AutoIntelligence

125 Years Bosch 1886–2011

Essential Information for the Modern Workshop | Issue 13 | Winter 2011

BOSCH Invented for life

125 years of Bosch
Invented for life

This year Bosch is celebrating 125 years as a technical innovator.

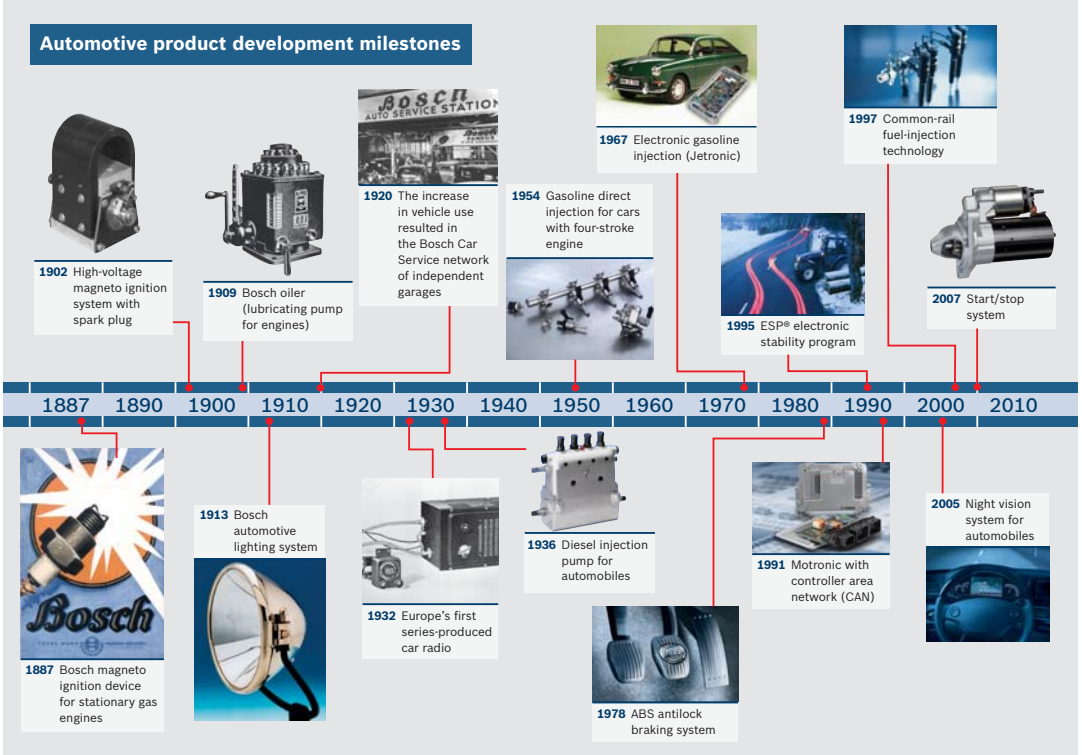
Since the company was set up in Stuttgart in 1886 by Robert Bosch (1861–1942) as a 'Workshop for Precision Mechanics and Electrical Engineering', Bosch has forged its reputation through a variety of highly successful products. Prominent examples include the magneto ignition device, the Bosch spark plug, the Bosch automotive lighting system, the diesel injection pump and the ABS antilock braking system.

The three Bosch business sectors – Automotive Technology, Industrial Technology, and Consumer Goods and Building Technology – each offer their customers a broad portfolio of modern products and services from a single source. For the automotive industry, Bosch offers a variety of products ranging from advanced fuel-injection systems for internal-combustion engines and concepts for hybrid vehicles to exhaust-treatment systems for diesel engines and safety and navigation systems for vehicles. Automotive Technology is the largest of the Bosch Group's three business sectors, and generates the most sales.

Bosch made its first decisive breakthrough in 1897, when it modified the low-voltage magneto ignition device so that it could be used in motor vehicles. This was then subsequently developed into the high-voltage magneto ignition system with a spark plug. That device was a huge success the world over and contributed greatly to the automobile's ascendance as a form of mass transportation in the early 20th century.

Today, Bosch is the world's leading manufacturer of fuel-injection systems for internal-combustion engines. In addition to the common-rail injection system for diesel engines, its products also include safety systems such as the ABS antilock braking system and the ESP® electronic stability program.

Automotive product development milestones



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Welcome

Welcome to issue 13 of Auto Intelligence. This year Bosch is celebrating 125 years as a technical innovator, so in this issue we are focusing on the latest vehicle technologies. Although there has been a great deal of interest in electric cars there are still relatively few on the road, but full hybrid and especially micro hybrid vehicles are growing in number. These technologies have now been around long enough for them to be appearing in independent workshops and they provide a new set of challenges to technicians.

So this issue features articles on both hybrid and micro hybrid technologies. On page 3 Auto Intelligence looks at the training on these systems now being provided by Bosch. The growing popularity of micro hybrid systems is covered on pages 4–5 and a look at the full hybrid systems developed by Bosch features on pages 6–7. The different components in a micro hybrid system and the battery requirements for these vehicles are covered on page 8.

The EU commission hopes to make driving safer for motorcyclists

New Bosch motorcycle ABS

Bosch is starting series production of a new version of the generation 9 ABS for motorcycles.

