

Thermal and Voltage Regulator Problems

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1. A power transistor mounted to a heat sink has the following characteristics: $\theta_{JC} = 1.7$ C/W, $\theta_{CS} = 0.9$ C/W, and $\theta_{SA} = 2.3$ C/W. The ambient temperature is 35C.
 - Find the junction temperature if the power dissipation is 20W. [answer: 133C]
 - Determine the maximum power dissipation for a junction temperature no higher than 100C. [answer: 13.2 watts]
 - Find the maximum tolerable ambient temperature if the maximum junction temperature is to be 100C and the power dissipation is 8W. [answer: 60.8C]

2. A series voltage regulator has an input voltage of 15 volts and an output voltage of 10 volts. The load current is 0.75 amperes.
 - What is the power dissipation of the regulator? [answer: 3.75 W]
 - What is the junction temperature if $\theta_{JA} = 6$ C/W and $T_A = 30$ C? [answer: 52.5C]

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3. A part has a rated maximum power dissipation of 0.5W at an ambient temperature of 25C and has a maximum operating temperature of 150C (when power dissipation is 0W). What is the maximum allowable power dissipation if the ambient temperature is 40C? [answer: note that the allowable power dissipation goes down $0.5/125 = 4 \text{ mW/C}$ – so $0.004*(40-25) = 0.060\text{W}$ so $P_{dmax} = 0.5 - 0.06 = 0.44 \text{ W}$]

4. A transistor has a rated power dissipation of 100W if mounted in an “infinite” heatsink at 25C. The maximum allowable junction temperature is 150C. What is the maximum allowable power dissipation if the total θ_{JA} is 2 C/W and the ambient temperature is 40C? [answer: 55 W]

5. Determine the maximum thermal resistance of a heatsink so that the junction temperature of a transistor dissipating 35W is no more than 110C when the ambient temperature is 40C. The θ_{JC} is 1 C/W and θ_{CS} is 0.5 C/W. [answer: 0.5 C/W]

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6. The output voltage of a regulator is 15.1 volts when the input voltage is 27.5 and the output is 14.9 volts when the input voltage is 20. What is the line regulation of the regulator using 15 volts as the nominal output voltage? [answer: 1.33%]

7. The output voltage of a regulator is 12.1 volts when the load current is zero and the output voltage is 12.02 volts when the load current is 3 amperes. What is the load regulation of the regulator? [answer: 0.66 %]

8. Analyze a zener regulator circuit to determine the maximum power dissipation of the series resistor and the maximum load current so that the zener current is no lower than ten percent of the maximum load current. The applied voltage may vary from 12 to 15 volts, the series resistor is 56 ohms, and the zener is 6.2 volts and rated for 1 watt – the minimum zener current should be 10 percent of rated current. [answer: 1.38 W – occurs at maximum V_{in} , 87 mA – driven by the minimum V_{in} and the minimum zener current]

