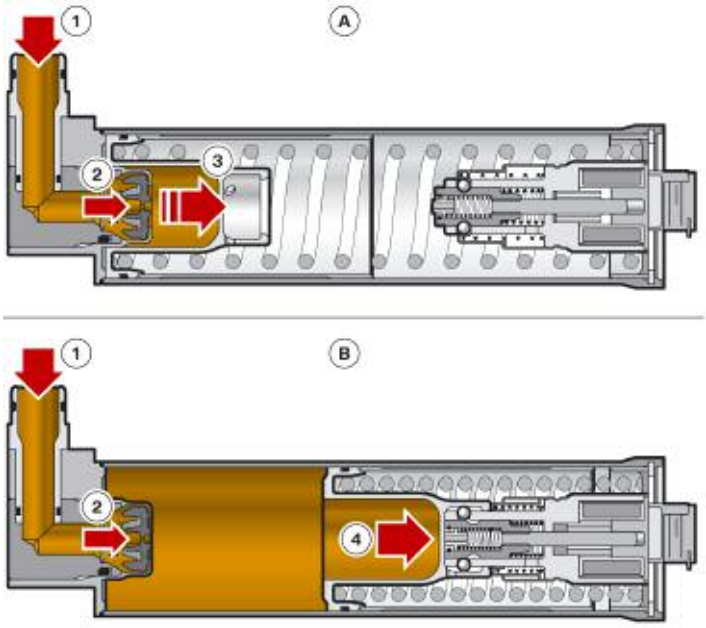
The cylinder of the hydraulic pressure accumulator is connected to the transmission's hydraulic system directly (without any valves between them). The hydraulic pressure accumulator in fact contains an element which functions as a throttle and non-return valve. The throttle limits the volumetric flow of the fluid while the hydraulic pressure accumulator is being filled. In general, this filling operation corresponds to the charging operation of the accumulator which is why the expressions "charging" or "discharging" are used in this description.

The non-return valve ensures that the transmission fluid flows into the hydraulic pressure accumulator via the throttle during charging. The transmission fluid does not flow through the throttle during the discharging process, the non-return valve now opens instead to allow an unrestricted flow of transmission fluid back into the hydraulic system. The purpose of the non-return valve is therefore not to maintain the pressure in the charged state. In the charged state, the transmission fluid in the hydraulic pressure accumulator is depressurized and the energy is stored in the tensioned spring.

Charging

The hydraulic pressure accumulator is therefore always charged when the engine is running and the transmission oil pump is working. During charging transmission fluid flows through the throttle into the hydraulic cylinder. In the process only a small volume is drawn from the hydraulic system so that the pressure level does not drop unintentionally. The transmission fluid pushes on the piston which acts against the spring force increasing the tension on the spring.

Charging of the hydraulic pressure accumulator



Index	Explanation
A	Discharged state - charging procedure starts
B	Charged state - charging procedure ends
1	Transmission fluid flows from the hydraulic system of the automatic transmission into the hydraulic pressure accumulator
2	Volumetric flow of the transmission fluid is limited by the throttle
3	The transmission fluid exerts force on the piston which moves and tensions the coil spring
4	Transmission fluid exerts a force on the piston so that it is held in the "charged" end position

At the end of the charging process the piston travels past the latch mechanism (locking balls) until it reaches the end/stop. The transmission fluid pressure holds the piston against the spring force in the end position.

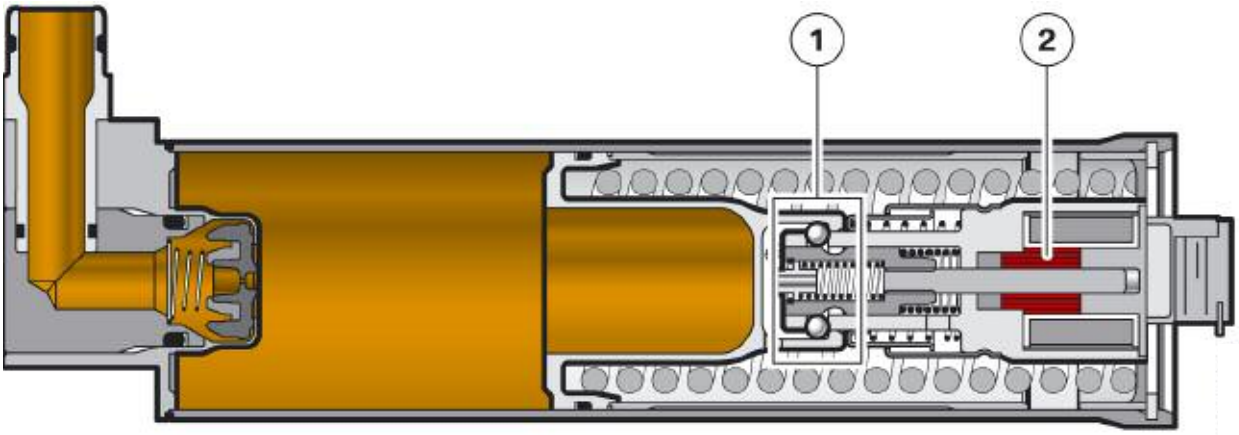
The latch mechanism does not engage yet. The hydraulic pressure accumulator is fully charged in this end position.

