



Basic Electronics Series



**Series vs. Parallel --
Ohm's Law Applied**



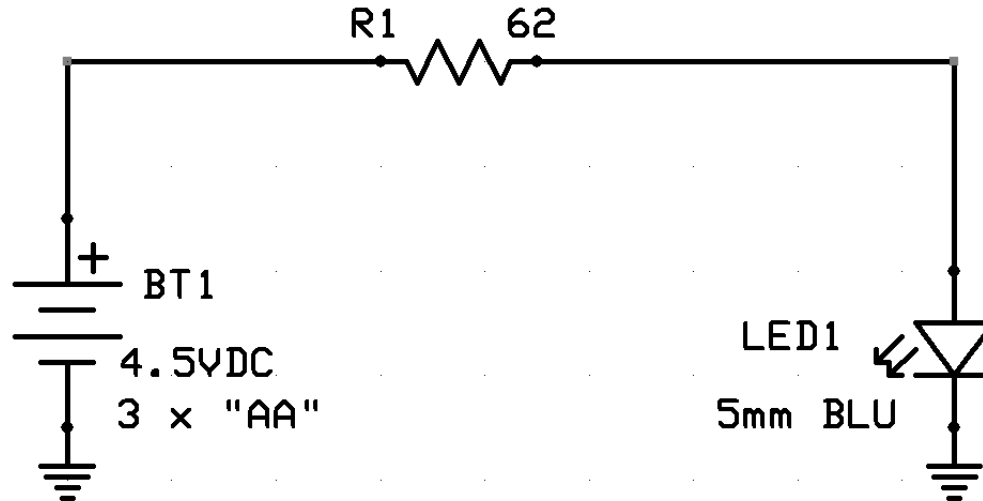


Series Circuits

- Only one path for the current to follow.
- Values of resistors add to get the total
- The same current flows through each and every resistor
- The total current is controlled by the total resistance
- The voltage drops proportionally across each of the resistances in the circuit.
- The sum of the individual voltage drops is equal to the source voltage.



Series Circuit



- Only one path for all current to follow.
- Voltage drops across each component.
- The same current flows through all components in the series path.
- LED₁ drops 3.2V, and R₁ drops balance (1.3V)
- LED₁ current 20.967mA ($1.3V / 62\Omega$)





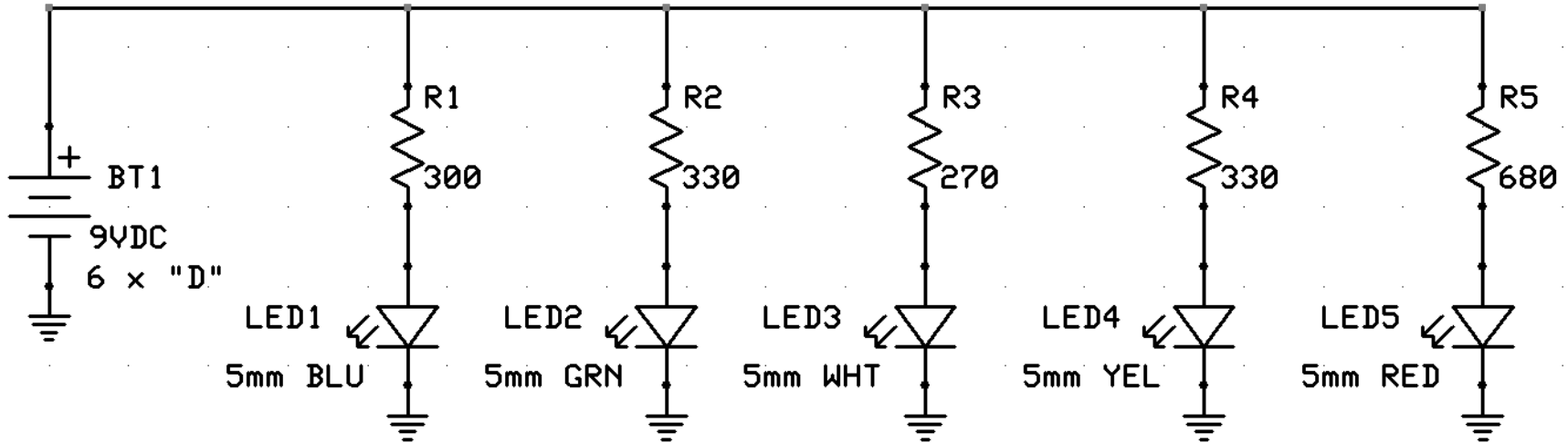
Parallel Circuits

- Multiple paths for current to follow.
- The total resistance is *lower than the lowest resistance in the circuit*.
- The current splits proportionally among the parallel branches based on the resistance of each branch.
- The source voltage is applied to each parallel branch of the circuit.
- While the currents in the individual parallel branches may be different, the same current flows through each component in a series path in each parallel branch.