The ABS 9 plus is currently the world's smallest and lightest brake control system for motorcycles. When motorcycle riders apply full braking, the dynamic changes in wheel load can cause the rear wheel to lift. To address this problem, all motorcycle versions of the generation 9 ABS evaluate how much each of the two wheels is slipping. If there is a danger that the motorcycle will roll over, the braking pressure on the front wheel is reduced. Bosch has integrated an additional pressure sensor into the new ABS 9 plus, which registers the braking pressure applied by the rider and can thus detect earlier if the rear wheel is lifting. The new system is currently going into series in two motorcycle models. Kawasaki offers it as an option on the Ninja ZX-10R as the Kawasaki Intelligent Anti-Lock Brake System (KIBS); Ducati is introducing it as standard on the Diavel.

Market entry

Bosch SMP137 marks entry into the integrated medium-pressure sensor market.

The Bosch SMP137 model series is the first time the company has offered integrated medium-pressure sensors for the automotive sector. The product range of the globally operating automotive supplier previously included sensors for the low-pressure range up to 10 bar and high-pressure sensors for 140 to well over 2,000 bar. The SMP137's primary area of application is in automatic transmissions. With a response time of less than a millisecond, it very precisely measures the pressure for activating a clutch. Pressure measuring in air conditioning systems is a further area of application.

Direct injection

Bosch gasoline direct injection for use in racing vehicles.

Bosch Motorsport is offering a new gasoline direct injection system for use in racing vehicles. With its engine control unit from the MS 5 product family and HPI 5 high-pressure power stage unit, the refined system incorporates all the electronic components. It also incorporates the complete hydraulic system: the HDEV 5 high-pressure injection valves and the HDP 5 high-pressure pump with an integrated demand control valve. "Bosch direct injection is the ideal basis for innovative engine designs" says Klaus Böttcher, the Director of Bosch Motorsport. Changes in engine specifications are now being discussed extensively in several racing series.

Electrically controlled HDEV 5 high-pressure solenoid valves with multi-hole technology typically use up to seven individual jets to generate a spraying pattern. Bosch Motorsport advises its customers on injection-pattern configuration and additionally offers individual jet configurations, in which the jet pattern is adapted to the specific geometrics of each engine's combustion chamber.

Bosch training course dates March to May 2011

VSTD9 Oscilloscope Operation & Signal Test Methods:
Bosch Diagnostic Technician
Tue 01/03/11 to Wed 02/03/11

VSTD20 Operation of the Bosch KTS 340 Diagnostic Tester:
Garage Equipment Training
Fri 04/03/11

VSG5 Gasoline Engine Management: System Components & Diagnosis:
Bosch Diagnostic Technician
Wed 09/03/11 to Fri 11/03/11

VSD15 Common-Rail System Diagnosis:
Bosch Diagnostic Technician
Wed 16/03/11 to Thu 17/03/11

VSG17 Gasoline Engine Emissions Analysis:
Bosch Master Technician
Mon 21/03/11 to Tue 22/03/11

VSG2 Gasoline Engine Management Ignition Systems:
Bosch Diagnostic Technician
Thu 24/03/11 to Fri 25/03/11

CS1 Customer Care for Technicians:
Bosch Diagnostic Technician
Tue 29/03/11

VSG11 Gasoline Direct Injection System Diagnosis:
Bosch Diagnostic Technician
Wed 30/03/11 to Thu 31/03/11

VSC6 Essential Braking & ABS:
Bosch Diagnostic Technician
Mon 04/04/11 to Tue 05/04/11

VSH24 Level 2 Award in Hybrid Electric Vehicle Operation & Maintenance:

Electric education

Servicing and repairing hybrid and full electric vehicles presents a new set of challenges to workshops and technicians. Auto Intelligence sat in on the latest Bosch training course designed for these vehicles.

Hybrid vehicles have been on the market long enough (over 10 years) for these vehicles to be appearing in independent workshops for service and repair. The high voltage battery packs and electric motors utilised by these vehicles mean that technicians need to adopt a different approach.

To address this requirement Bosch has developed the VSH 24: Electrically Propelled and Hybrid Vehicles training course. This is a two-day course that offers an IMI level 2 award to technicians that successfully pass. There is no prerequisite for delegates to have passed any other Bosch technical courses. As such VSH 24 includes a module covering essential electrical knowledge. This ensures all attending technicians have a basic understanding of electricity.

The course features the following seven modules:

- Overview of high voltage vehicle technology:
  - Hybrid electric vehicle (HEV) systems
  - Electric vehicle (EV) systems
- HV vehicle – Awareness of health and safety
- Essential electrical knowledge
- HV components – Construction and operation
- HV vehicle – Protective and test equipment
- HV vehicle – Maintenance procedures
- Additional technical information

Experienced Bosch trainer and vehicle electronics expert, John Batten, delivered our course. The course begins with John giving an overview of high voltage vehicles and an explanation of the different categories (mild/strong hybrids). As with all Bosch training this course is not delivered as a lecture. John explains the technologies and actively encourages discussion and questions from the delegates. This overview not only covers the different technologies it also explains the benefits (and downsides) for each system.

The course offers both practical and theory sections. On day one the delegates get to inspect a hybrid vehicle (Toyota Prius) in the workshop, familiarising themselves with the system and component layout. One of the main areas of focus for the course is health and safety. Although the vehicle systems are designed to be very safe the high voltage components can be dangerous if they are not worked on using the correct procedures and equipment. The awareness of health and safety module looks at the potential hazards facing technicians working on HEV and EV systems. These range from electrocution, the danger of arc flash, effects of magnetism, to corrosion/contamination hazards from the battery. As such the course offers a set of procedures that technicians are strongly advised to follow when working on the vehicles. This includes the need for special personal protection and test equipment.

