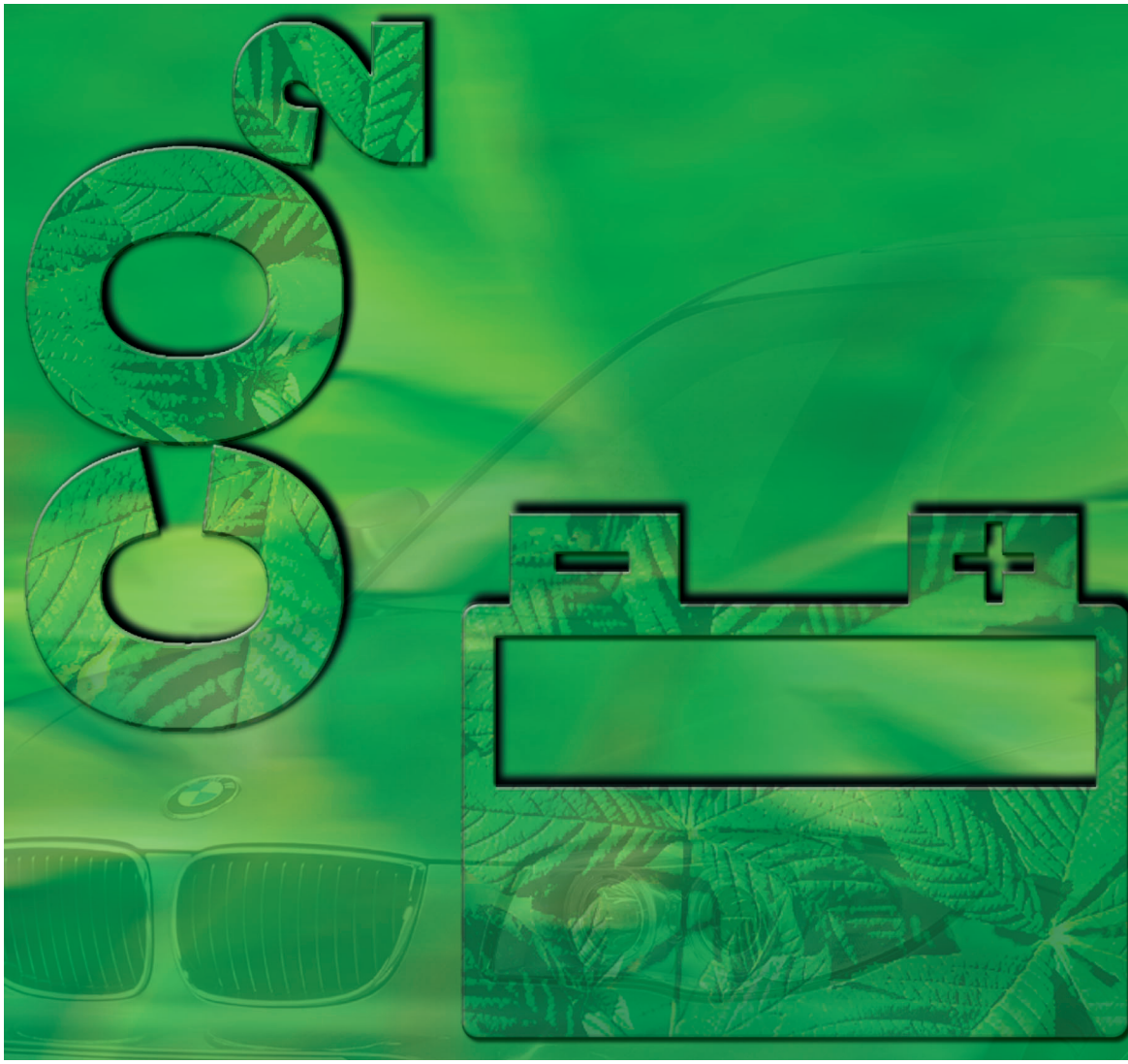
Aftersales Training - Product Information.

Intelligent alternator control IGR.



BMW Service

The information contained in the Product Information and the Workbook form an integral part of the training literature of BMW Aftersales Training.