Parallel Circuit

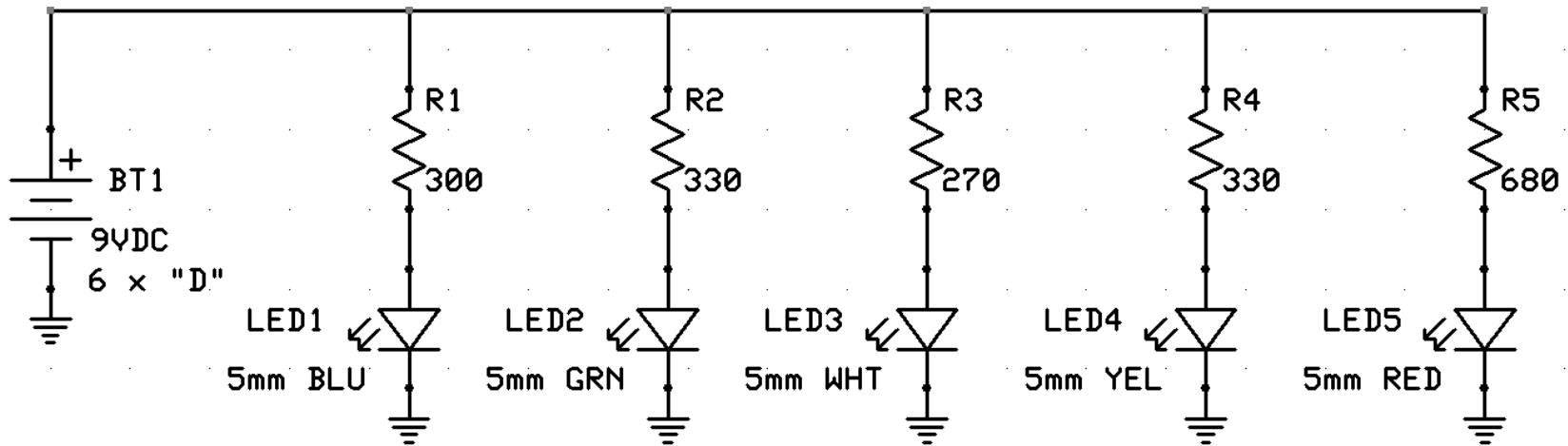


- Multiple paths for current to follow
- Source voltage (9V) is applied to each branch
- Overall current divides by branch resistances
 - A different current flow will be present in each branch, based upon the resistance of the branch





Parallel Circuit



- LED₁ drops 3.2V – R₁ drops balance (5.8V)
 - LED₁ current = 19.333mA (5.8V / 300Ω)
- LED₂ drops 2.1V – R₂ drops 6.9V, current = 20.910mA
- LED₃ drops 3.6V – R₃ drops 5.4V, current = 20.000mA
- LED₄ drops 2.3V – R₄ drops 6.7V, current = 20.303mA
- LED₅ drops 1.7V – R₅ drops 7.2V, current = 10.588mA

NOTE: Forward voltage of each LED is found on LED datasheet.

