

## MOSFET - Losses

1) Conduction

$$P_{\text{cond-H}} = R_{\text{ds}} I_{\text{out}} D$$

$$R_{DS} = 1.38 \Omega$$

$$I_{\text{cond-L}} = R_{ds} I_{\text{out}} (1-D)$$

$$I_{out} = 2.5 \text{ A}$$

$$D = \% 20$$

$$P_{\text{cond-H}} = (1.38)(2.4)\left(\frac{20}{100}\right) = 0.66 \text{ W}$$

$$P_{\text{cond-L}} = (1.38)(2.4) \left(1 - \frac{20}{100}\right) = 2.64 \text{ W}$$

## 2) Switching

$$P_{SW} = V_{IN} \times I_O \times (t_r + t_f) \times f_{SW}$$

$$t_r = 22 \text{ ns}$$

$$t_f = 21 \text{ ns}$$

$$V_{IN} = \frac{24}{20/100} = 120 \text{ V}$$

$$I_{out} = 2.4 \text{ A}$$

$$f_{sw} = 100 \text{ kHz}$$

$$P_{sw} = 120 \times (2.4) \times (43 \times 10^{-9}) \times 10^5$$
$$= 1.23 \text{ W}$$

High side market  $\rightarrow P = 0.66W + 0.615W = 1.275W$   
Low " "  $\rightarrow P = 2.64W + 0.615 = 3.255W$

High size motor → P = 2.64 W + 0.615 = 3.255 W  
Low " " "

Without Heatsink

$$T_{Junc} = T_{amb} + P_{loss} \cdot R_{JA} = 25 + (3.255) \times 90 = 317.95^{\circ}\text{C}$$

Heat sink Requirements :  $\rightarrow 2.$

$$R_{HA} = \frac{T_{\text{Junction, max}} - T_{\text{ambient}}}{P_{\text{loss}}} - R_{\text{CH}} - R_{\text{JC}}$$

$$K_{HA} + 2 = \frac{125}{1.275}$$

$R_{HA} < 96.03 \text{ } ^\circ\text{C/W}$

High side

$$R_{HA} + 2 = 38.4$$

$$R_{HA} < 36.4 \text{ } ^\circ\text{C/W}$$

Low side ✓

## Diode Losses

### 1) Conduction

$$P_{\text{cond}} = V_{\text{forward}} \times I_{\text{diode}} = 1.10 \times (0.5) = 0.55 \text{ W}$$

### 2) Reverse Recovery Losses $Q_{rr} = 50 \text{ nC}$

$$P_{rr} = V_{\text{reverse}} \times I = V_{\text{reverse}} \times f_{sw} \times Q_{rr} = V_{\text{reverse}} \times f_{sw} \times t_{rr} \times I_{rr} \times \frac{1}{2}$$

$\downarrow$   
260

$$P_{rr} = 260 \times 10^5 \times 50 \times 10^{-9} = 1.3 \text{ W}$$

$$\text{Total} \rightarrow 1.85 \text{ W}$$

~~$$Q_{rr} = I_{rr} \times I_{rr} \times \frac{1}{2} = 2.5 \times 10^{-6} \times 0.25 \times 0.5 = 312.5 \text{ nC}$$~~

~~$$P_{rr} = 260 \times 10^5 \times 312.5 \times 10^{-9} = 8.125 \text{ W}$$~~

0.28 V



~~$$P_{\text{diode}} = 0.55 + 8.125 = 8.7 \text{ W}$$~~

Without Heat sink

$$T_{\text{junc}} = T_{\text{amb}} + P_{\text{loss}} R_{\theta} = 25 + 1.85 \times 53 = 123.05 < 150$$

✓