On day two the course covers HV components, construction and operation. Having been given an overview of the HEV and EV systems, the delegates now look in more detail at the components and how they function and interact during the driving cycle. This is followed up with a closer look at two different manufacturer's systems. Recuperative braking, energy storage and the internal combustion engines are also covered. The different types of battery are explained plus the applications and handling.

The practical section for day two includes the delegates carrying out the procedures discussed on the first day, on the Prius in the workshop. The trainer supervises and monitors the delegates to ensure correct practice is being observed. The course concludes with a multiple-choice test, which requires a minimum 60% score to pass.

Barnaby Donohew
General Manager
& Diagnostics,
T.J. Lobb – Cornwall

"I'm attending this course due to customer demand. We have sold some used Toyota Prius' and we want to able to support those customers with proper aftersales service. One customer has bought a car on the basis that I will be trained to service it."

"The course has been very good. Bosch training is always very high quality and I've learned a lot on this course. This is a very safety led course and there are some potential pitfalls if you don't know what you are doing. It's also given me a much better insight into the technology now being used."

Qualifications Credit Framework
Thu 07/04/11 to Fri 08/04/11

VSTD7 Operation of Bosch KTS 5xx/6xx Diagnostic Testers:
Garage Equipment Training
Mon 11/04/11 to Tue 12/04/11

VSG14 Gasoline Engine Management Advanced Systems Controls:
Bosch Master Technician
Wed 13/04/11 to Fri 15/04/11

VSG5 Gasoline Engine Management System Components & Diagnosis:
Bosch Diagnostic Technician
Tue 19/04/11 to Thu 21/04/11

VSE1 Essential Test Procedures:
Bosch Diagnostic Technician
Wed 27/04/11 to Thu 28/04/11

VSD12 Electronic Diesel Control:
Bosch Diagnostic Technician
Wed 04/05/11 to Fri 06/05/11

VSG11 Gasoline Direct Injection System Diagnosis:
Bosch Diagnostic Technician
Wed 11/05/11 to Thu 12/05/11

VSC13 Advanced ABS & Electronic Stability Control:
Bosch Master Technician
Wed 18/05/11 to Fri 20/05/11

VSTD7 Operation of Bosch KTS 5xx/6xx Diagnostic Testers:
Garage Equipment Training
Mon 23/05/11 to Tue 24/05/11

VSTD9 Oscilloscope Operation & Signal Test Methods
Bosch Diagnostic Technician
Thu 26/05/11 to Fri 27/05/11

All courses held at Robert Bosch Ltd. Denham.

For more information on these courses please call: 01895 878032

Micro **hybrid**

While full hybrid and electric vehicles are on the roads in relatively low numbers, cars featuring micro hybrid technology are becoming increasingly common. Bosch discusses the systems and components.

Start/stop systems, fitted to standard internal combustion engines, are designed to reduce unnecessary fuel consumption. When the vehicle is at a standstill and after a check of the state of charge of the battery, the system automatically switches off the engine. Measurements in the new European driving cycle (NEDC) indicated savings in consumption and reductions in emissions of around 8%. In real urban traffic, savings can be considerably higher.

In conjunction with a modern gasoline engine, a warm start only consumes as much fuel as is consumed in 0.7 seconds of idling. This means that stops are worthwhile from the first second onwards. When the journey is to be continued, operating the clutch automatically restarts the engine. During the standstill phases no fuel is consumed and no CO_2 is emitted. The electrical consumer units in the vehicle continue to be supplied during the stop and the current energy consumption is monitored. The EFB and AGM battery technologies from Bosch ensure optimal energy supply.

Increase in revenues for the workshop

The growing number of vehicles with start/stop systems is changing the way in which car batteries are sold and serviced. The battery is assuming a key role in the system. It is integrated in the functions for fuel saving and reduction of CO_2. Batteries are no longer replaced with the 'do-it-yourself' method. A workshop professional now has to perform this task, as battery replacement often has to be notified to the control unit with the help of a diagnostic tester.