Refer to the latest relevant BMW Service information for any changes/supplements to the technical data.

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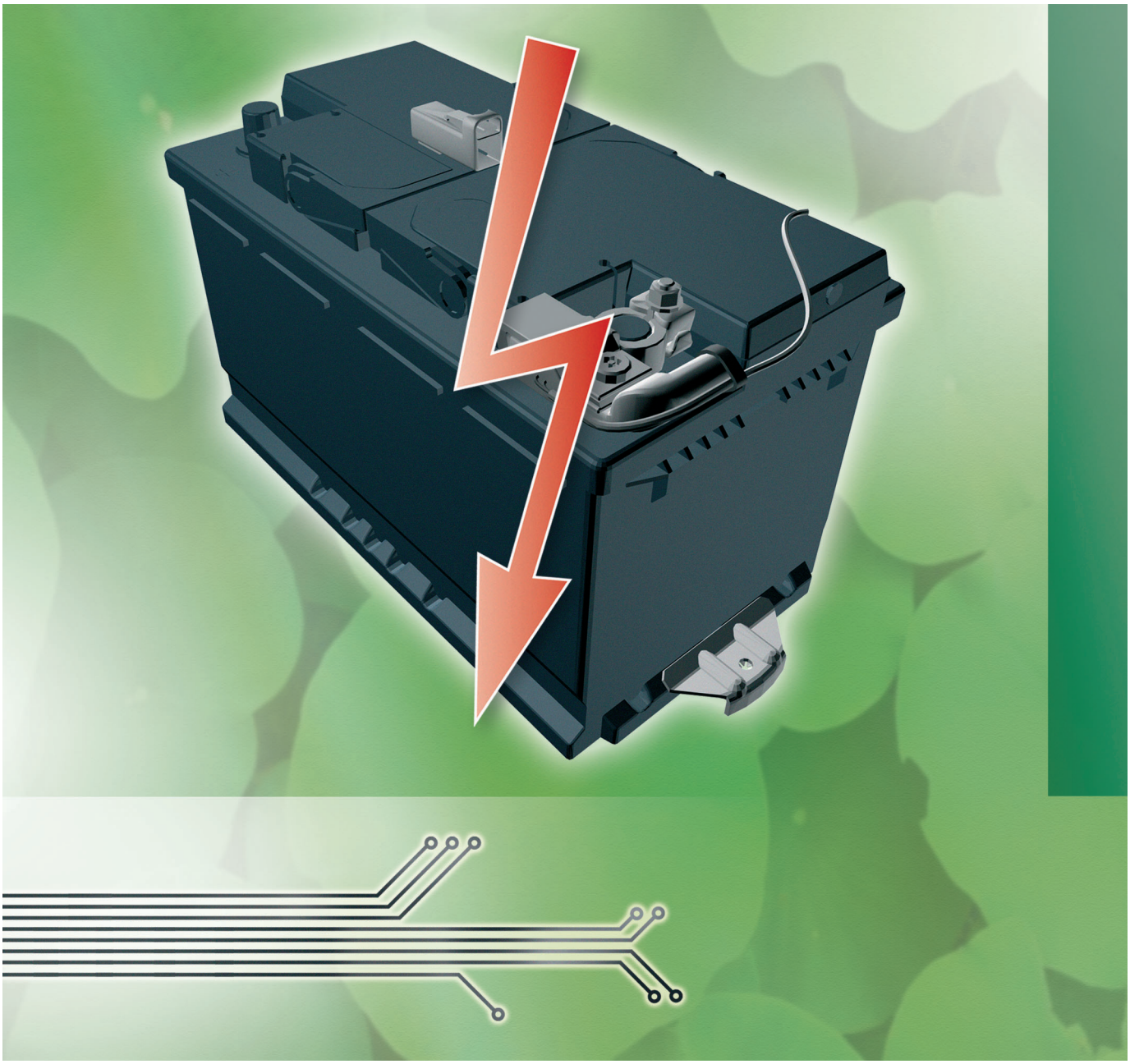
Product Information.
Intelligent alternator control IGR.

