Keywords: EPOT, Thevenin equivalent

APPLICATION NOTE 804

Finding the Thevenin Equivalent Circuit for the EPOT-Based Offset Resistor Network

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Abstract: This application note explains how to find the Thevenin equivalent circuit for an offset resistor network based on an electronically controlled potentiometer (EPOT).

Additional Information: EPOT Applications: Offset Adjustment in Op-Amp Circuits

To model the network shown below in **Figure 1** as the Thevenin equivalent shown below in **Figure 2**, find the Thevenin Voltage (V_{th}) and the Thevenin Resistance (R_{th}). In this case, V_{th} is the same as V_{os} (with no external load present) and R_{th} is the resistance looking back from V_{os} with the voltage sources shorted out. Start by replacing the EPOT with its Thevenin equivalent and then substitute that replacement into the original network.
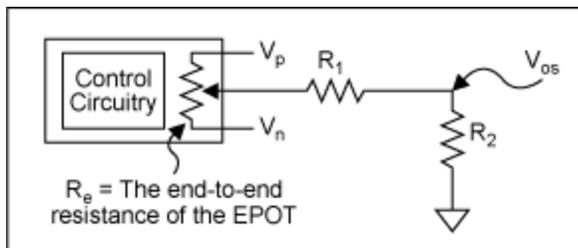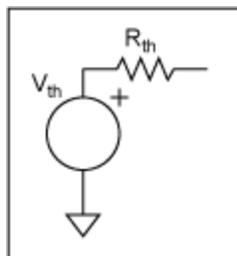

Figure 1.

Figure 2.

Note 1: In this analysis, N = (Current EPOT setting)/(total number of taps). In other words, for a 32 tap EPOT, a setting of 8 makes N = 0.25.
Note 2: V_p = the positive supply voltage and V_n = the negative supply voltage
Note 3: V_{pot} = the voltage at the wiper of the EPOT

$$V_{pot} = V_p - \left[N \bullet R_e \bullet \frac{(V_p - V_n)}{R_e} \right]$$ (1)
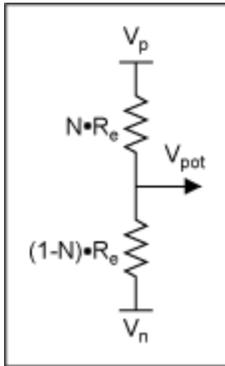
$$V_{pot} = V_p - [N \bullet (V_p - V_n)]$$

Figure 3.

To find the EPOT's equivalent resistance (R_{pot}), short out the sources, i.e. it's just the two resistances in parallel.

$$\frac{1}{R_{pot}} = (N \bullet R_e) \parallel [(1-N) \bullet R_e] = \frac{(1-N) \bullet R_e + N \bullet R_e}{N \bullet (1-N) \bullet R_e \bullet R_e}$$ (2)

$$R_{pot} = N \bullet (1-N) \bullet R_e$$

The final step is to substitute the Thevenin circuit for the EPOT into the original circuit and find the overall Thevenin replacement.

$$V_{os} = \frac{V_{pot} \bullet R_2}{R_{pot} + R_1 + R_2} = \frac{\{V_p - [N \bullet (V_p - V_n)]\} \bullet R_2}{N \bullet (1-N) + R_1 + R_2}$$ (3)

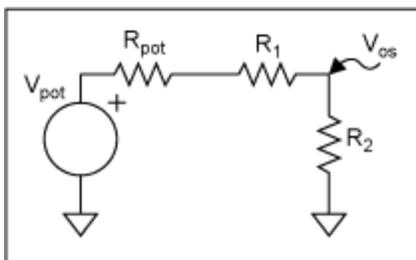$$R_{th} = (R_{pot} + R_1) \parallel R_2 = (N \bullet (1-N) + R_1) \parallel R_2$$ (4)

Figure 4.

Related Parts

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