

Automotive Electrical Systems

Basic Electronics

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Automotive Electrical Systems

Automotive Electronics

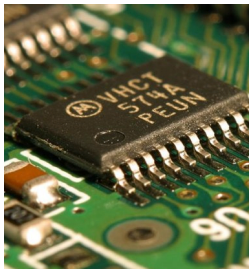
- Advantages
 - Ease of diagnosis
 - Convenience
 - Less wiring
 - Increased efficiency
 - Increased reliability
- What automotive systems are controlled with electronics?



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Computer Memory

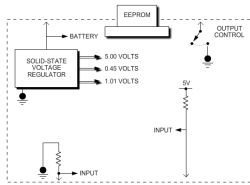
- RAM
 - Random Access Memory
- ROM
 - Read Only Memory
- PROM
 - Programmable Read Only Memory
- EEPROM
 - Electrically Erasable Read Only Memory



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Computer Operation

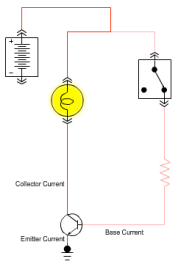
- Receive system status and operation data from input sensors
- Process input information
 - Look-up tables
- Produce outputs that operate the system
 - Directly
 - Indirectly
- Provide regulated voltage to sensors



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NPN Transistor Circuit

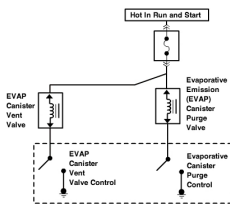
- Transistors act as solid state relays
- Control units normally contain multiple transistors or drivers to control outputs



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Direct Output

- Direct outputs are wired directly to the module
- The module's transistor or driver operates the output by providing ground or power to the device
- Outputs are normally ground side switched
- What outputs are often controlled directly?



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Indirect Output

- Indirect outputs are controlled through another device, typically a relay
- The module's transistor or driver operates the output by providing ground or power to the relay
- Outputs are normally ground side switched
- What outputs are often controlled indirectly?

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Output Signals

- Duty Cycle
 - Percentage of on time compared to total cycle time
 - Idle air control solenoids are normally duty cycle controlled
- Pulse Width
 - Measurement of on time typically measured in milliseconds
 - Fuel injectors are normally pulse with controlled

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Input Signals

- Sensor inputs can be analog or digital
- Sensors can divide control unit voltage signals or produce voltage signals

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Analog Signals

- Continuously variable voltage signal
- Analog signals can be AC or DC voltage
- DC analog signals are usually amplitude based inputs
- AC analog signals are usually frequency based inputs

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Digital Signals

- Digital signals are either on or off
- A DC signal is always positive
- Digital sensors
 - Switches
 - Hall effect sensor
 - Photo transistor

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Switch Inputs

- Digital input
- Power side switches
 - Voltage is measured before module's internally grounded resistor
 - High voltage signal when the switch is closed
- Ground side switches
 - Voltage is measured after module's externally grounded resistor
 - Low voltage signal when the switch is closed

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Thermistors

- Temperature sensitive variable resistor
- Wired in series with an internal control unit resistor
- As temperature increases the thermistor's resistance decreases
- As the resistance decreases the voltage signal measured by the control unit decreases

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Photoresistors

- Photoresistors change resistance based on the intensity of light striking the sensor's surface
- As the level of light increases the sensor's resistance changes
- If the resistance increases the voltage signal measured by the control unit increases

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Potentiometers

- A potentiometer uses a variable resistor and wiper circuit to provide an analog voltage signal indicating a component's position

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Potentiometer Operation

- Three wire variable resistor position sensor
 - Sensor reference voltage
 - Input signal voltage
 - Sensor ground
- Potentiometers send a voltage signal directly to the computer
- Input signal voltage is used by the control unit to determine a component's position
- What are some examples of where a potentiometer might be used?

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Variable Reluctance Sensor

- Use magnetism to generate an AC voltage signal
- Signal frequency is used by the control unit to calculate speed and position
- Frequency and increases with speed
- A VRS consists of a toothed trigger wheel called a reluctor and a permanent magnet sensor wrapped with a coil of wire

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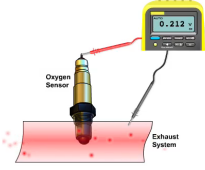
Hall Effect Sensor

- Hall effect sensors generate a digital on/off signal based on magnetic fields
- Signal provides the control unit with speed and/or position information
- When the Hall element is exposed to the magnetic field the circuit is closes
- When the Hall element is shielded from the magnetic field the circuit opens

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Oxygen Sensor

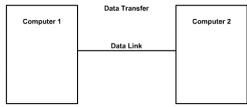
- Most O2 sensors generate a zero to one volt signal based on the difference between the oxygen content in the exhaust gas and the atmosphere
- Voltage output increases as the difference between the two samples increase
 - Rich mixtures increase voltage output
 - Lean mixtures decrease voltage output



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Serial Data

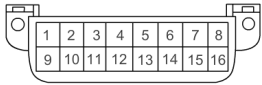
- Computers use various protocols or standards to share information with one another using serial data over a single wire
- Serial data is a group of on and off signals transmitted between computers
- Serial data can also be read by a scan tool connected to the vehicle's Data Link Connector



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Data Link Connector

1. Manufacturer's Discretion	12. Manufacturer's Discretion
2. Bus + Line, SAE J1850	13. Manufacturer's Discretion
3. Manufacturer's Discretion	14. Manufacturer's Discretion
4. Chassis Ground	15. L Line, ISO 9141
5. Signal Ground	16. Vehicle Battery Positive
6. Manufacturer's Discretion	
7. K Line, ISO 9141	
8. Manufacturer's Discretion	
9. Manufacturer's Discretion	
10. Bus - Line, SAE J1850	
11. Manufacturer's Discretion	



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Scan Tools

- Scan tools are connected to a vehicle's DLC
- Scan tools are commonly used to:
 - Retrieve diagnostic trouble codes
 - View, graph and record sensor inputs signals and control unit output commands
 - Activate control unit outputs for diagnosis



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Diagnostic Trouble Codes


- A DTC tells you if and where a fault may exist
- DTCs are commonly retrieved with scan tools or from automotive component displays
- Most DTCs are 5 digit alpha numeric codes
 - P=Powertrain
 - C=Chassis B=Body
 - U=Undefined



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Parameter Identification Data


- PIDs allow you to monitor the input and output data
- PIDs are like a window into the module
- PIDs can be viewed as tabular data or graphed



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Output State Control

- OSC allows you to control an output using a scan tool
- The scan tool sends a signal to the control module
- The module controls the output device
- You must then verify the output's operation



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Breakout Boxes

- Placed in series with control units, Data Link Connectors or electronic system components
- Breakout boxes allow the system to be operated while connected and permit easy input/output signal measurement with DVOMs and/or lab scopes