Intelligent energy recuperation

Part of energy management

CO_2 emission reduction



Notes on this Product Information

Symbols used

The following symbols are used in this Product Information to facilitate better comprehension and to draw attention to important information.

⚠ contains information to facilitate better understanding of the described systems and their function.

◄ identifies the end of a note.

Information status and national variants

BMW vehicles conform to the highest safety and quality standards. Changes in terms of environmental protection, customer benefits and design render necessary continuous development of systems and components. Consequently, this may result in deviations between this Product Information and the vehicles available in the training course.

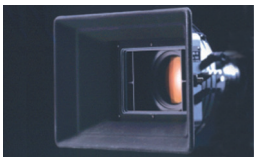
If not otherwise specified, this document describes Europe specification left-hand drive vehicles. Some controls or components are in part arranged differently in right-hand drive vehicles than shown on the graphics in the Product Information. Further differences may arise as the result of the equipment variants used in specific markets or countries.

Additional sources of information

Further information on the individual subjects can be found in the following:

- Owner's Handbook
- BMW diagnosis system
- Workshop systems documentation
- SBT BMW Service Technology.

Contents.
Intelligent alternator control IGR.



Introduction.
Intelligent alternator control IGR.

As part of CO_2 measures, BMW is introducing various technologies with the aim of reducing fuel consumption in all vehicles of the BMW Group. One of these measures is the partial recovery or recuperation of the kinetic energy used by the engine. Depending on the driving profile, the intelligent alternator control alone can reduce CO_2 emission by up to 3 % and therefore save energy. For the customer this function has no influence whatsoever on the power output development of BMW vehicles.

The core principle of the intelligent alternator control is an expanded charging strategy for the vehicle battery. Accordingly, the battery is no longer fully charged but charged to a defined level depending on various environmental/ambient conditions (outside temperature, battery age, etc.). In contrast to conventional charging strategies, energy recuperation now takes place only during the overrun (coasting) phases of vehicle operation. Alternator excitation is at a maximum during these phases, electrical energy is generated and fed to the vehicle battery. Fuel is not consumed and the kinetic energy produced by the vehicle in coasting mode acts on the alternator via the wheels and engine so that electrical energy is generated.

The alternator is not excited during the acceleration phases of the vehicle. Consequently, no energy is generated and therefore no fuel is used for the purpose of generating electrical energy.

Energy recuperation

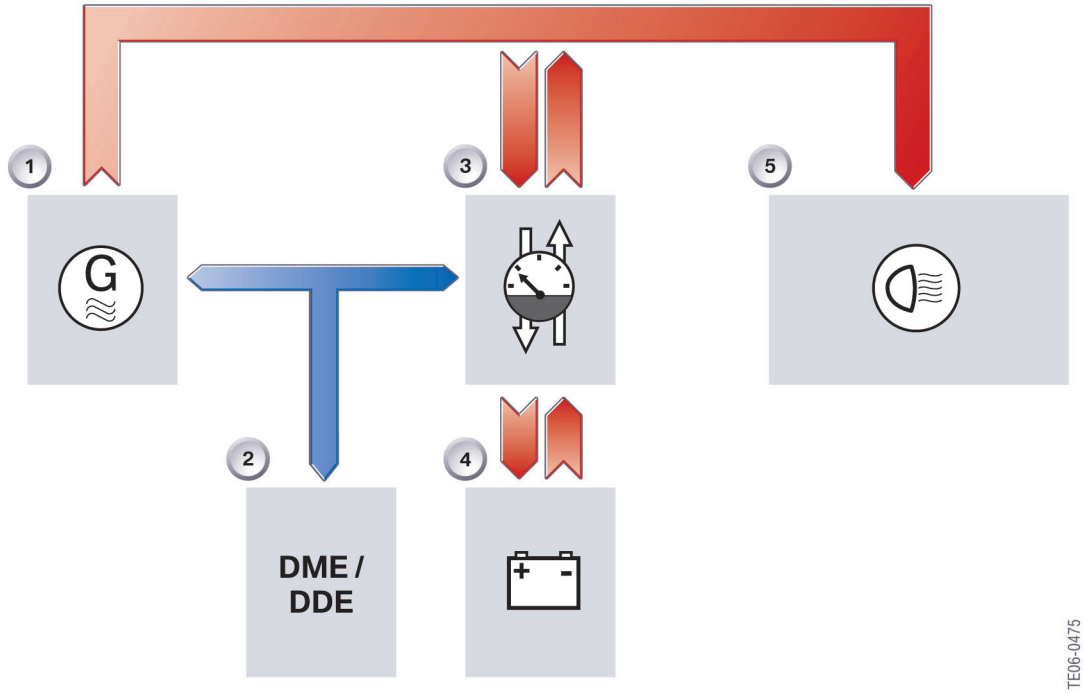
Fuel consumption is reduced by way of energy recuperation in favourable vehicle operating modes (overrun phases) based on a request to increase the alternator voltage (target value). This energy recovered without the use of fuel is stored in a "receptive battery". The charge status of the battery must be within certain levels that permit charging. A fully charged battery (100 % charged) cannot accept energy and is therefore avoided as part of the intelligent alternator control strategy.

