Changing from charging

Part 2 - Smart Charging Techniques

Last month's article looked at the traditional methods of alternator charging systems. This article examines open loop control systems in more detail.

Some manufacturers are now bringing together alternator output control, electrical power distribution and mechanical power distribution. This is known as intelligent or smart charging.

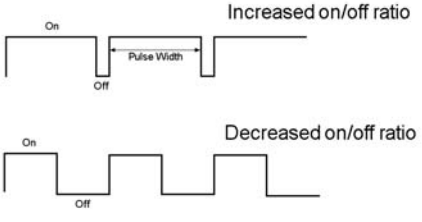
Open Loop Control

The principle of open loop control charging is that the alternator regulator and the powertrain control module (PCM) communicate. This allows new features to be developed that benefit the battery and offer other improvements such as:

- **Reduced charge times**
- **Better idle stability**
- **Improved engine performance**
- **Increased alternator reliability**
- **Better control of electrical load**
- **Improved diagnostic functions**

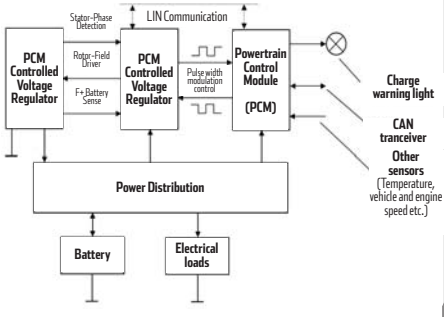
Communication between regulator and PCM is by signals that are pulse width modulated. This signal is used in both directions. It is a constant frequency square wave with a variable on/off ratio or duty cycle.

Figure 1: Two Signals with Different Pulse Width Modulation (PWM)



The PCM determines the set voltage point (regulated voltage) and transmits this to the regulator using a specific duty cycle signal. The regulator responds by transmitting back the field transistor duty cycle. In this way a variety of features can be implemented.

Figure 2: Block Diagram Showing 'Smart Charge' System



Battery Lifetime

Closed loop regulators estimate the battery temperature based on their own temperature. With an open loop 'smart charge' system the PCM can calculate a more accurate figure for battery temperature because it has sensors measuring, for example, coolant temperature, intake air temperature and ambient air temperature. This means a more appropriate charge rate can be set.

Battery recharge times are not only reduced but a significant increase in battery lifetime can be achieved because of this accurate control.

Engine Performance

One of the main causes of idle instability is the torque load that the alternator places on the engine. Because a PCM control system is 'aware' of the alternator load, it calculates the corresponding torque load and sets the idle speed accordingly. Overall, the idle can be set at a lower value, thus reducing fuel consumption and emissions.

When required, the PCM can increase idle speed to increase alternator output and prevent battery drain. This would be likely to occur after a cold start, in the dark, when the screen is frosted over. In these conditions it is likely that, because the driver

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would switch on lights, interior heaters and screen heaters, there would be an increased electrical load. In addition to the normal load (fuel, ignition etc.), the battery would also create a high demand after a cold start. The PCM can ensure that it sets an idle speed which results in sufficient alternator output to prevent battery drain.

Dynamic Adjustment

Dynamic adjustment to the set voltage point is now possible. This may be used during starting, to reduce load on the battery. It can also be used during transient engine loads (acceleration, for example). An alternator producing 70A at 14V is putting out about 1kW of power (P = VI). Taking into account the mechanical to electrical energy conversion efficiency of the alternator, the result is a significant torque load on the engine. If the set point (regulated voltage) is reduced during hard acceleration, the 0 to 60 time can be increased by as much as 0.4s.

Fault Conditions

As well as communicating the load status of the alternator to the PCM, the regulator can also provide diagnostic information. In general the following fault situations can be communicated:

- **No communication between regulator and PCM**
- **No alternator output due to mechanical fault (drive belt, for example)**
- **Loss of electrical connection to the alternator**
- **System over or under voltage due to short or open circuit field driver**
- **Failure of rotor or stator windings**
- **Failure of a diode**

The PCM can initiate appropriate action in response to these failure conditions. For example, to allow fail-safe operation or at least illuminate the warning light! Suitable test equipment can then be used to aid diagnostic work.

Summary

Smart or intelligent charging systems are here now, and are here to stay. The ability of the alternator regulator and engine control systems to communicate means new possibilities, increased efficiency and improved performance.

New diagnostic equipment may be necessary but new diagnostic techniques certainly are required. However, remember that PWM signals can be examined on a scope or even a duty cycle meter. And, if the voltage you measure across the battery is less that 13V, it is probably not recharging – unless of course you are measuring it during a 0 to 60 acceleration test!

