Passive Components
voltage |ˈvɒltɪdʒ|
noun Physics
an electromotive force or potential difference which causes electrons to flow, expressed in volts.
current |ˈkərənt; ˈkə-rənt|
noun
a quantity representing the rate of flow of electric charge, usually measured in Amperes.
**Ohm’s Law**

The voltage drop across a conductor is equal to the product of the resistance and the current flowing through the conductor $(V=IR)$.

**resistance**  |ri'zistəns|
---|---
noun
the degree to which a substance or device opposes the passage of an electric current, causing energy dissipation.
\[ R = ab \times 10^c \]
Passive Circuit Analysis
Kirchhoff’s Voltage Law
The sum of the voltage changes in a loop must equal zero.

Kirchhoff’s Current Law
The sum of the currents flowing into and out of a node must equal zero.
series resistors

\[ R = R_1 + R_2 \]

parallel resistors

\[ R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{R_1 R_2}{R_1 + R_2} \]
Voltage Divider
Passive linear circuit that produces an output voltage that is a fraction of the input voltage.

\[ V_{\text{out}} = \frac{R_2}{R_1 + R_2} V_{\text{in}} \]

assuming the output draws NO CURRENT
**di•ode** |ˈdiˌōd|

**noun** Electronics

a semiconductor device which allows current to flow in only one direction.

current only flows from anode to cathode

fixed voltage drop (typ. 0.6V)
Light-Emitting Diodes

light intensity is proportional to current
LTE-4206 IR LED

peak wavelength = 940 nm (IR)
max continuous forward current = 60 mA
peak forward current = 1 A
typ. forward voltage = 1.2V
reverse breakdown voltage = 5V

FIG. 1 SPECTRAL DISTRIBUTION

FIG. 5 RELATIVE RADIANT INTENSITY VS. FORWARD CURRENT

FIG. 6 RADIATION DIAGRAM
**transistor**  |  *tran'zistər*

**noun** Electronics

a semiconductor device used to amplify signals, wherein a voltage or current applied to one terminal changes the current flowing through another pair of terminals.
LTR-4206 NPN Phototransistor

peak wavelength = 940 nm (IR)

collector-emitter saturation = 0.4V

emitter-collector breakdown = 5V
mechanical interface elements
Potentiometers

\[ V_{out} = \frac{R_1}{R_{total}} V_{in} \]
<table>
<thead>
<tr>
<th>Poles</th>
<th>Number of Circuits</th>
<th>SP (single pole)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DP (double pole)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MP (multi pole)</td>
</tr>
<tr>
<td>Throws</td>
<td>Number of Possible Circuits</td>
<td>ST (single throw)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DT (double throw)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MT (multi throw)</td>
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</tbody>
</table>

- **SPST**
- **DPST**
- **SPDT**
- **DPDT**
<table>
<thead>
<tr>
<th>Momentary</th>
<th>Switch holds state while depressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Normally Open Momentary</td>
</tr>
<tr>
<td>NC</td>
<td>Normally Closed Momentary</td>
</tr>
<tr>
<td>Toggle</td>
<td>Two stable positions</td>
</tr>
<tr>
<td>Slide</td>
<td>Linear motion</td>
</tr>
<tr>
<td>Rotary</td>
<td>Dial motion</td>
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</tbody>
</table>
PC Interface with the Phidget InterfaceKit 8/8/8
8 analog inputs

8 digital inputs

8 digital outputs

analog input connectors

Analog Input

Power (+5V)

Ground (0V)
Prototyping Circuits
solderless breadboards
<table>
<thead>
<tr>
<th>AWG</th>
<th>Dia. (thou)</th>
<th>Ohms/1000ft</th>
<th>Current (A)</th>
<th>Fusing Current</th>
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<tbody>
<tr>
<td>12</td>
<td>80.8</td>
<td>1.619</td>
<td>9.33</td>
<td>235</td>
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<td>13</td>
<td>72</td>
<td>2.042</td>
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<td>5.87</td>
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<td>3.247</td>
<td>4.65</td>
<td>140</td>
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<tr>
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<td>3.69</td>
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<tr>
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<td>30</td>
<td>10</td>
<td>105.2</td>
<td>0.144</td>
<td>10.2</td>
</tr>
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**Solid-core**

**Stranded**

- **Current capacity**
- **Pliability & fatigue**
- **Use heat shrink**
- **Use strain relief**

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clean tip (wet sponge)
clean surfaces
heat shrink on first!
heat target
tin wires first