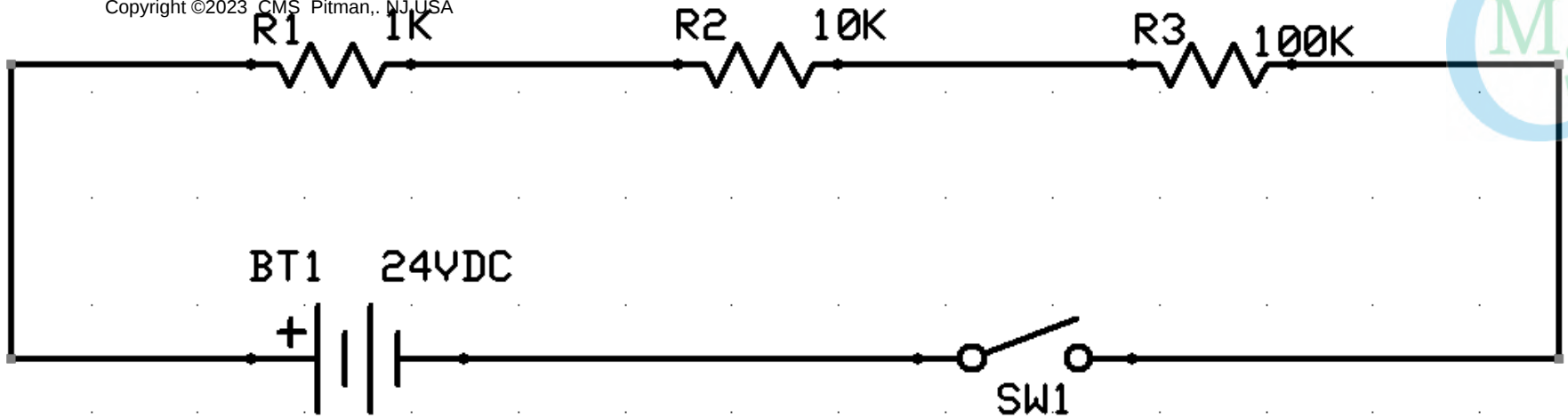




Resistance Formulas

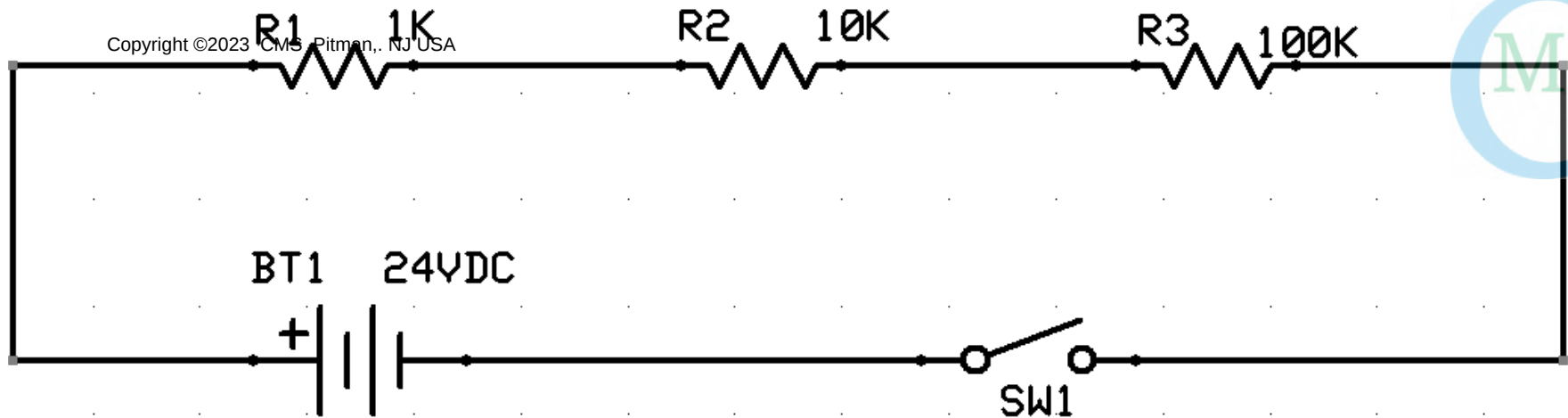
- Series resistances
 - $R_T = R_1 + R_2 + R_3... etc.$
- Parallel resistances
 - If only two resistances – product over sum
 - $R_T = (R_1 \times R_2) / (R_1 + R_2)$
 - If more than two resistances...
 - $1/R_T = 1/R_1 + 1/R_2 + 1/R_3...etc.$ or
 - $R_T = 1/(1/R_1 + 1/R_2 + 1/R_3...etc.)$
- *If combination of series and parallel, work out parallel resistance first, then add that to the series resistance.*





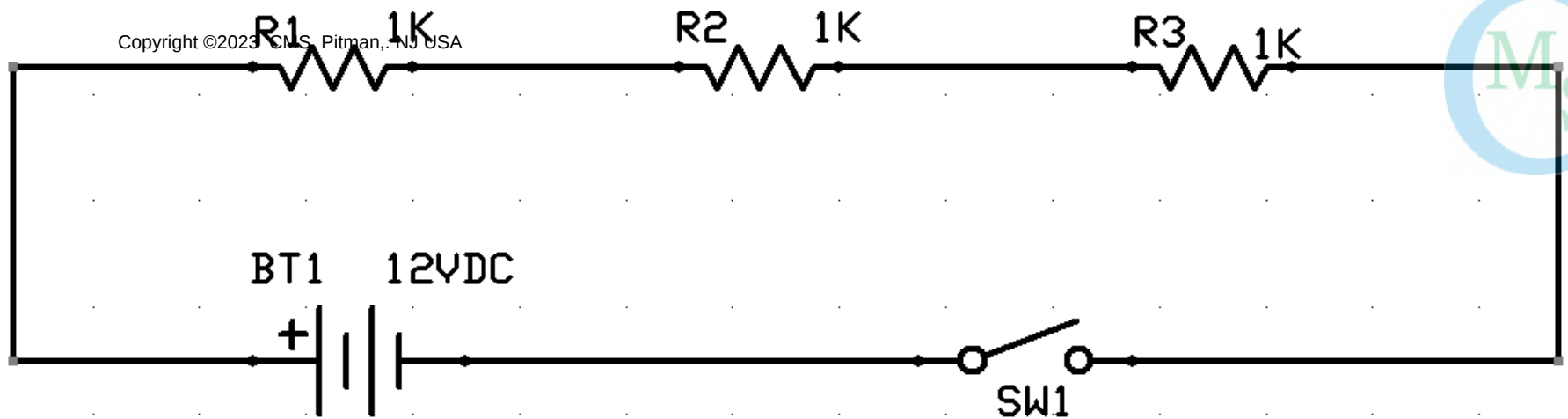
- What is the total resistance?
 - $R_T = R_1 + R_2 + R_3 \dots$
 - $R_T = 111,000\Omega$
- What is the current through R2?
 - $I = E / R$
 - $I = 24/111,000 = 0.0002162162A$
 - $I = 0.21262162mA$





