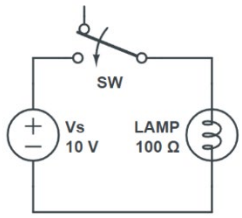
EEP1 ELogBook – Week 10

AXXXXXXX - Brians Tjipto Meidianto

Studio

Activity 1a

Average power dissipated by the lamp.



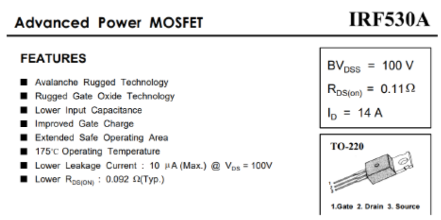
6PM – 11AM: 17 hrs

$$P_{avg} = \frac{V^2}{R} \times \frac{Ton}{T} = \frac{10^2}{100} \times \frac{17}{24} = 0.7083W$$

Activity 1b

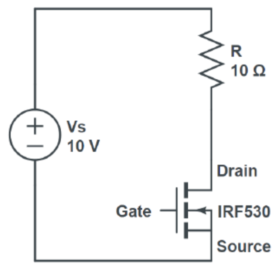
a. When MOSFET is OFF

$$V_{DS} = 10 \times \frac{0.11}{10.11} = 0.1088V$$
$$P = V_{DS} \times I_D = 0.1088V \times 14A = 1.523W$$



b. When MOSFET is ON

$$P = \frac{(V_{DS})^2}{R} = \frac{0.1088^2}{0.11} = 107.6mW$$



c. Average Power dissipated.

   a. duration of ON state: D x T_S seconds (0 < D < 1),
   b. duration of OFF state: (1 - D) x T_S seconds.

$$P_{avg} = \frac{DT_S \times 107.6 + (1-D)T_S \times 0}{T_S} = 107.6DmW$$
$$D = 0.5 - 107.6 \times 0.5 = 53.8mW$$
$$D = 0.8 - 107.6 \times 0.8 = 86.1mW$$

	T_S = 0.5ms	T_S = 1.0ms
D = 0.5	53.8mW	53.8mW
D = 0.8	86.1mW	86.1mW

d. Fill in the blanks with appropriate words:

   a. If TS is increased keeping D unchanged, the conduction loss of MOSFET will be unchanged.
   b. If D is increased keeping TS unchanged, the conduction loss of MOSFET will be dependent on the increase of D.
   c. In fact, the MOSFET will have additional loss while changing state. This is due to delayed changes in V_{DS}, V_{GS} and I_D caused by additional parasitic capacitance / inductance.
   d. The delayed changes will cause switching loss, which is dependent on the switching frequency fs. Higher fs results in more switching loss.

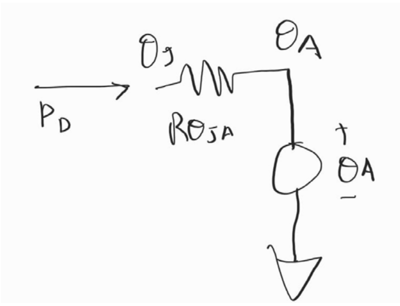
Activity 2

Conduction: from the junction to the outer surface of the casing

Convection: from the outer surface to the surrounding air

Radiation: from the outer surface to another object if there is one.

Activity 3a



$$\theta_J = 25°C + 62.5\frac{°C}{W} \times 3W = 212.5\,°C$$

It will not function properly, as 212.5°C is more than the operational temperature for the junction.

Activity 3b

Dissipation path:

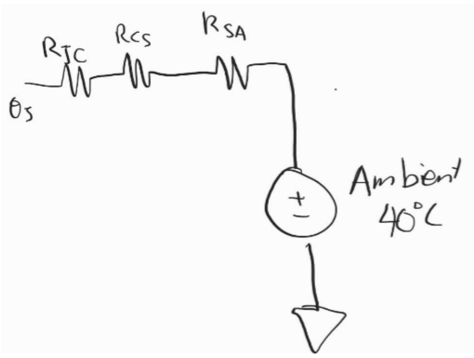
Conduction: junction -> case

Conduction: case -> sink

Convection: sink -> ambient

$$R_{\theta JA,desire} < \frac{T_i - T_a}{P} = \frac{175 - 40}{3} = 45\frac{°C}{W}$$

$$R_{\theta CS} = R_{TIM} = \frac{Thickness\ (L)}{Conductivity\ (\lambda) \times Area\ (A)} = \frac{0.03\text{mm}}{0.8\frac{W}{m°C} \times (10mm \times 10mm)} = 0.38\frac{°C}{W}$$



$$R_{\theta JC} = 2.74\frac{°C}{W}$$

$$R_{\theta SA} < R_{\theta JA,desire} - R_{\theta CS} - R_{\theta JC} = 45 - 0.375 - 2.74 = 41.88\frac{°C}{W}$$

Worst case, natural convection, temperature rise is 50°C.

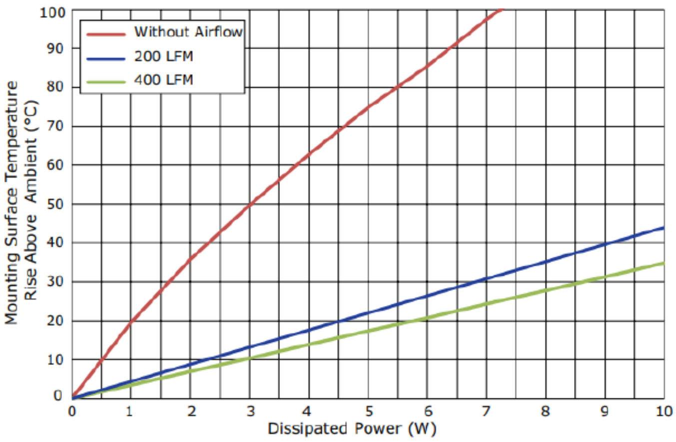
$$R_{\theta SA} = \frac{50}{3} = 16.67\frac{°C}{W}$$

PERFORMANCE CURVES

HSE-B20250-040H

Power (W)	Heatsink Temperature Rise Above Ambient (ΔT = Ths - Ta) (°C)		
	Natural Conv.	200 LFM	400 LFM
0	0	0	0
1	19.57	4.28	3.44
2	35.77	8.76	6.98
3	49.68	13.06	10.36
4	62.71	17.44	13.88
5	74.79	21.93	17.35
6	85.46	26.39	20.74
7	97.48	30.77	24.33
8	108.09	35.20	27.77
9	117.16	39.64	31.31
10	127.50	43.98	34.86

Ths: "hot spot" temperature measured on the heatsink
Ta: ambient temperature



$$\theta_{junction} = \theta_{ambient} + P(R_{\theta CS} + R_{\theta JC} + R_{\theta SA})$$

$$\theta_{junction} = 40 + 3(16.67 + 0.38 + 2.74) = 99.37°C$$