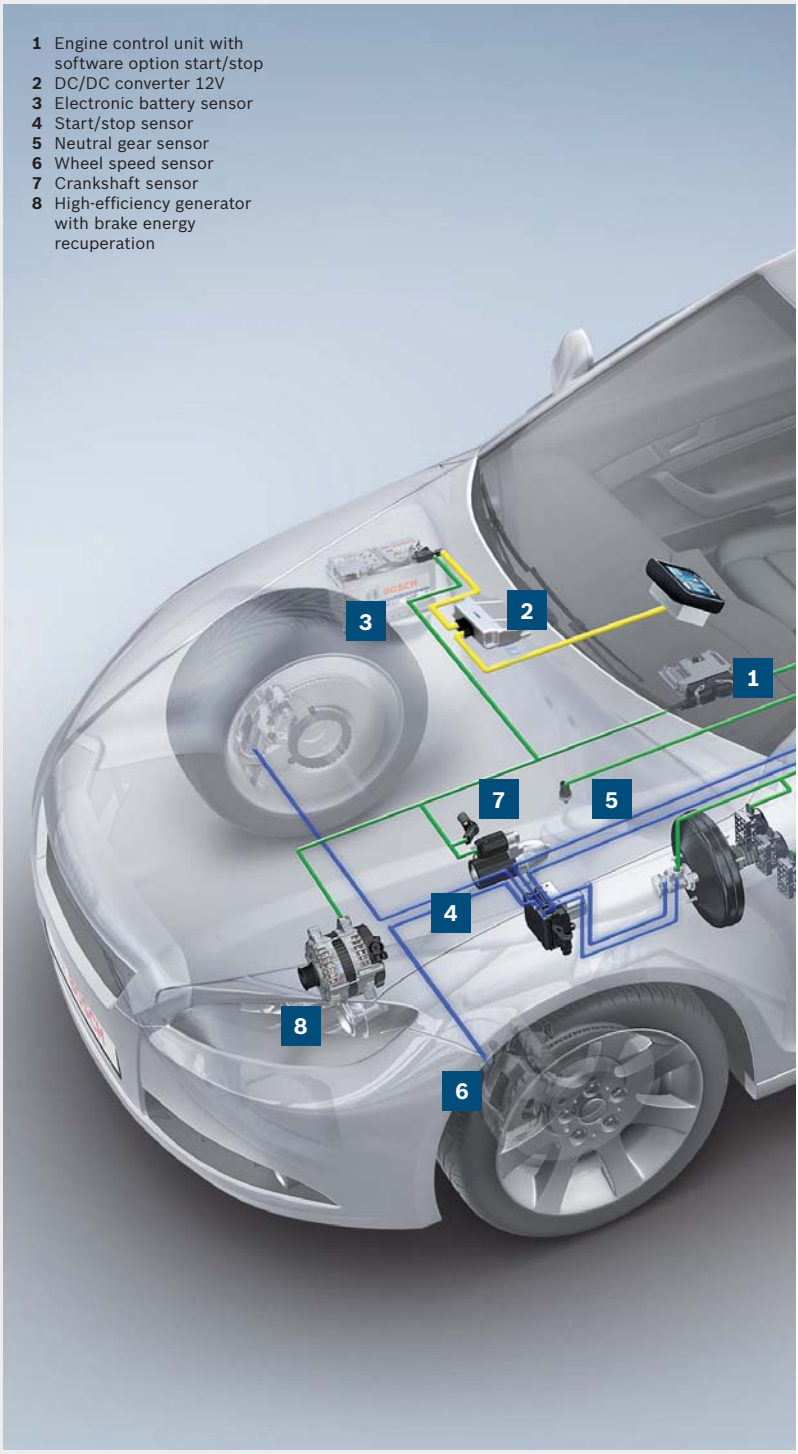
By 2015, more than 30 million vehicles in Europe will be equipped with start/stop systems. This will create strong demand in the workshop for the corresponding batteries that require professional replacement.

System know-how

Bosch has been working for more than 30 years on the development of hybrid technologies and can rely on comprehensive know-how in the field of battery, electric drive, and brake management as well as engine and transmission-shift control. As well as start/stop systems another example of this is brake energy (recuperation), where by kinetic energy is converted into electrical energy in the over-run mode and stored in the battery. If required, the energy that is recuperated is available to increase engine power and save fuel in that the alternator is switched off temporarily (passive boost).

Intelligent control

The function of the start/stop system is achieved by adapting and intelligently controlling existing components in the vehicle. A key component is the specially developed start/stop starter motor, which has been configured for the special requirements and is networked with the engine control unit. The entire system includes regulation software and a battery sensor as well as a crankshaft sensor and the corresponding sensor technology in the pedals. An enhanced-efficiency alternator in conjunction with a deep-cycle resistant battery allows frequent start and stop operations.



Coordination: Energy management (1 and 3)

The engine control unit with integrated start/stop coordinator and the battery sensor are major components of the energy management on vehicles with a start/stop system. It also includes the deep-cycle resistant battery with EFB or AGM technology and the DC/DC converter.

Direct current: DC/DC converter (2)

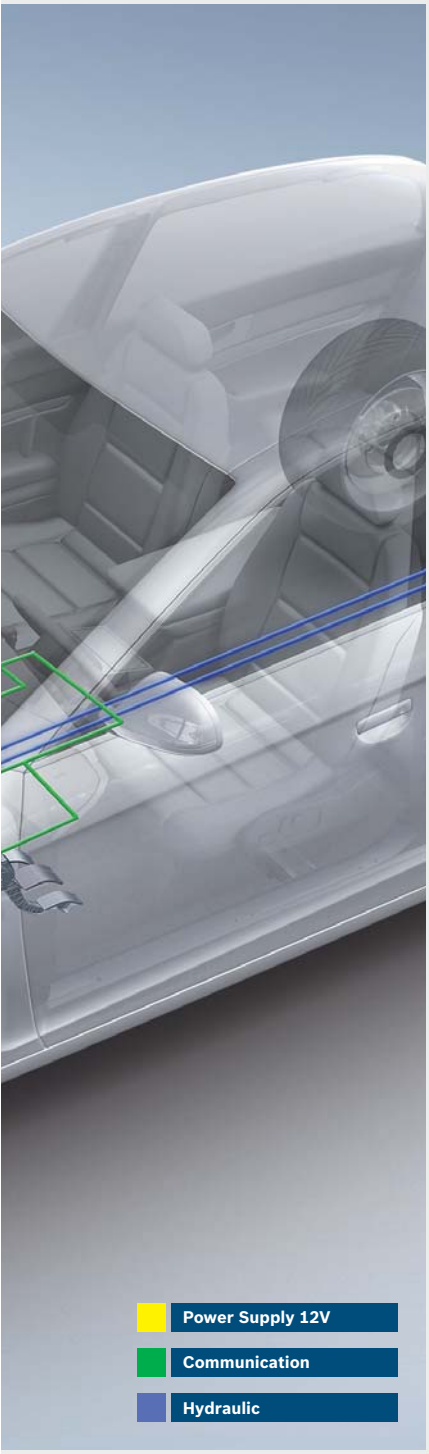
When the starter is actuated, the voltage level of the vehicle electrical system falls temporarily. This can impair the function of electronic devices. To prevent this loss of comfort and convenience, Bosch has developed the direct voltage converter (DC/DC converter) for deployment with start/stop systems. This stabilises the voltage for parts of the vehicle electrical system so that comfort and convenience are not diminished.