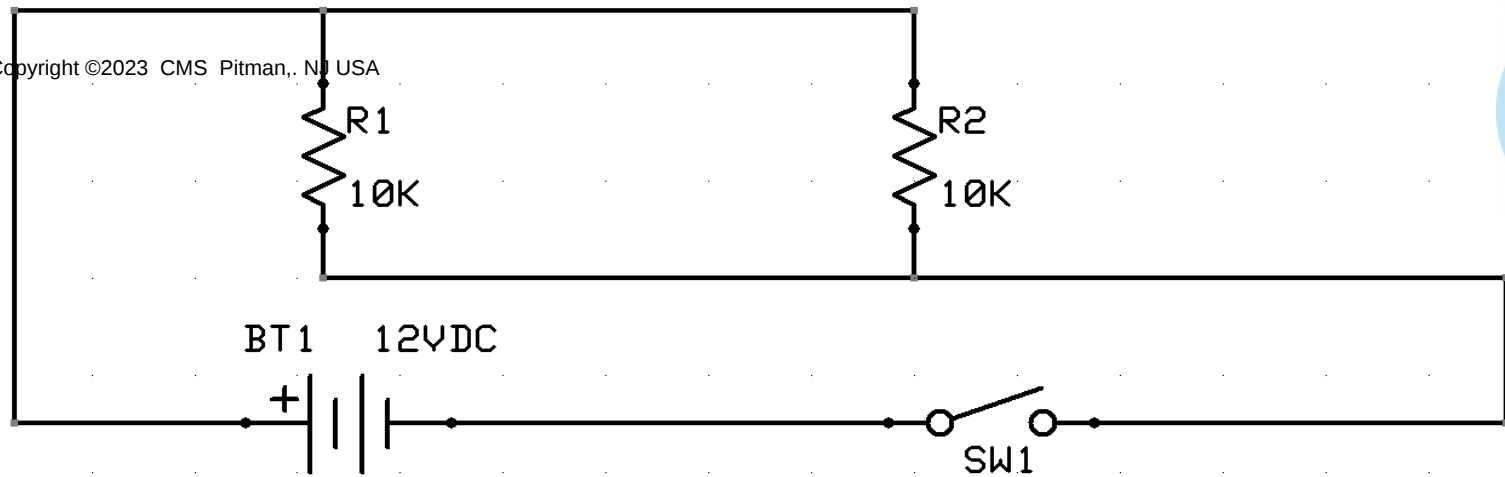
- What is the voltage drop across R_1 , R_2 , & R_3 ?
 - $I = 24/111,000 = 0.0002162162A$
 - $E_{R1} = I \times R_{R1} = 0.0002162162 \times 1,000$
 - $E_{R1} = 0.2162162V$
 - $E_{R2} = I \times R_{R2} = 0.0002162162 \times 10,000$
 - $E_{R2} = 2.162162V$
 - $E_{R3} = I \times R_{R3} = 0.0002162162 \times 100,000$
 - $E_{R3} = 21.62162V$