System overview
Intelligent alternator control IGR

Energy and information flow

The IGR function is integrated in the form of software in the DME/DDE.

The system components are shown in the system overview.



1 - Information flow - intelligent alternator control

Index	Explanation	Index	Explanation
1	Alternator	5	Electrical load in vehicle
2	Engine control system (DME/ DDE)	Red	Energy flow in vehicle
3	Intelligent battery sensor IBS	Blue	Information flow in vehicle
4	Vehicle battery		

The engine-control system communicates with the intelligent battery sensor and with the alternator via the bit-serial interface (shown in blue). The information from the intelligent battery sensor is used to calculate the charge and ageing status of the vehicle battery in the power management. The power management is the software that is responsible for all energy management calculations. On vehicles equipped with intelligent alternator control, the application is additionally responsible for the control processes of the intelligent alternator control.

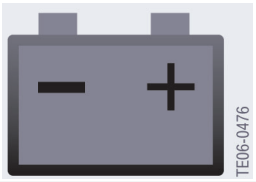
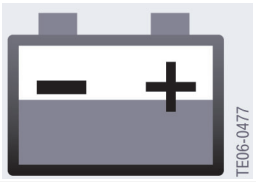
The control units connected to the overall bus system represent further sources of information. General conditions that influence the charging procedure are derived from the acquired information.

This control process results in precisely co-ordinated charging of the vehicle battery using the least possible energy from the engine.

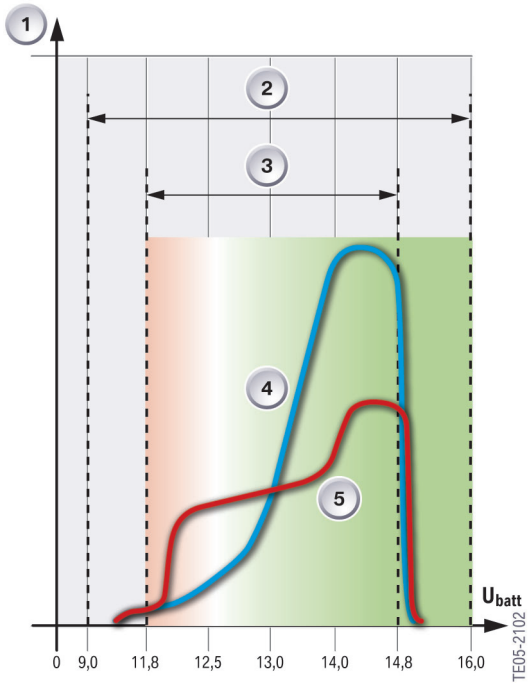
Functions.
Intelligent alternator control IGR.