Monitoring: Electronic Battery Sensor (EBS) (3)

The electronic battery sensor (EBS) is a central part of the electronic energy management. Installed in the terminal recess of the battery, it precisely and dynamically registers the operating data such as power, voltage and temperature. With the measured values, it monitors the performance capability of the battery.

A special boost: Start/stop starter motor (4)

The starter motor has been optimised for frequent start operations by reinforcing attachment points that are subjected to high loads and improving the transmission.



Information managers: Sensors (5, 6 and 7)

The sensors provide current information and can optimise the starting operation. While the neutral gear sensor indicates whether a gear is engaged, the wheel-speed sensor measures whether the vehicle has really come to a standstill. The crankshaft sensor reports engine activity accordingly.

Continued comfort in any situation

The air conditioning and additional electrical functions, such as power windows, boot lid lock, engine cooling etc. represent a burden on the energy system, especially when the engine is switched off. The electronic consumer units are still supplied with power by the battery while the vehicle is at a standstill.

System functions: Check before automatic engine shutdown

- Engine is in neutral gear (idling)
- The wheel-speed sensor signals vehicle at standstill
- The battery management system signals sufficient energy for the next start

Reliable electricity supplier: Alternator (8)

Efficiency Line alternators for start/stop systems generate more electrical energy for supply of the vehicle electrical system even in the low speed range and directly after the vehicle has been started. In conjunction with the powerful battery, they increase the availability of the start/stop function.

New! FSA 050 tester for electronic and hybrid drives

To test vehicles with an electronic or hybrid drive, the new FSA 050 hybrid tester can also be connected wirelessly to the FSA 500 or the high-end FSA 7-series test systems from Bosch. The hybrid tester can be used to perform high-voltage and insulation tests, for example, to verify the integrity of line connections. As a stand-alone device, the FSA 050 also represents an affordable entry point into electronic and hybrid drive testing.

Workshop skill: Installing batteries safely

Important aspects of battery service for vehicles with start/stop systems:

- Replacement of AGM with AGM
- Replacement of EFB with EFB or AGM
- Conventional lead-acid battery cannot be used.
- In many vehicles with start/stop systems (e.g. Audi, BMW, Volvo), a suitable control unit diagnostics tester, for example a device from the Bosch KTS series, has to be used to register the newly installed battery at the control unit

High frequency battery chargers

Workshops need the right equipment to test and maintain modern vehicle electric systems.

High frequency battery chargers
During diagnostic work a battery charger should always be connected to the vehicle to provide a backup power supply. Modern vehicles can draw a lot of current when running actuator tests, cranking multiple times during the diagnosis and for ECU reprogramming. The voltage drop caused by these consumers can lead to additional ECU errors and misleading test results.

Also battery replacement can lead to a loss of the vehicle settings, for example the radio code. With a high frequency charger connected to the vehicle, whilst replacing the battery, these systems will be unaffected.

BAT 490 – Microprocessor controlled battery charger suitable for 12V or 24V standard lead acid, maintenance free, gel, fleece and AGM batteries.

Features:
- Variable charge current (0–90A)
- Automatic detection of 12V or 24V systems
- Shorter charging time due to optimised charging process
- Electronic protection management system
- Protects against: reverse polarity; overcharging; overheating; short circuit; voltage peaks; malfunction; damage of car components
- Updateable via a USB interface

BAT 430 – Similar to the 490 but with a maximum output of 30A.

BAT 121 – This portable charger is suitable for all types of 12V batteries.
The load-free test procedure takes less than 12 seconds and incorporates six different test standards to choose from.

Additionally the BAT 121 can perform an alternator test and is equipped with a printer, which shows all the test results at a glance.

Features:
- Suitable for all types of 12V batteries e.g. standard lead acid, maintenance free, fleece, gel and AGM batteries
- Can be used for motorbikes, passenger cars, LCVs and HGVs
- Automatic test procedure
- Alternator and charging system test (Test standard to choose from: IEC, DIN, EN, SAE, CCA and JIS)
- Printer
- Reverse polarity protection
- Overload protected
- Software updates possible

BAT 110 – A fast and reliable battery tester suitable for all kind of 12V batteries.
The load-free test procedure incorporating six different test standards to choose from. Also alternator tests can be performed.