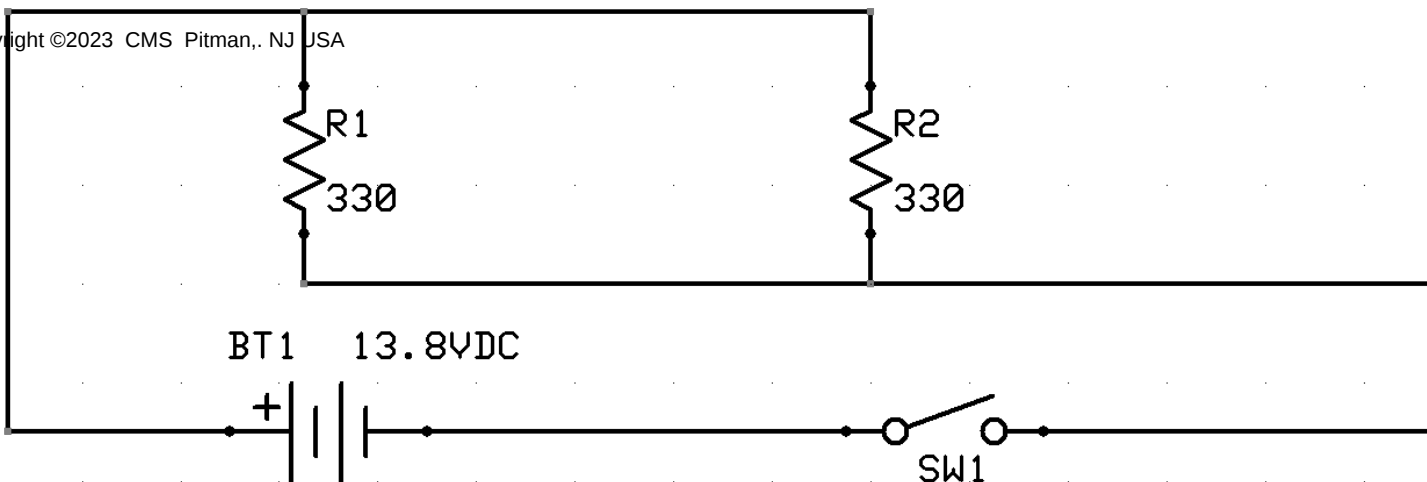
- What is the total resistance?
 - $R_T = R_1 + R_2 + R_3 \dots$
 - $R_T = 3,000\Omega$
- What is the current through R_2 ?
 - $I = E / R$
 - $I = 12/3,000 = 0.004A$
 - $I = 4mA$





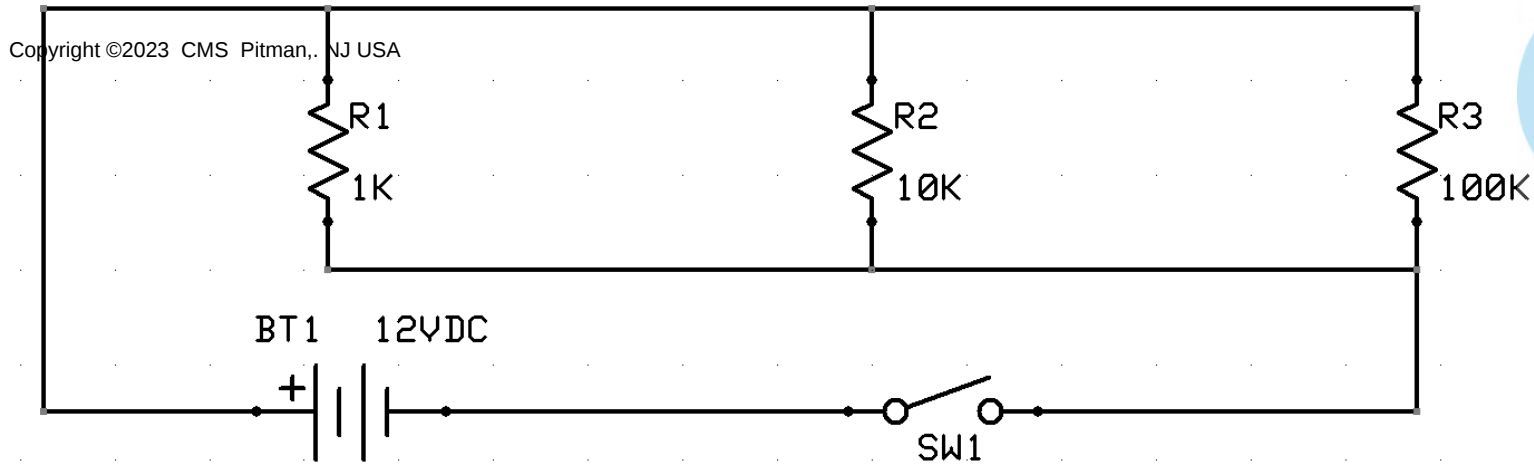
- What is the total resistance?
 - $R_T = (R_1 \times R_2) / (R_1 + R_2) = 100,000 / 20,000...$
 - $R_T = 5,000\Omega$
- What is the current through R_1 ?
 - $I = E / R$
 - $I_T = 12 / 5,000 = 0.0024A$
 - $I = 1.2mA$
 - R_1 and R_2 are same value – current splits evenly