New battery charging strategies

The new battery charging strategy provides various advantages as well as differences for the environment and customer:

	Conventional power management	**New power management**
Charging objective	Fully charged at all times	Minimum levels defined according to requirements, depending on: • Battery quality • Various environmental conditions, such as temperature
Battery size	Maximum size is determined by following general conditions: • Closed-circuit current • Cold start • Consumption while stationary	Higher capacity reserve as battery is never fully charged. AGM battery because of higher cyclic stability.
Current intake	Greatly reduced as charge level increases	Distinctly increased current intake also after longer driving period
CO_2 strategy	None	IGR utilizes the released charge range
Energy recuperation	Minimal recuperation options (only shortly after starting)	High recuperation potential
		

Charge level and voltage control



1 - Charge level and voltage control

Index	Explanation
1	Frequency of alternator voltage
2	Maximum permissible voltage range in vehicle
3	Alternator control range
4	Charging voltage, conventional alternator control - the charging alternator charging voltage is predominantly in the range between 13 V and 15 V
5	Charging voltage, intelligent alternator control - the charging voltage is predominantly in the range between 12 V and 15 V. It is possible to charge the battery while the vehicle is in overrun (coasting) mode.
U_{batt}	Battery voltage

In contrast to conventional charge control, the intelligent battery control avoids a 100 % charge. The charge level of the battery reaches about 70 - 80 % of the maximum possible charge.

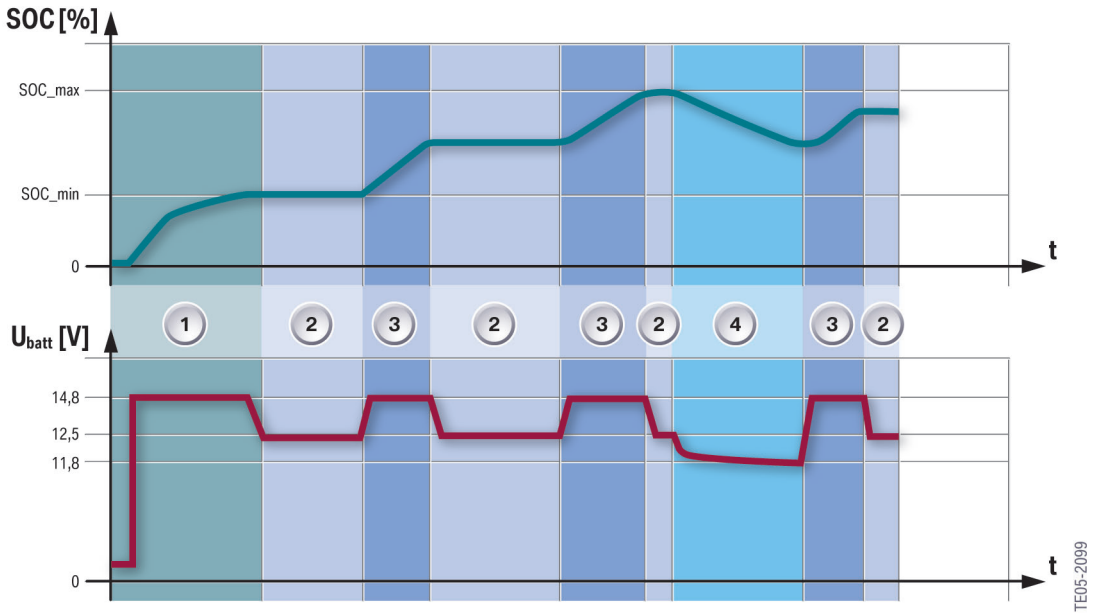
The intelligent alternator control is suppressed cyclically in order to allow 100 % battery charge to maintain the full capacity of the battery over time (regeneration).

In the intelligent alternator control system, the alternator voltage is correspondingly more often in the lower voltage range in order to achieve more effective charge intake by the vehicle battery.

