SERIES-PARALLEL CIRCUITS TROUBLESHOOTING

The experienced technician can generally get a basic idea of what the problem is by hearing the symptoms. Here again we hear the doctor say "What is wrong?" This is always the question confronting the technical person.

The circuit presented in this lesson is simple. This means the student must master the simple before he moves on to the more complicated.

It must be remembered that all circuits can be reduced to one power source and one equivalent resistance, or a simple series circuit.

It is always best to determine by calculation what you should have, before you try to measure and test to see if you do have it.

If the technician knows how a circuit should function, the malfunctioning circuit will have symptoms that will describe what is wrong.

The circuit that will be studied will be found in FIGURE 3.

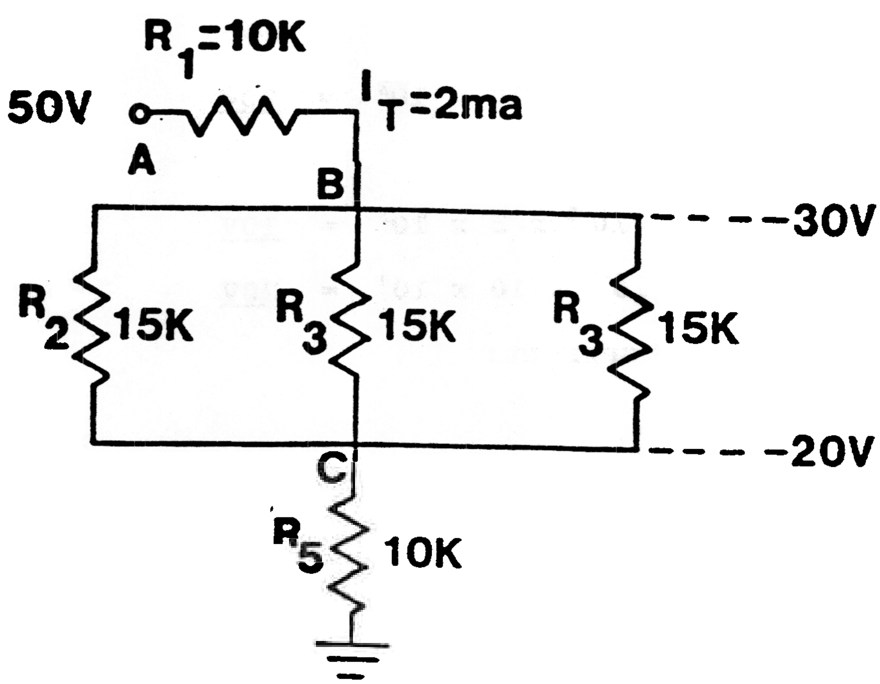

FIGURE 3 (Slide EP16AL-S03)

To determine some of the circuit values the student will assume and make calculations as if all conditions are normal.

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EXAMPLE:

From FIGURE 3; calculate equivalent resistance

$$= \frac{R}{3} = \frac{15K}{3} = 5K \qquad R_2 = R_3 = R_4$$

Calculate total resistance

$R_T = R_1 + Req + R_5$

$R_T = 10K + 5K + 10K$

$R_T = \underline{25K\Omega}$

Calculate total current:

$$I_T = \frac{E_A}{R_T} = \frac{50V}{25K} = \frac{50}{25 \times 10^3} = 2 \times 10^{-3} \quad \underline{2ma}$$

Calculate the voltage drops:

$$I_T = \frac{E_A}{R_T} = \frac{50V}{25K} = \frac{50}{25 \times 10_3} = 2 \times 10^{-3} \quad \underline{2ma}$$

Calculate the voltage drops:

$E_{R1} = I_T R_1 = 2 \times 10^{-3} \times 10 \times 10^3 = \underline{20V}$

$E_{E2} = E_{R3} = E_{R4}$

$E_{Req} = I_T Req = 2 \times 10^{-3} \times 5 \times 10^3 = \underline{10V}$

$E_{R5} = I_T R_5 = 2 \times 10^{-3} \times 10 \times 10^3 = \underline{20V}$

Calculate the branch current:

$I_T = I_2 + I_3 + I_4$

NOTE: $I_2 = I_3 = I_4$, thus 1/3 of the total current will be $I_T/3$,

$$= \frac{2 \times 10^{-3}}{3} = 0.67ma$$

$I_2 = I_3 = I_4 = 0.67ma$

All the values for normal operation of the circuit in FIGURE 3 have been determined, thus, any deviation from these values will help isolate the malfunction. Voltage at A = 50V, at B = 30V, at C = 20V.

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We will now assume that there is a malfunction in the circuit in FIGURE 3. Voltage measurement at A = 50V, B = 0V, C = 0V.

The process we have gone through is what is commonly called "single tracing." Lack of continuity due to an open circuit will cause current to be stopped before reaching points B and C.

To confirm what the malfunction is, the following must be done;

First, using ground as a reference, measure from the power supply, point A, to ground; read 50 volts at point A.

Second, move to point B, or just below R_1. Read 0V at point B. This immediately tells us that the signal (voltage) is interrupted at some place between A and B, thus, R_1 would have to be open.

If R_1 could be isolated, sometimes this is impossible, it would measure open. Attempts to measure in circuit resistance without isolation is not without error.

Now assume that the first malfunction has been corrected and another initiated. You are still using ground as reference for the multimeter. You measure 50V at point A, 31.8V at point B, and 18.2V at point C. According to the original measurements these are not correct. What is wrong?

Analysis:

The voltage at point A is normal and 50V. At point B the voltage has increased from 30V to 31.8V. The voltage at point C has decreased from 20V to 18.2V.

First, it is known R_5 is not open, because if it were it would have the applied voltage across it.

Second, we know that R_5 is not shorted. If it were, then it would have zero volts dropped across it.

Third, for the voltage to decrease across R_1 the current I_T, through R_1, would have to decrease.

Fourth, this leaves 2 possibilities; R_1 or Req had to increase.

Fifth, it is known that R_1 is not open because there is voltage at point B.

Sixth, therefore it must be concluded that R_2, R_3 or R_4 must be open.

If there is no physical evidence of damage to one of the 3, and they cannot be isolated, a current measurement would have to be taken in each leg to determine which one is open.

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If the circuit is restored and another malfunction is initiated and again ground is reference for the multimeter. The following readings are made;

Point A

Point B = 16.7V

Point C = 0V

What is the malfunction?

Analysis:

It is obvious that R_5 is shorted because the voltage drop across it is zero volts.

Again the following readings were observed;

Point A =

Point B =

Point C =

Analysis:

If point B and C, each measure 25V, then obviously there is no (0) difference of potential between B and C. Thus, there is a short between B and C. Without isolation or being able to measure for current in the parallel branches it would be impossible to determine which resistor, R_2, R_3 or R_4, is shorted.

SUMMARY:

During this conference we have discussed some malfunctions and their effect on the operation of series-parallel circuits. Since a series-parallel circuit is a combination of a series circuit and a parallel circuit, troubleshooting methods for both kinds of circuits are also combined to locate a malfunction.