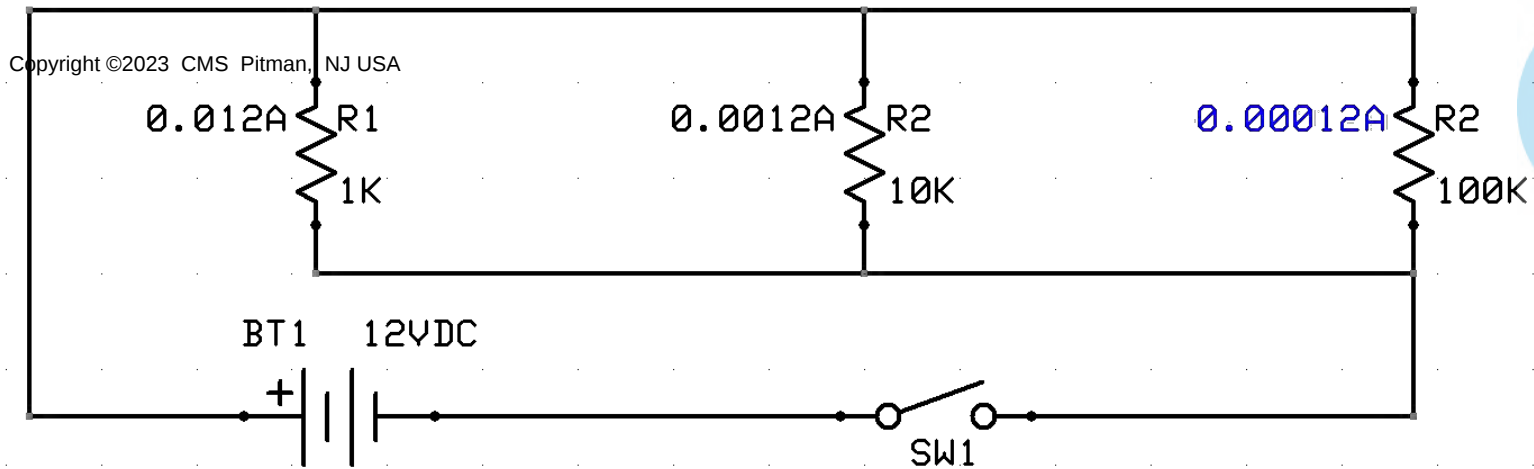
- What is the total resistance?
 - $R_T = (R_1 \times R_2) / (R_1 + R_2) = 108,900 / 660$
 - $R_T = 165\Omega$
- What is the current through R_2 ?
 - $I = E / R$
 - $I = 13.8 / 330 = 0.0418181818$
 - $I = 41.81818\text{mA}$
 - $I_{R2} = 41.81818\text{mA} / 2$, as $R_1 = R_2$ so current splits evenly between the two resistive paths
 - $I_{R2} = 20.90909\text{mA}$





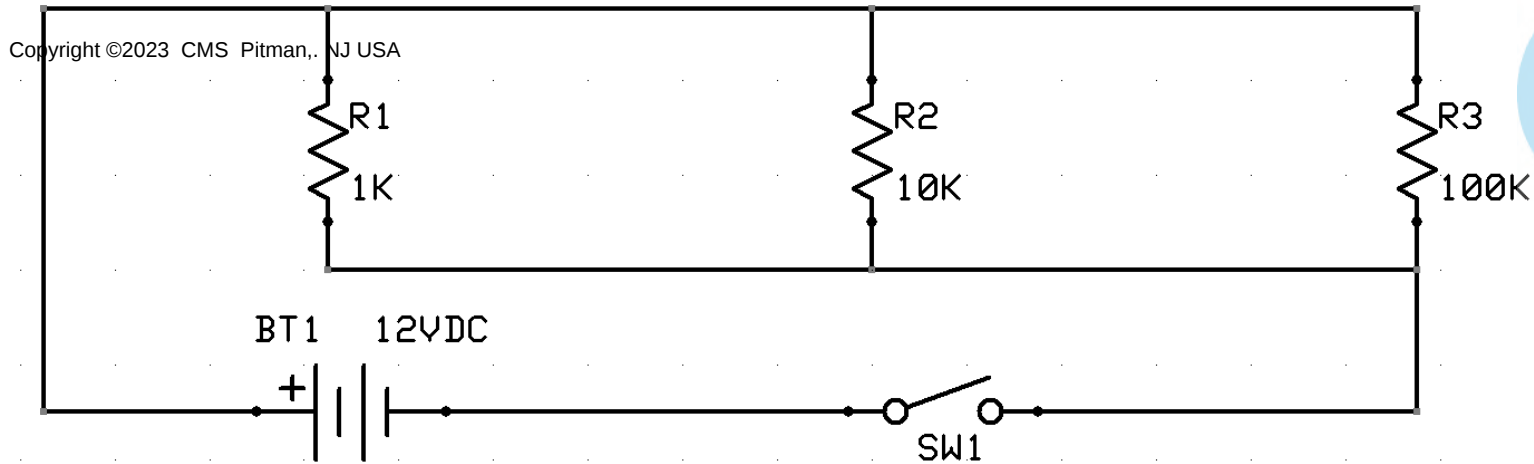
- What is the total resistance?
 - $1/R_T = 1/R_1 + 1/R_2 + 1/R_3$
 - $1/R_T = 0.001 + 0.0001 + 0.000001 = 0.001111$
 - $R_T = 1/0.001111 = 900.9009\Omega$
- What is the total current in the circuit?
 - $I = E / R$
 - $I_T = 12/900.9 = 0.01332A$
 - $I_T = 13.32mA$