Operating statuses of the intelligent alternator control

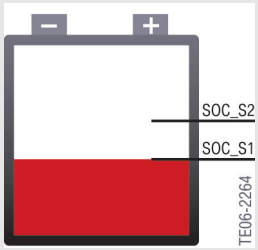
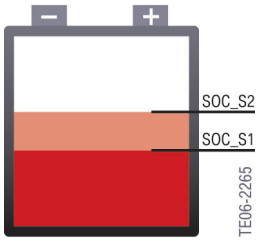
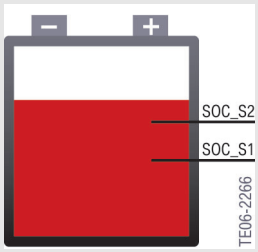
The IGR function is subdivided into three operating statuses:

- IGR-Low: The alternator voltage is increased during overrun phases and the battery is charged (energy recuperation)
- IGR-Medium: Battery discharge is not permitted in the phase between IGR-Low and IGR-High so that the current charge status is maintained (partial relief of alternator load)
- IGR-High: Energy returned from the battery into the vehicle electrical system (relief of alternator load)



2 - IGR operating statuses

Index	Explanation
1	The battery charge level is low, the battery was not charged over a longer period of time.
2	IGR-Medium: In the meantime, the battery charge has reached a sufficiently high level, battery discharge is avoided, the energy required for the electrical loads is provided by the alternator.
3	IGR-Low: The vehicle is in the overrun (coasting) phase, electrical energy is fed to the battery.
4	IGR-High: The vehicle is accelerated, the energy required for operation of the electrical loads is provided by the battery.
SOC	State of charge
U_{batt}	Battery voltage
t	Time

Index	Explanation
	The IGR cuts in when the battery has reached a certain charge level. The battery is always charged up to this point. The charge control in the vehicle always operates as in conventional vehicles, i.e. also during the drive phases. The IGR cuts in when a defined state of charge is reached (SOC_S1).
	IGR-Medium takes place in the phase between SOC_S1 and SOC_S2. The alternator only provides sufficient energy for the electrical loads in the drive phases. The battery is no longer charged. The voltage in the electrical system is maintained.
	IGR operates to its full extent as soon as the SOC_S2 limit is exceeded. This means the load on the alternator is fully relieved during the drive phases (IGR-High), neither the battery is charged nor is the electrical system supported. The alternator charges the battery with maximum possible power (IGR-Low) during the overrun phase and is able to charge the battery far beyond SOC_S2.

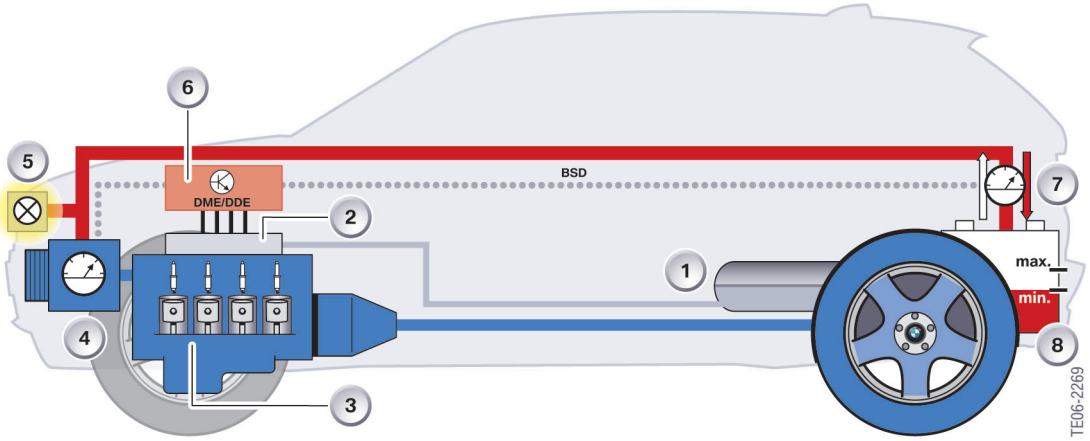
SOC_S1 - State of battery charge, stage 1
SOC_S2 - State of battery charge, stage 2
SOC (State Of Charge)

IGR-Low

The alternator voltage is increased during the overrun (coasting) phases (this alternator load status occurs only at engines speeds above 1000 rpm and at vehicle speeds of 10 km/h).

The IGR increases the alternator voltage during the vehicle overrun phases. The increased voltage facilitates increased battery charging.

The battery charge level increases with increasing number and duration of overrun phases (the state of charge can reach up to 100 % during the IGR-Low phase).