Features:
- Suitable for all kind of 12V batteries e.g. standard lead acid, maintenance free, fleece, gel and AGM batteries
- Can be used for motorbikes, passenger cars, LCVs and HGVs
- Clear indication of battery condition (good or bad)
- Automatic test procedure
- Test standard to choose from: IEC, DIN, EN, SAE, CCA and JIS
- Charging system test
- Quick test procedure

Driving the future: Hybrid technology

Bosch is heavily involved in the development of hybrid vehicle technologies. This article looks at current and future hybrid vehicle programmes.

Full-hybrid versions of the Porsche Cayenne S and Volkswagen Touareg have been recently launched, and these are the first vehicles worldwide to feature Bosch's parallel-hybrid technology. In addition, PSA Peugeot Citroën and Bosch have formed an engineering alliance to develop diesel hybrids with electric four-wheel drive, which will go into series production in 2011. For these vehicles, Bosch is developing and manufacturing the power electronics and electric motors.

Using hybrid and electrical powertrains has an impact on many other automotive components and systems. They include efficient auxiliary units, such as electric power steering. Then there are braking and ESP® systems tailored to hybrid and electric vehicles, that coordinate the interaction between the conventional friction brake and the braking effect of the generator. Finally, there are features such as efficient thermal management for the heating and cooling systems in the electric vehicle, or navigation systems that compute the optimum route in terms of fuel efficiency. Bosch is also investing in these areas.

Control technology

For the hybrid versions of the Volkswagen Touareg and Porsche Cayenne S Bosch worked closely with the two automakers to develop the control technology that manages the interaction between the vehicle's internal combustion engine and electric motor, without requiring a mechanical power splitting device. This essentially involves replacing run-of-the-mill mechanics with intelligence: instead of using a planetary gear unit as a power splitting device, control technology is employed to split the torque between the electric motor and the internal combustion engine.

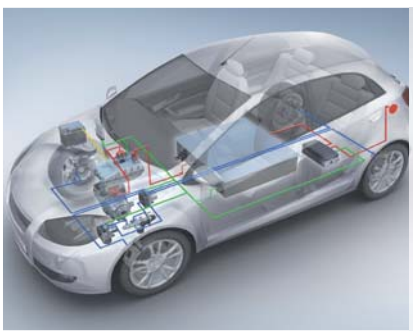
Bosch helped make the first hybrids a reality back in the 1970s, and the key to the system they have now created stemmed from progress made on the internal combustion engine. While they were busy developing the Motronic engine management system, the engineers learnt how to switch between different operating points without any change in torque. The basic idea was to allow direct injection systems to switch from homogenous operating mode to lean operation without any jump in torque – so smoothly that the driver does not even notice that anything has changed. Smooth engagement is especially important when the electric motor hands over to the internal combustion engine, when both sources work together, or when the combustion motor temporarily shuts down. In the parallel full hybrids developed by Volkswagen and Porsche, this is all performed automatically. The system works on the basis of how much torque the driver is asking for with the control unit monitoring the pressure on the gas pedal. The hybrid control unit translates the pressure applied to the gas pedal into electric-powered, hybrid, or combustion engine-powered driving. At the same time, it monitors the pressure applied to the brake pedal to determine how much brake torque should be set by the electric motor.

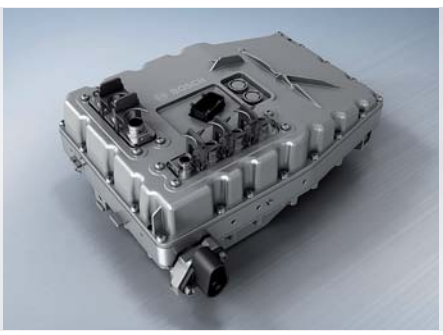
Seamless transition

So how do engineers manage to synchronize the Cayenne and Touareg V6 engine with the Bosch electric motor down to a precision of just a few milliseconds? More to the point: how do the developers get a 245 kilowatt (333 hp) direct injection engine providing up to 440 Newton meters of torque to seamlessly blend together with the electric motor's rating of 34 kilowatts (47 hp) and 300 Newton meters? The trick lies in measuring, controlling, and regulating – in other words, in maintaining perfect interaction between sensor systems, control technology and actuators.

Taking a look at how the system is designed makes it easier to understand how it works. The electric motor is positioned between the SUV's internal combustion engine and eight-speed automatic transmission. The hybrid module encompasses the Integrated Motor Generator (IMG), a separate clutch controlled by actuators, a water cooling system, and – of course – the permanent magnets and coils of the rotor and stator.

For good measure, the developers have also incorporated digital sensors designed to continuously monitor the rotor position. The IMG enables the Volkswagen and Porsche to be driven on electric power alone at speeds of up to 60 kph. By joining forces with the internal combustion engine, it can accelerate the parallel hybrid from 0 to 100 kph in less than 6.5 seconds. This 'boost' function increases the vehicle's performance to 279 kilowatts (380 hp), offering the driver a maximum torque of 580 Newton meters. Under steadier driving conditions and when braking, the IMG functions as a generator, supplying electrical power to a further core element of the hybrid vehicle: the power electronics.





Power electronics

The power electronics are also supplied by Bosch. They are integrated within the water-cooling circuit as the device offers a high-power transformer within a volume of just 10 litres. Two things happen here. Firstly, the device acts as an interface between the 288 Volt (370 Amp) network of the hybrid drive and the vehicle's 12 Volt electrical system. Secondly, bipolar transistors convert the direct current from the battery into three-phase alternating current for the electric motor, and vice versa.