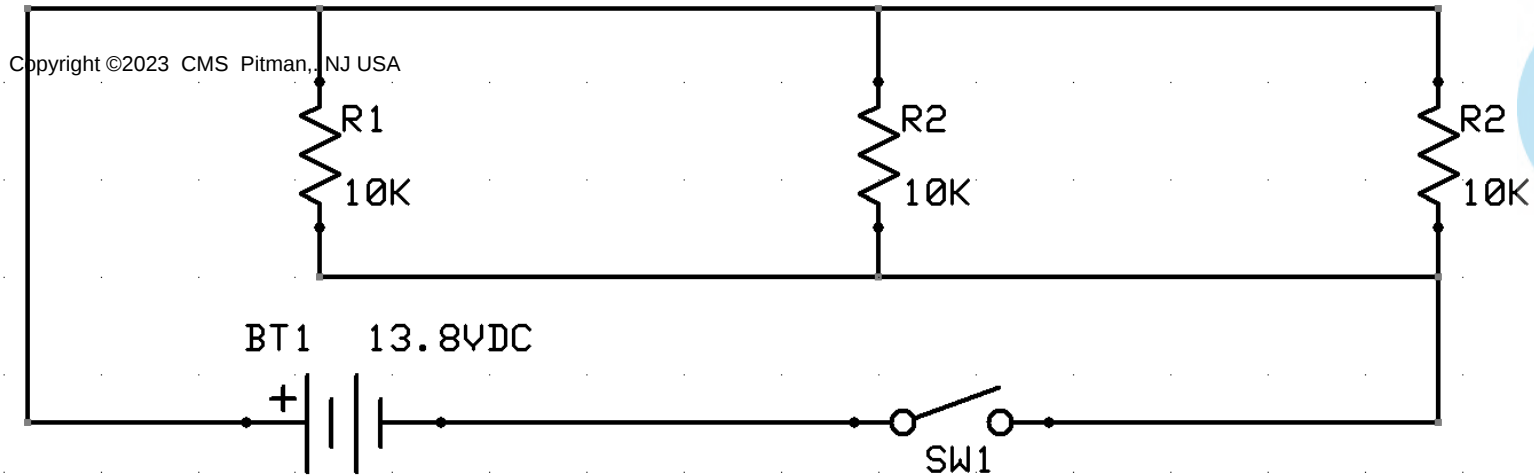
- What is the total current in the circuit?
 - $I_T = I_{R1} + I_{R2} + I_{R3} = 0.01332A$
- What is the power consumed in the circuit?
 - $P = I \times E$
 - $P = 12 \times 0.01332$
 - $P = 0.15984W$
 - $P = 159.84mW$





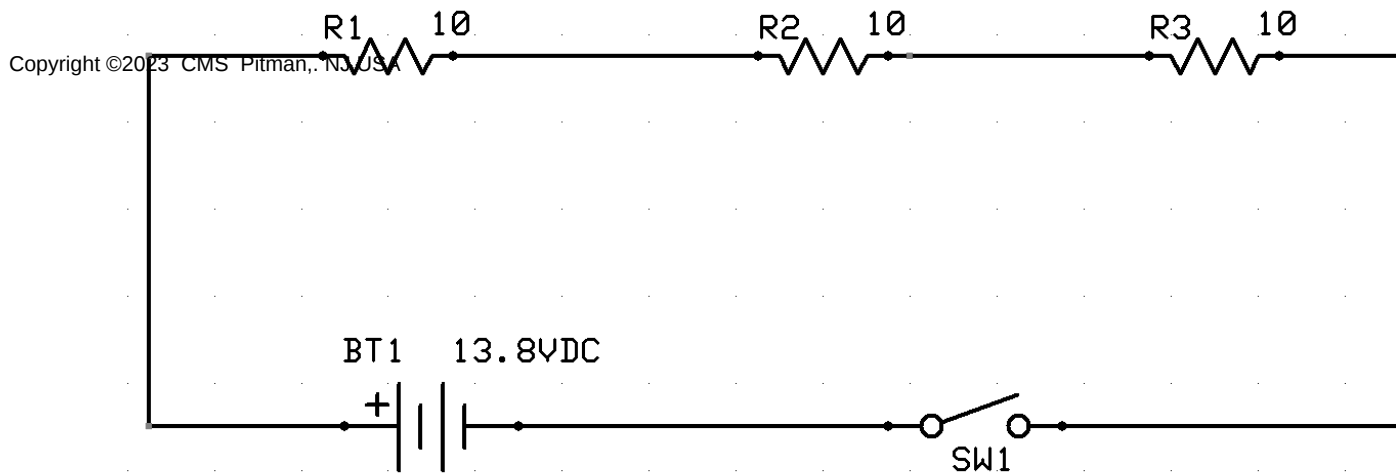
- What is the total resistance?
 - $1/R_T = 1/R_1 + 1/R_2 + 1/R_3$
 - $1/R_T = 0.001 + 0.0001 + 0.000001 = 0.001111$
 - $R_T = 1/0.001111 = 900.9009\Omega$
- What is the current through R3?
 - $I = E / R$
 - $I_{R3} = 12/100,000 = 0.00012A$
 - $I_{R3} = 0.12mA$





