# Solution to lecture 12 exercises

## 12-101 a)

The losses of the MOSFET IRF540 is given by the RMS load current and the drain-source on-state resistance, $R_{DS(on)}$ = 0.077 ohm, as given by the data sheet.

$P_{on-state} = R_{DSon} \cdot I_D^2 = 0.077 \cdot 0.95^2 = 0.069$ W

The thermal resistance data from the data sheet are:

- $R_{thJA}$ = 62 K/W
- $R_{thJC}$ = 1.0 K/W

This means the total thermal resistance from junction to ambient is 62 K/W. The thermal resistance between is the junction and case is specified separately, but will be part of the total thermal resistance from junction to ambient.

$$T_j = T_a + R_{thJA} P_{on-state} = 25 + 62 \cdot 0.069 = 25 + 4.3 = 29.3\ ℃$$

The case temperature is calculated by subtracting the temperature difference, junction-to-case.

$$T_c = T_j - R_{thJC} P_{on-state} = 29.3 - 1 \cdot 0.069 = 29.2\ ℃$$

Practically, the junction and case has the same temperature under these conditions.

## 12-101 b)

The MOSFET will be mounted on a heatsink which has a thermal resistance to ambient defined as $R_{thHA}$. The interface between the MOSFET and the heatsink gives a thermal resistance $R_{thCS}$ = 0.50 K/W as defined in the datasheet. The power dissipation is defined considering an RMS current equal to the peak current divided by $\sqrt{2}$ .

$$T_c = T_a + (R_{thHA} + R_{thCS}) P_{on-state}$$

$$P_{on-state} = R_{DSon} \cdot \left(\frac{20}{\sqrt{2}}\right)^2 = 15.4\ W$$

$$\Rightarrow R_{thHA} = \frac{T_c - T_a}{P_{on-state}} - R_{thCS} = \frac{80 - 25}{15.4} - 0.5 = 3.07\ K/W$$

Consequently, to ensure the temperature is below 80℃ a heatsink of 3 K/W is required.

## 12-101 c)

The junction temperature is defined by the temperature rise related to junction-to-case interface with $R_{thJC}$.

$$T_j = T_c + R_{thJC} P_{on-state} = 80 + 1.0 \cdot 15.4 = 95.4\ ℃$$

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