The engineers also incorporated expertise from the realm of start/stop systems, which taught the developers how to quickly start up combustion engines in different modes without jarring. One essential step was ensuring that sensors were in place to send a continuous supply of information to the control unit regarding temperatures, piston position, and engine speed.

Another new feature is the way in which the combustion engine shuts down when the driver releases the gas pedal, activating what the engineers call the 'sailing' mode, which can be used at speeds up to around 160 kph. This reduces fuel consumption and allows the electric motor to operate as a generator supplying power to the vehicle's 12 Volt electrical system.

Using hybrid and electrical powertrains has an impact on many other automotive components and systems. They include efficient auxiliary units, such as electric power steering.

As soon as the combustion engine is needed, the specially designed clutch system ensures a rapid response. It continuously tracks the point at which the combustion engine starts to transfer torque and records this touch point in the hybrid control unit as a reference value for the next shift between power sources. Sensor data from the IMG, combustion engine, battery and other components also funnel through to this control unit, which analyses the flow of data in real time and extrapolates this data to provide inferred information on other components that are not being directly monitored. This allows it to control the meshing of the drives using the clutch actuator system within just a few milliseconds.

Parallel full hybrid technology in detail

Power electronics

Function: The link between the battery, which requires direct current, and the electric motor, which requires and generates three-phase alternating current. A pulse inverter 'chops' the direct current using bipolar transistors – basically switching elements that switch on and off at a lightning-fast rate. In addition, a DC-DC converter acts as an interface between the vehicle's 12 Volt electrical system and the 288 Volt network of the electric drive.

Electric motor (Integrated Motor Generator, IMG)

Function: The electric motor is a round 'disc' – 30 centimeters in diameter – positioned between the internal combustion engine and the transmission. More precisely, it is a water-cooled, permanent magnet-excited synchronous machine with an inner rotor. It starts up the internal combustion engine, enables the vehicle to be driven on electric power alone, can be operated in tandem with the combustion engine, and acts as a generator to convert braking energy and combustion engine torque into electricity.

Hybrid Control Unit

Function: The control unit is the 'brain' of the parallel hybrid, drawing together sensor data from the electric and internal combustion engine powertrains. The flow of data allows the control unit to infer the state of other components that are not directly monitored by sensors. All this happens in real time and provides the perfect basis for efficient and seamless interaction between the combustion engine and electric motor. One of the key input variables comes from interpreting the driver's wishes by monitoring the pressure on the gas pedal and brake pedal.

Lithium-ion batteries are the energy storage medium of the future

Energy storage

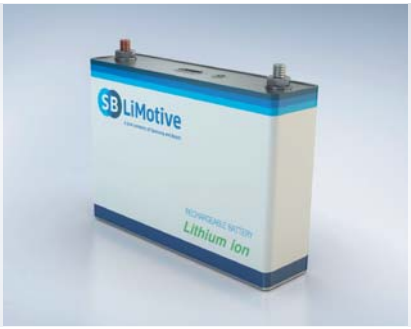
In the future, Bosch intends to market itself as a single-source supplier of complete, fully integrated electric drives with lithium-ion batteries. To achieve this, Bosch has embarked on a joint venture with Samsung SDI and has formed SB LiMotive.

When it comes to hybrid and electric vehicles, lithium-ion batteries are the energy storage medium of the future. Five aspects are central to the development of lithium-ion batteries: cost, energy density, power density, safety, and service life.

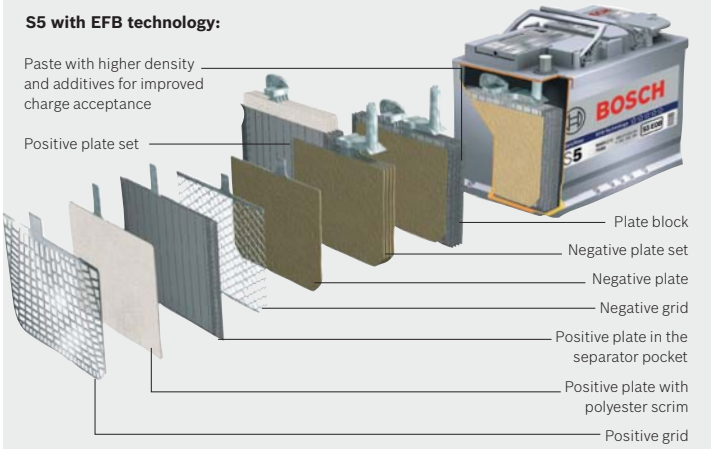
Range, which depends in large part on the energy density of the battery cell, is another crucial factor for the success of electric vehicles. To meet customer demands, engineers are looking to double energy density.

Batteries also need to last as long as the car. In a hybrid, that means over one million charge cycles for the battery, since hybrids switch very frequently between motor and generator mode, recovering energy during braking.

