Basic Electronics

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Automotive Electronics

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

Computer Memory

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

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

NPN Transistor Circuit

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

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?
Automotive Electrical Systems

**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?

**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 width 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

**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

**Digital Signals**

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

**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
**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

**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

**Potentiometers**

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

**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?

**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

**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 closed
- When the Hall element is shielded from the magnetic field the circuit opens
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

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

Data Link Connector

1. Manufacturer’s Discretion
2. Bus + Line, SAE J1850
3. Manufacturer’s Discretion
4. Chassis Ground
5. Signal Ground
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
12. Manufacturer’s Discretion
13. Manufacturer’s Discretion
14. Manufacturer’s Discretion
15. L Line, ISO 9141
16. Vehicle Battery Positive

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

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

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
**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

**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