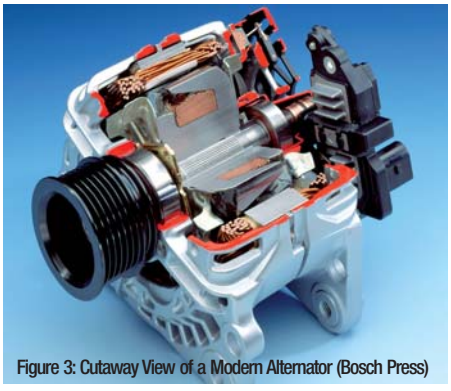
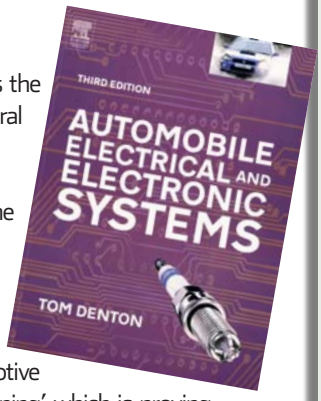


Figure 3: Cutaway View of a Modern Alternator (Bosch Press)

About the author



Tom Denton is the author of several automotive textbooks published in the UK and USA. He has also written the multimedia series 'Automotive Technician Training', which is proving popular in many UK colleges. His best selling book, 'Automobile Electrical and Electronic Systems', is now in its third edition. Further information on www.automotive-technology.co.uk.

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Q: A 1998 Vauxhall Vectra 1.6 suffers from very low power. All electrical components are sound and no trouble codes were logged. Plenty of fuel is reaching the injectors, the air intake has no restrictions and the exhaust system is not blocked. Disconnecting the exhaust made some improvement but nothing major. A compression test proved the engine was in good mechanical health and no air or vacuum leaks were found, but the manifold vacuum at idle was found to be low.

A: A valve timing problem can be the only cause in this case. Check the crankshaft sprocket key – on this engine it tends to shear off, causing the valve timing to alter. With the valves not opening and closing at the correct time, engine power is severely affected. A new crankshaft sprocket and key should cure the problem by ensuring the valve timing is correct and restoring the intake manifold vacuum to normal.

Q: The ABS warning light on a 2001 Rover 75 2.0 CDT stays on. All component and wiring tests show that the system is good and no faults can be found.

A: If the ABS system tests prove that there are no problems, the fault can be caused by a faulty wheel bearing. The "active" wheel speed sensors fitted to this model rely on an undamaged wheel bearing face to produce a speed signal. Check and replace wheel bearings as necessary.

Q: A 2004 Ford Mondeo 2.0 TDCi engine stops intermittently, especially on cold mornings. The following diagnostic trouble codes were recorded in the engine control module (ECM): P0251 (injector pump fuel metering control A, circuit malfunction) and P1211 (injector control pressure high/low). Testing the fuel system has found no faults.

A: The clue here is "cold mornings". Frozen water in the fuel system is probably reducing or stopping the flow of fuel to the engine. The ▶

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◀ system should be drained and cleaned and the fuel in the fuel tank checked for water contamination and replaced as necessary.

Q: Why do the headlights of a 2005 Fiat Idea stay on all the time, even when the switch is off?

A: On this vehicle, if the body control module (BCM) detects a fault in the lighting system it will automatically try to set the headlights to 'on' as a default setting. The strategy assumes that it is better to have the headlights switched on even if they are not required than to be without headlights at night.

Q: A 2000 Vauxhall Zafira 2.0 DTi is taking far too long to start or will not start at all from cold, especially in the morning. No trouble codes are logged in the system and the glow plugs are in good condition. When tested, the pre-heating time was very short but within the manufacturer's specifications.The injectors have been replaced and there is plenty of fuel during cranking. A compression test of all cylinders has been carried out and it believed the engine is mechanically sound.

A: The glow plug system on this model has been designed to switch on only for a very short time unless the system senses very cold weather and even then the pre-heating time is quite short. This is done because a direct injection diesel engine should start even without the glow plugs being switched on. After a few thousand miles on the clock, however, the cylinder compressions drop slightly to affect cold starting, as the engine relies entirely on the heat generated by compression to ignite the fuel mixture.

The glow plugs can compensate for the compression loss if they are switched on for longer; the increase in combustion chamber temperature will help ignite the fuel. As the glow plug system is entirely controlled by the engine control module, the cure is easy. The ECM software can be reprogrammed to switch the glow plugs on for longer enabling the engine to start quicker.

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Diagnostic Techniques

Part 6 Over-enthusiastic ABS

The latest in a series of articles which examine a given symptom and describe a number of logical tests, and results obtained from these. You're then given an opportunity to submit your views on the probable fault and suggest further tests that may be carried out to confirm the fault.

Please email these answers/suggestions to techtalk@proautotraining.com

A WH Smith token to the value of £30 will go to the reader giving the most accurate and technically detailed response each month.

In this case the customer complained that the brakes were working normally most of the time but occasionally there was an apparent lack of braking power at lower speeds accompanied by a vibration/buzzing feeling. The technician who road tested the car noticed that the condition was worse during firm, non-emergency braking on bumpy surfaces approaching road junctions and he thought the ABS appeared to be operating before it was actually necessary, hence the vibration/noise. The ABS operated normally when braking very heavily, stopping the car with little or no skidding and the warning lamp illuminated at the same time.

No fault codes were recorded and the warning lamp was not illuminated except during ABS operation as described above.

Can you tell what it is yet?

We look forward to receiving your answers and suggestions. Remember, a WH Smith token to the value of £30 goes to the reader giving the most accurate and technically detailed response. Good luck! techtalk@proautotraining.com

Part 5 of this series appeared in the March issue.

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