3 - IGR-Low

Index	Explanation
1	Fuel tank - No fuel is used
2	Fuel injection - The injection nozzles are switched off
3	Engine - The engine is moved by the kinetic energy from the driven wheels
4	Alternator - The alternator generates the maximum possible electrical power output
5	Electrical loads - The alternator supplies the electrical loads with electrical energy
6	DME/DDE - The DME/DDE is connected to the IBS and the alternator via the bit-serial data interface
7	IBS - The intelligent battery sensor detects when the battery is being charged
8	Battery - The battery is charged with maximum possible voltage

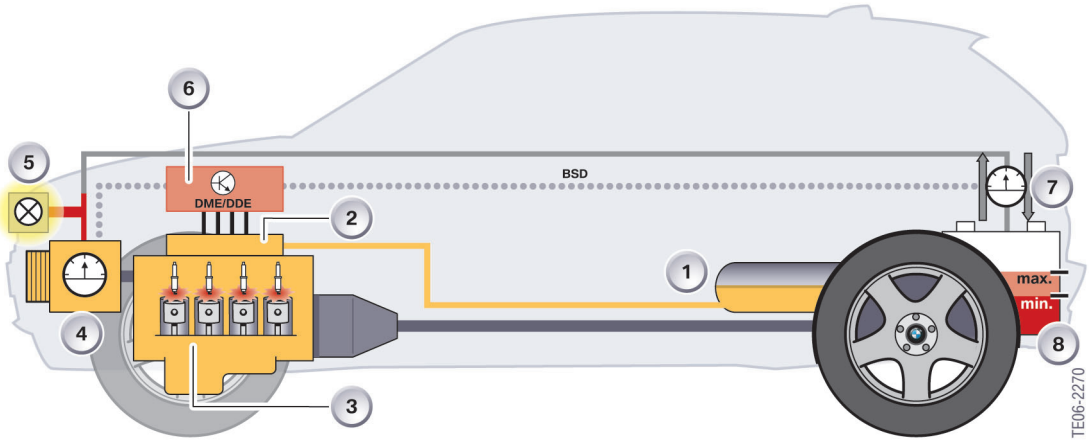
IGR-Medium

A request to partially relieve the alternator load is triggered during vehicle operating phases where fuel is used. The battery is no longer actively charged but rather only the state of charge is maintained at a sufficient level.

A request to partially or fully relieve the alternator load is required in connection with low current demand from the electrical system (acceleration phase) in order to ensure controlled discharge of the battery which is charged only in the overrun phases with the aim of avoiding CO_2 emissions. This takes place when the state of battery has reached a certain level (approx. 70 - 80 %).

Intelligent alternator control takes place when a certain minimum battery charge is reached.

At sufficient battery charge level, the alternator voltage is controlled such that the state of charge remains virtually constant outside the overrun (coasting) phases. The alternator then only supplies the vehicle electrical system.