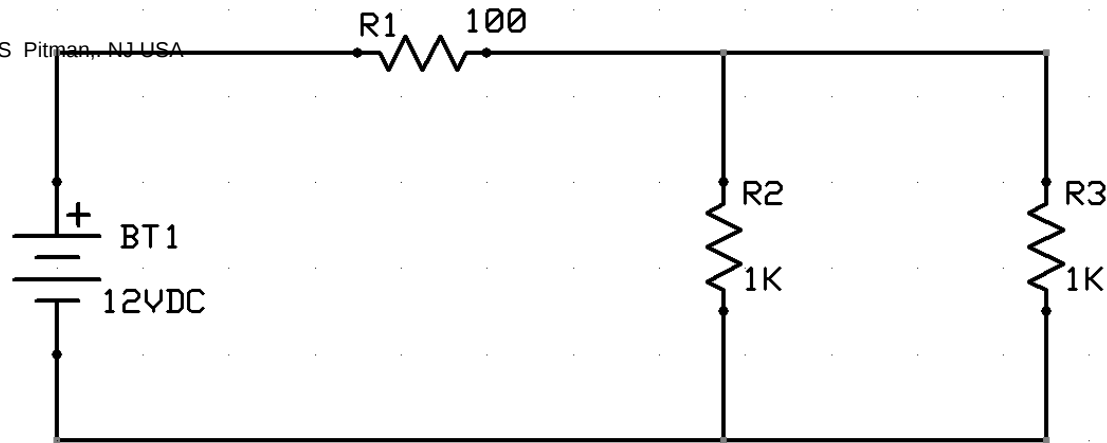
- What is the total resistance?
 - $1/R_T = 1/R_1 + 1/R_2 + 1/R_3$
 - $1/R_T = 0.0001 + 0.0001 + 0.0001 = 0.0003$
 - $R_T = 1/0.0003 = 3,333.3333\Omega$
- What is the total current in the circuit?
 - $I = E / R$
 - $I_T = 13.8/3,333.3333 = 0.00414A$
 - $I_T = 4.14mA$





- What is the power consumed in this circuit?
 - $P = I \times R \dots$ *or* $P = E^2 / R$
 - $E = 13.8V$ and $R = 30\Omega$
 - $P = (13.8 \times 13.8) / 30$
 - $P = 190.44 / 30$
 - $P = 6.348W$





- What is the total resistance in this circuit?
 - Solve for parallel resistance first...
 - $R_{(R2+R3)} = 1,000,000 / 2,000 = 500\Omega$
 - Then add series resistance...
 - $R_T = R_1 + (R_2 + R_3) = 100 + 500$
 - $R_T = 600\Omega$
- Most working circuits are combinations of series and parallel circuits in some form.





Capacitance Formulas

- Parallel Capacitances
- $C_T = C_1 + C_2 + C_3... etc.$
- Series Capacitances
 - If only two capacitances – product over sum
 - $C_T = (C_1 \times C_2) / (C_1 + C_2)$
 - If more than two capacitances...
 - $1/C_T = 1/C_1 + 1/C_2 + 1/C_3...etc.,$ or
 - $C_T = 1/(1/C_1 + 1/C_2 + 1/C_3...etc.)$
- *If combination of series and parallel, work out series capacitance first, then add that to the parallel capacitance.*





Inductance Formulas

- Series inductances
 - $L_T = L_1 + L_2 + L_3 \dots etc.$
- Parallel inductances
 - If only two inductances – product over sum
 - $R_T = (L_1 \times L_2) / (L_1 + L_2)$
 - If more than two inductances...
 - $1/L_T = 1/L_1 + 1/L_2 + 1/L_3 \dots etc.$ or
 - $L_T = 1/(1/L_1 + 1/L_2 + 1/L_3 \dots etc.)$
- *If combination of series and parallel, work out parallel inductance first, then add that to the series inductance.*





ANY QUESTIONS?