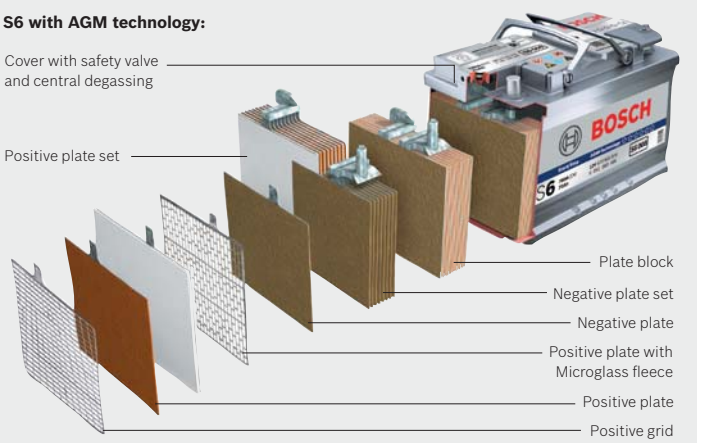
For the battery packs, cell monitoring is central. The battery management system continuously registers and regulates the current, voltage, temperature, and level of charge, preventing the battery from losing too much charge or overheating. A sophisticated thermal management system makes sure the battery always stays within an ideal and thus safe temperature range. A constant operating temperature of about 35 to 40 degrees Celsius means that the battery can perform at all times. Lower temperatures would lead to drops in power; higher ones would shorten the service life.



S5 with EFB technology:



S6 with AGM technology:



Start/stop

Here we take an in depth look at 'start/stop' systems.

Kevin Lyon
Technical Support

What is the start/stop system?

The basic principle is that the vehicle's control system will switch the engine off when the vehicle is for example in a queue of traffic or stopped at traffic lights. It then re-starts the engine when the driver wishes to pull away.

Basic components: Battery

Depending on the level of efficiency of the micro-hybrid system, the battery can be of EFB or AGM construction.

Starter motor

Due to the increased number of starter operations, the starter motors are modified to cope with the extra load. This includes strengthening of bearings subjected to heavy loading, a stronger fork and pinion with larger commutator and brushes for longer life. On some later systems starter motors with two solenoids and electronic control may be incorporated.

Intelligent battery sensor (IBS)

Fitted as part of the battery's' negative terminal, it monitors the physical variables of the vehicle's battery, such as voltage level, temperature and current. Internal Battery State Detection (BSD) software provides information about the current battery state of charge (SOC) and battery state of function (SOF) as well as the predicted future electrical behaviour.

Alternator

The alternator has a 2–3% increase in efficiency over a standard alternator. This is achieved by optimising the cooling of the alternator and fitting high efficiency diodes (HED). The voltage regulator is digitally controlled, usually via LIN BUS (Local Interconnect Network). The start/stop controller, engine or battery management control unit can be used to monitor and control alternator output.

12V DC-to-DC convertor

When the starter is actuated the voltage level of the battery briefly drops. This can affect the electrical auxiliaries, and for example, could result in a brief interruption in radio reception or loss of the navigation system. To prevent this, some systems will use a DC/DC convertor; this stabilises the voltage supply for other components of the vehicle electrical system during engine start.

Start/stop system: Operation

When the vehicle comes to a standstill, the system checks the state of charge of the battery. If the battery has sufficient charge and other parameters are met, such as clutch switch and gear position, the system turns the engine off. The electrical consumer units in the vehicle continue to have battery voltage supply whilst the engine is off. The current consumption is continuously monitored. Restarting of the engine is achieved by operating the clutch or selecting a gear.

Brake energy (recuperation)

If required, during braking and on overrun, additional alternator output can be harnessed to keep the battery at an optimal charge. It can also allow the alternator to be switched off temporarily (passive boost), which increases engine power and saves fuel.

This function is not a standard option on all vehicles with start-stop, and is applicable only with some vehicle manufacturers.

Bosch batteries for modern demands

Enhanced Flooded Battery (EFB) uses technology midway between a normal starter battery and an AGM design. It has thicker plates with special separators to cope with increased number of cycles and a higher density of active material and additives compared to a normal starter battery to improve charge acceptance.

The advantages of Bosch battery S5 EFB technology:

- Enhanced service life compared to conventional starter batteries
- Reliable start even at extreme temperatures
- Two times higher cycling performance compared to conventional starter batteries
- Enhanced charge acceptance
- With additional polyester scrim between plate and separator
- Perfect for short-distance urban driving conditions
- Secured against leaks and tilting up to 55°
- Absolutely maintenance-free
- Original-equipment quality

Absorbent Glass Mat (AGM) uses the best available technology. The casing is sealed and valve regulated. Special glass mat separators isolate electrodes and improve cyclic performance; the acid is impregnated into the glass mat separator. These features allow three to four times the number of cycles (to cope with all the start/stops).

The advantages of Bosch battery S6 AGM technology:

- Enhanced service life compared to conventional starter batteries
- Constant power even for short distances, stop-and-go traffic or high consumption with the car at a standstill
- Up to four times higher deep-cycle resistance in comparison with conventional starter batteries
- Acid is completely bound in microglass fibre mats
- Excellent charge acceptance
- Can be installed in any location, secured 100% against leaks and tilting
- Absolutely maintenance-free
- Original-equipment quality

The battery market

The growing number of new vehicles with start/stop systems will have an effect on how the independent garage approaches the repair of these systems. It changes the way in which car batteries are sold and serviced. Additionally the replacement of any the main components such as battery, starter motor and alternator are system critical, and should only be replaced like for like. With the wrong battery type, the function and positive effects of the start/stop system are diminished. The service life of the battery is also reduced.

Batteries fitted to vehicles with these systems can no longer be replaced by the 'do-it-yourself' method. In most cases the replacement of the battery requires resetting or reprogramming of the vehicle's control unit that is used for the battery monitoring functions.