SERIES PARALLEL CIRCUITS

A series-parallel circuit is a combination of a series and a parallel circuit. This means both series and parallel circuit voltage, current and resistance laws must be applied to a series-parallel circuit. In previous lessons on series and parallel circuits you were taught the basic principles and relationships of voltage, current and resistance. It is necessary that you understand these principles because they will have to be applied in combination in series-parallel circuits. Keeping missile systems operating at peak performance depends upon your knowledge and application of these basic principles in actual circuit operation and troubleshooting procedures.

During this lesson it must be remembered that the use of Ohm's and Korchhoff's Law are still applicable to the Series-Parallel Circuit.

There is a way to calculate the total resistance (R_T) of the circuit. This process has been described in previous lessons and involves the steps taken to reduce the series-parallel circuit to a series circuit.

The first step is to reduce the parallel branch to one series resistor or equivalent resistance, Req. Step one is demonstrated in FIGURE 3.

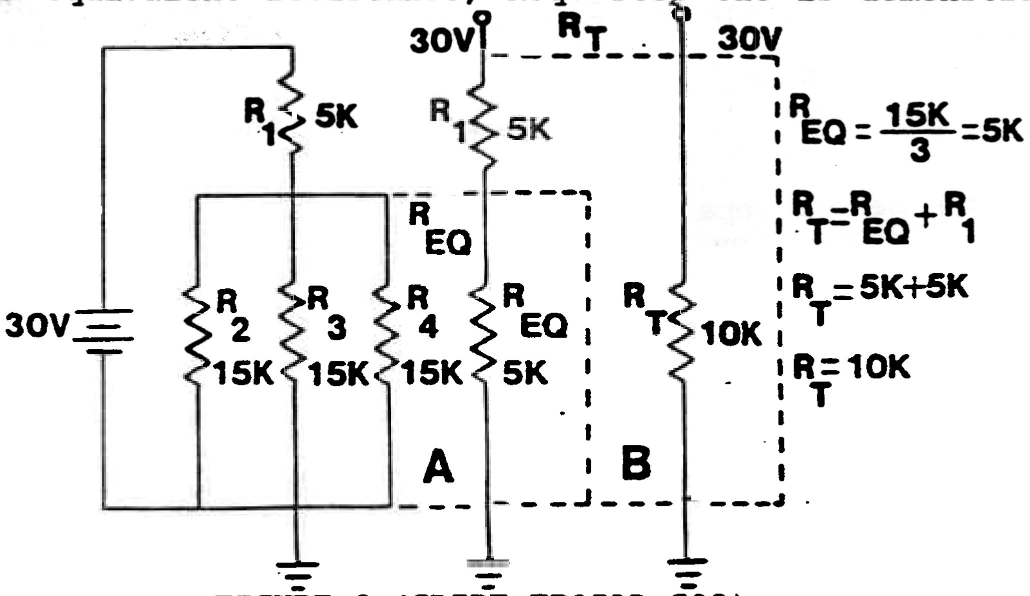

FIGURE 3 (SLIDE EP15AL-S03)

The second step is to reduce the series resistor circuit to circuit B in FIGURE 3, one voltage source and one resistance R_T.

Using FIGURE 3, as an example the student is now ready to calculate the total current, I_T. Since the circuit has been reduced to a simple series circuit in FIGURE 3B, it is now a simple Ohm's Law problem.

$$I_T = \frac{EA}{R_T} = \frac{30}{10K} = 3 \text{ ma}$$

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The series circuit in FIGURE 3 A, consisting of R_1 and Req, may be used to give the voltage drops across R_1 and Req.

$$E_{R1} = I_T \times R_1 \qquad E_{Req} = I_T \times Req$$

$$E_{R1} = 3ma \times 5K \qquad E_{Req} = 3\ ma \times 5K$$

$$E_{R1} = 15V \qquad E_{Req} = 15V$$

$$\text{thus } E_A = E_{R1} + E_{Req}$$

$$30V = 15V + 15V$$

$$= 30V$$

The branch currents in the parallel portion of the series-parallel circuit can now be easily calculated by the use of Ohm's Law for current.

The Req for the parallel branches was found to be 5K ohms. From this and the current flow, the voltage drop E_{Req} was found to be 15V. According to the rules of parallel circuits, the voltage drop across the parallel circuit is 15V. Thus, if Ohm's Law is used here the current can be calculated for each leg of the parallel branch as follows:

$$I_{R2} = \frac{E_{Req}}{R_2} = \frac{15V}{15K} = 1ma$$

$$I_{R3} = \frac{E_{Req}}{\ } = \frac{15V}{15K} = 1\ ma$$

$$I_{R4} = \frac{E_{Req}}{R_4} = \frac{15V}{15K} = 1\ ma$$

$$I_T = I_{R2} + I_{R3} + I_{R4}$$

I_T = 1ma + 1ma + 1ma = 3ma; this is true by Kirchhoff's Current Law.

We may conclude that in a parallel circuit, resistors of equal value will have equal current flow, 1ma of current flow through each 15 K resistor.

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To summarize, during the conference you were taught how to calculate resistance, voltage, and current in series - parallel circuits. A series - parallel circuit can be simplified by changing the parallel portion of the circuit to an equivalent series resistor, thus making the circuit a simple series circuit. When calculating for the equivalent resistance of the parallel network, one of the following formulas will be used:

(1) When the parallel portion of the circuit contains two or more resistors equal in value, the formula:

$$= \frac{R1}{N}$$ will be used.

(2) When the parallel portion of the circuit contains two resistors of unequal value, the formula:

$$= \frac{R1 \times R2}{R1 + R2}$$ will be used

(3) When the parallel portion of the circuit contains 3 or more resistors of unequal value, the formula:

$$= \frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}}$$ will be used.

After the series-parallel circuit is changed to a series circuit, Ohm's law can be used to calculate circuit values.