Locking

When the engine is switched off (while the hydraulic pressure accumulator is charged) the transmission oil pressure drops causing the spring to be released slightly. This allows the piston to slide into the locked position where locking balls hold the piston mechanically in place.

The now energized solenoid holds the inner slide in place so that the locking balls cannot enter the channels designated for releasing the lock. The electric power used for this is low (< 10 W) and is only required while the engine is off. Therefor the additional energy consumption of the hydraulic pressure accumulator viewed over an entire driving cycle is very low.

Charged and locked state of the hydraulic pressure accumulator



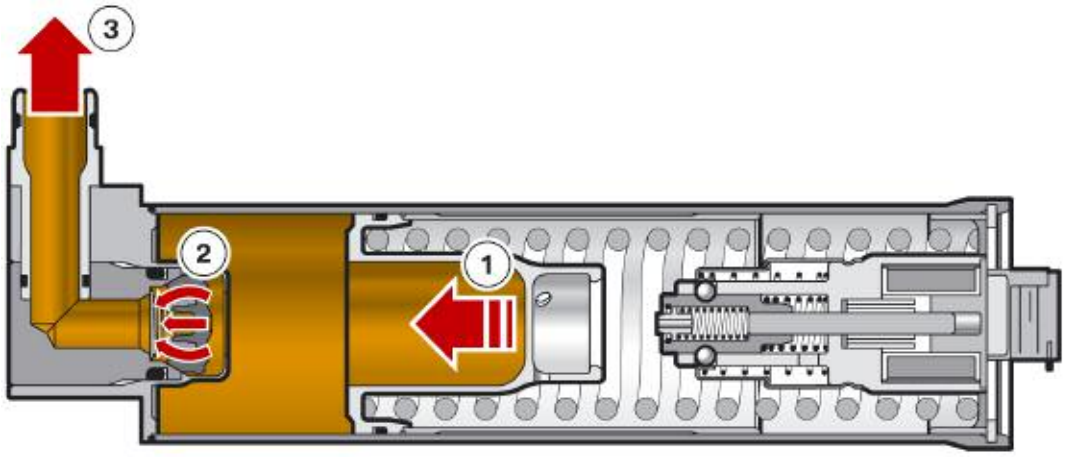
Index	Explanation
1	Mechanical latch mechanism
2	Solenoid activated

Discharging

When the engine is started, as the driver wants to drive off, the gearshift elements in the automatic transmission for driving off must be engaged. The hydraulic pressure accumulator supplies the transmission fluid pressure required for this during the discharging process.

As the solenoid is deactivated for discharging the inner slide (driven by a small spring) moves in the direction of the locking balls. This allows the balls to enter the channels designated for releasing the lock which in turn releases the piston. The spring (compressed during the charging process) exerts force on the piston which pressurizes the transmission fluid in the cylinder.

Discharging of the hydraulic pressure accumulator



Index	Explanation
1	The large spring pushes on the piston,which in turn, forces the transmission fluid out of the hydraulic cylinder
2	Transmission fluid can now flow through the throttle **and** the opened non-return valve
3	Transmission fluid flows from the hydraulic pressure accumulator back into the hydraulic system of the automatic transmission

The piston moves (in the graphic to the left) and thereby pushes the transmission fluid back into the transmission hydraulic system. The transmission fluid exits the cylinder through the now opened non-return valve and throttle.

The oil volume forced back into the hydraulic system of the transmission is sufficient to engage the gearshift elements needed for the driving off process. This system is designed to provide the initial fluid pressure needed for the transmission to go into “Gear” at the exact moment just before the engine is started. As soon as the engine is started, the transmission fluid pressure is then again generated by the transmission oil pump and the entire process is restarted.

Service Information

Protection Against Automatic Engine Start

Observe the safety precautions when carrying out repair work on vehicles with the automatic start/stop function.

The engine is prevented from starting automatically when repair work is being carried out in the engine compartment. The automatic start/stop function is deactivated as soon as the engine compartment lid is opened. The diagnosis system can also be used to deactivate the automatic start/stop function temporarily.

