Problem 5.1 (50 points)

This problem uses information extracted from portions of the data sheet for a Vishay Siliconix power MOSFET SiHF620 (the full datasheet is available at http://www.vishay.com/docs/91027/sihf620.pdf). The on-state resistance of this MOSFET ($R_{DS(on)}$) is 0.8 Ω at 25°C. This on-state resistance varies with junction temperature, as illustrated in Fig. 4 (note that Fig.4 plots the normalized variation).

VISHAY

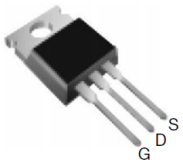
IRF620, SiHF620

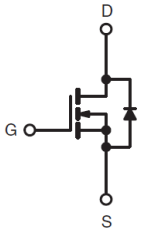
Vishay Siliconix

Power MOSFET

PRODUCT SUMMARY		
V_{DS} (V)	200	
$R_{DS(on)}$ (Ω)	V_{GS} = 10 V	0.80
Q_g (Max.) (nC)	14	
Q_{gs} (nC)	3.0	
Q_{gd} (nC)	7.9	
Configuration	Single	

TO-220AB





N-Channel MOSFET

FEATURES

- Dynamic dV/dt Rating
- Repetitive Avalanche Rated
- Fast Switching
- Ease of Paralleling
- Simple Drive Requirements
- Compliant to RoHS Directive 2002/95/EC

Available
RoHS* COMPLIANT

DESCRIPTION

Third generation Power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The TO-220AB package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 W. The low thermal resistance and low package cost of the TO-220AB contribute to its wide acceptance throughout the industry.

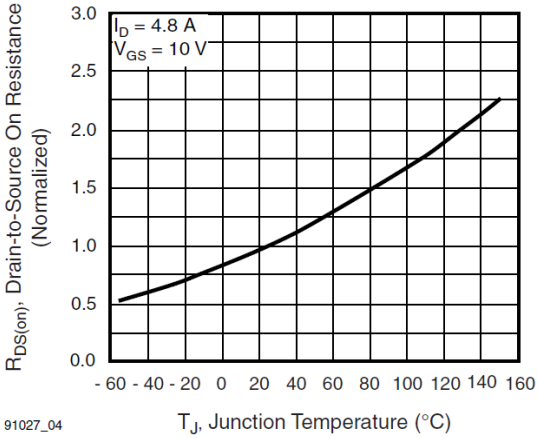


Fig. 4 - Normalized On-Resistance vs. Temperature

THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	R_{thJA}	-	62	°C/W
Case-to-Sink, Flat, Greased Surface	R_{thCS}	0.50	-	
Maximum Junction-to-Case (Drain)	R_{thJC}	-	2.5	

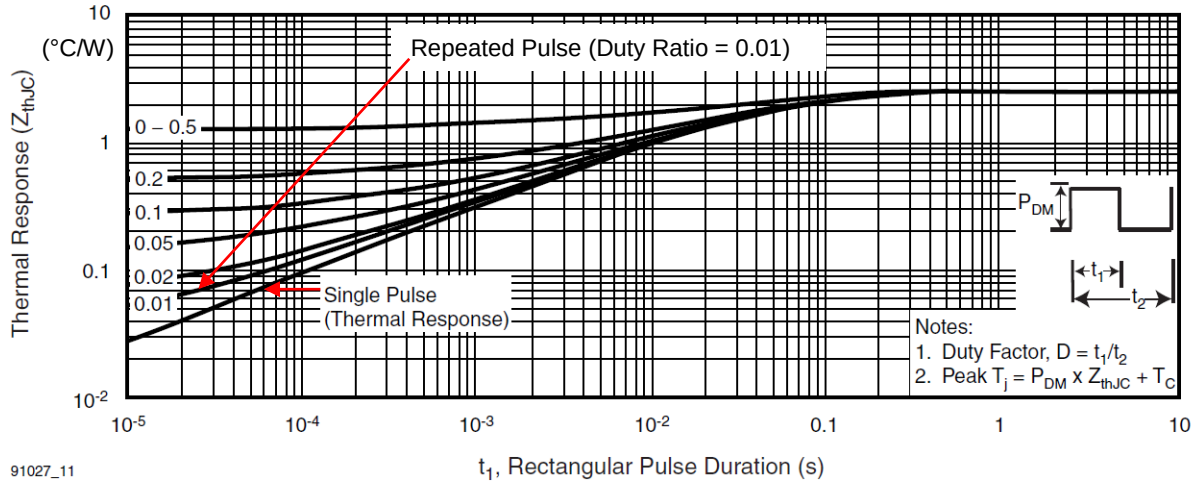


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

The junction-to-case thermal resistance (R_{thJC}) is 2.5°C/W (see above table). Also the junction-to-case transient thermal impedance versus pulse duration, for a single rectangular power dissipation pulse and repeated pulses of different duty ratios, is given in Fig. 11.

For both parts of this problem assume that the maximum allowable junction temperature (T_J) is 140˚C and the maximum ambient temperature (T_A) is 50˚C.

a) The MOSFET is first attached to a heat sink using an insulating pad resulting in a case-to-sink thermal resistance (R_{thCS}) of 0.75˚C/W. Assuming that the MOSFET must carry a (forward) rms current of 2.5 A, and that switching losses can be ignored, what is the maximum allowable thermal resistance of the heat sink (R_{thSA})?

b) The MOSFET is now instead operated in a pulsed fashion, carrying rectangular pulses of current of magnitude I_p, 1 ms in duration with 99 ms of off time between pulses. If the MOSFET is mounted to an extremely good heat sink that maintains the *case* temperature at 50˚C, what is the maximum allowable current pulse magnitude (I_p)? You may assume that the MOSFET on-state resistance is always at its 140˚C value.

Problem 5.2 (50 points)

Do Textbook (Fundamentals of Power Electronics 2nd Edition) Problem 5.1 (pg. 126).

Problem 5.3 (50 points) [Additional problem only for ECEN 5797 students]

Do Textbook (Fundamentals of Power Electronics 2nd Edition) Problem 5.2 (pg. 126).