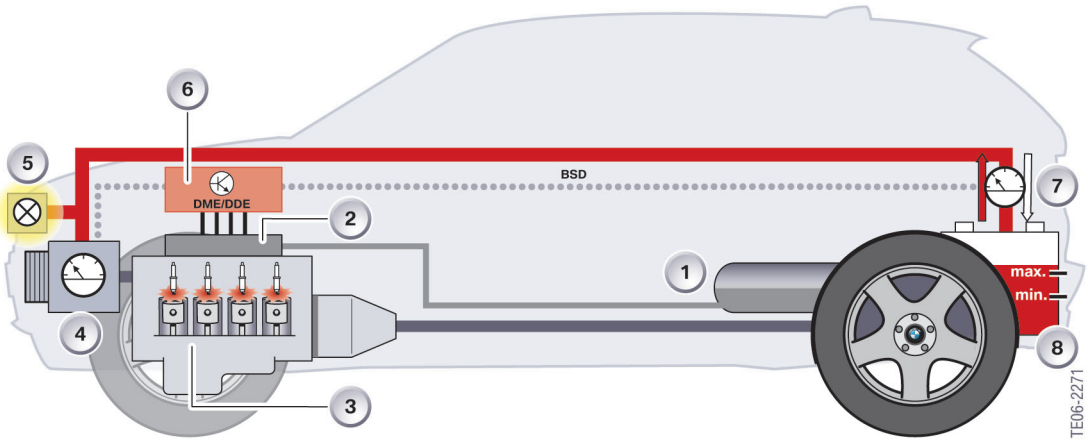
4 - IGR-Medium

Index	Explanation
1	Fuel tank - No fuel is used
2	Fuel injection - The injection nozzle supply fuel to the engine
3	Engine - The engine converts the chemical energy of the fuel into mechanical energy
4	Alternator - The alternator generates sufficient electrical power in order to cover the current consumption of electrical energy
5	Electrical loads - The alternator supplies the electrical loads with electrical energy
6	DME/DDE - The DME/DDE is connected to the IBS and the alternator via the bit-serial data interface
7	IBS - The intelligent battery sensor detects that the battery is neither charged nor discharged
8	Battery - The state of battery charge is maintained

IGR-High

At sufficient battery charge level, the alternator voltage is controlled such that the battery is discharged at an acceptable rate. In this phase, the vehicle electrical system is partly supported by the battery.

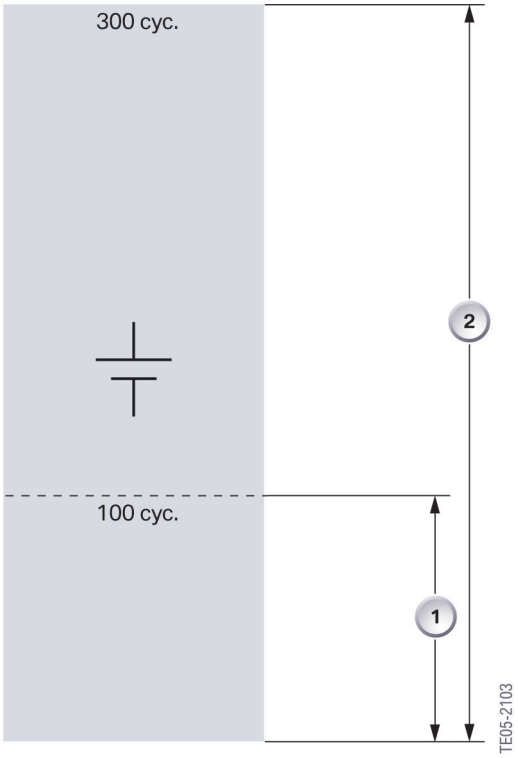
The load on the alternator is at a minimum in this phase, however, it only has a stabilizing effect for the vehicle electrical system. The required IGR voltage level is limited by the power management to a voltage compatible for the electrical system.



5 - IGR-High

Index	Explanation
1	Fuel tank - Fuel is used
2	Fuel injection - The injection nozzle supply fuel to the engine
3	Engine - The engine converts the chemical energy of the fuel into mechanical energy
4	Alternator - The alternator only has a stabilizing effect for the electrical system
5	Electrical loads - The electrical loads are largely supplied by the battery with electrical energy
6	DME/DDE - The DME/DDE is connected to the IBS and the alternator via the bit-serial data interface
7	IBS - The intelligent battery sensor detects that electrical energy is taken from the battery
8	Battery - The battery is discharged

Cyclic stability



6 -

Index	Explanation
1	Cyclic stability of "normal" batteries
2	Cyclic stability of AGM batteries

An IBS (intelligent battery sensor) is installed in all cases.

A vehicle battery with AGM technology is always used due to its higher cyclic stability. The cyclic strength of the AGM battery is three times higher.

The control process of the IGR or vehicles with MSA (automatic engine start) makes such a vehicle battery necessary.

⚠ The battery will age prematurely if a "normal" battery is installed. ◄

Deactivation of intelligent alternator control

The intelligent alternator control is deactivated under following conditions:

- Battery charge level too low
- Ambient temperature too low
- Deactivation in stages as soon as the AGM battery has reached the maximum cyclic stability

⚠ The intelligent alternator control must be deactivated during an alternator test conducted with the BMW diagnosis system. ◄

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