Note: When the compartment lid contact switch is pulled out it engages in the Service position. The automatic start/stop function is subsequently active although the hood is open

The engine can be restarted via the start/stop button.

The automatic start/stop function is reactivated if:

- the engine compartment lid is closed and the engine is started
- the engine compartment lid is closed and the vehicle is travelling at a speed of > 5 km/h/3 mph*

* > 9 km/h/5 mph - vehicles with automatic transmission

Automatic start/stop function checklist of possible customer complaints

In the event of customer complaints, check these against the "Automatic start/stop function checklist".

Process any fault entries using the diagnosis system. If no fault entries exist, check the condition of the automatic start/stop function with the automatic start/stop function system check.

The automatic start/stop function system check service function shows an overview of the automatic start/stop function status that was previously present and provides further assistance with troubleshooting.

Customer complaint	YES	NO
Frequently no engine shutdown: the engine repeatedly does not stop in situations where it should shut down automatically.		
Check the general prerequisites for automatic engine shutdown in dialog with the customer:		
Driver's seat belt fastened?	☐	☐
Vehicle at standstill?	☐	☐
Automatic transmission in position "D", brake pedal depressed?	☐	☐
Engine at operating temperature?	☐	☐
Vehicle not driven backwards before stopping?	☐	☐
Automatic start/stop function activated (automatic start/stop function button not operated - LED does not light up)?	☐	☐
Ambient temperature > 3 °C/ 37.4 ° F?	☐	☐
State of charge of battery OK (no long immobilization periods or excessive short distance driving)?	☐	☐
Quality level of battery OK (no external charging procedure, no other devices connected to the battery)?	☐	☐

If all criteria have been answered with **Yes**:

- Operate automatic start/stop function system check service function.

If at least one criterion has been answered with **No**:

- Automatic start/stop function is in working order.

Customer complaint	YES	NO
Sometimes no engine shutdown: the engine sometimes does not stop in situations where it should shut down automatically.		
Check whether the engine shutdown has been blocked by the automatic function for safety or comfort reasons. **Explain the automatic functions to the customer:**		
Heating and air conditioning system switched on and passenger compartment in cooling-down period (e.g. when setting off or following engine shutdown)	☐	☐
Windshield starts to fog up with automatic air conditioning	☐	☐
Steering wheel movements when vehicle is at a standstill	☐	☐
Stop-and-go traffic (at least three stops made in short succession at a speed of < 25 km/h/15 mph)	☐	☐

If all criteria are answered with **No**:

- Operate automatic start/stop function system check service function.

If at least one criterion is answered with **Yes**:

- Automatic start/stop function is in working order.

Customer complaint	YES	NO
Sudden automatic engine start: the engine unexpectedly starts automatically.		
Check whether the engine has been automatically started by the automatic function for safety or comfort reasons. **Explain the automatic functions to the customer:**		
Passenger compartment heating up with heating and air conditioning system switched on	☐	☐
Windshield starts to fog up with automatic air conditioning	☐	☐
Steering wheel movements when vehicle is at a standstill	☐	☐
Vehicle has started rolling (speed < 5 km/h/3 mph or 9 km/h/5 mph)	☐	☐
Low brake vacuum due to repeated operation of brake pedal	☐	☐
State of charge of battery too low due to extended engine stop phases	☐	☐

If all criteria are answered with **No**:

- Operate automatic start/stop function system check service function.

If at least one criterion is answered with **Yes**:

- Automatic start/stop function is in working order.

Customer complaint	YES	NO
Engine not starting: the brake pedal was released but the engine did not start automatically.		
Driver's door **and** seat belt buckle unfastened during the engine stop phase?	☐	☐
Or engine compartment lid open?	☐	☐

If answered with **No**:

- Operate automatic start/stop function system check service function.

If answered with **Yes**:

- Automatic start/stop function is in working order.

Automatic Deactivation of Terminal 15

Terminal 15 is switched off automatically via the door contact when the driver's door is opened and closed with the engine switched off.

Terminal 15 can be permanently switched back on by subsequently pressing the start/stop button.

Power Management and Battery Replacement

The automatic start/stop function and power management are strongly intertwined.

Battery type and charge state data may be lost following:

- programming of the engine control
- replacement of the intelligent battery sensor
- disconnection of the battery
- battery replacement

This data is only available again once a standby current measurement has been carried out internally in the vehicle and once it has gone to sleep and has been locked. This measurement takes around 6 hours and the vehicle must not be woken up during the process. Providing the data has not been transferred, the automatic start/stop function will not be active.

In order for the battery data to be registered by the vehicle following battery replacement, its internal standby current must be measured.

If the battery is replaced, an AGM battery must be reinstalled to ensure the automatic start/stop function remains in proper working order.