
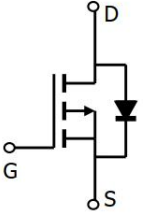


## VCRRP-Channel Enhancement Mode Power MOSFET

<p><b>Description</b></p> <p>The VCRR60P09K uses advanced trench technology and design to provide excellent <math>R_{DS(ON)}</math> with low gate charge. This device is well suited for use as a load switch or in PWM applications.</p> <p><b>Application</b></p> <ul style="list-style-type: none"> <li>● Load switch</li> <li>● PWM application</li> </ul>	<p><b>General Features</b></p> <ul style="list-style-type: none"> <li>● <math>V_{DS} = -60V, I_D = -9A</math></li> <li>● <math>R_{DS(ON)} &lt; 173m\Omega @ V_{GS} = -10V \quad I_D = -7A</math></li> <li>● <math>R_{DS(ON)} &lt; 210m\Omega @ V_{GS} = -10V \quad I_D = -9A</math></li> <li>● <math>R_{DS(ON)} &lt; 220m\Omega @ V_{GS} = -4.5V \quad I_D = -4A</math></li> <li>● High density cell design for ultra low <math>R_{dson}</math></li> <li>● Fully characterized avalanche voltage and current</li> <li>● Excellent package for good heat dissipation</li> <li>● 175 °C operating temperature</li> <li>● Pb-free lead plating</li> </ul>
<p><b>TO-252</b></p> 	 <p><b>Schematic Diagram</b></p>

### Package Marking and Ordering Information

Device Marking	Device	Device Package	Reel Size	Tape width	Quantity
VCRR60P09K	VCRR60P09K	TO-252	Ø330mm	16mm	2500 units

### Absolute Maximum Ratings ( $T_c = 25^\circ C$ unless otherwise noted)

Parameter	Symbol	Limit	Unit
Drain-Source Voltage	$V_{DS}$	-60	V
Gate-Source Voltage	$V_{GS}$	$\pm 20$	V
Drain Current-Continuous	$I_D$	-9	A
Pulsed Drain Current (Note 1)	$I_{DM}$	-36	A
Maximum Power Dissipation	$P_D$	40	W
Single pulse avalanche energy (Note 5)	$E_{AS}$	24	mJ
Operating Junction and Storage Temperature Range	$T_J, T_{STG}$	-55 To 175	$^\circ C$

### Thermal Characteristic

Thermal Resistance, Junction-to-Case (Note 2)	$R_{\theta JC}$	3.75	$^\circ C/W$
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## Electrical Characteristics (T<sub>c</sub>=25°C unless otherwise noted)

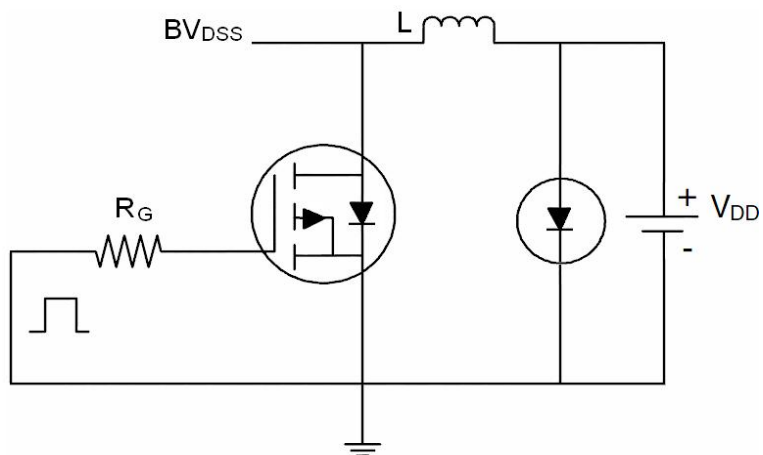
Parameter	Symbol	Condition	Min	Typ	Max	Unit
<b>Off Characteristics</b>						
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> =0V, I <sub>D</sub> =-250μA	-60	-	-	V
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> =-60V, V <sub>GS</sub> =0V	-	-	-1	μA
Gate-Body Leakage Current	I <sub>GSS</sub>	V <sub>GS</sub> =±20V, V <sub>DS</sub> =0V	-	-	±100	nA
<b>On Characteristics</b> (Note 3)						
Gate Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =-250μA	-1.4	-2.0	-2.6	V
Drain-Source On-State Resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> =-10V, I <sub>D</sub> =-7A	-	-	173	mΩ
		V <sub>GS</sub> =-10V, I <sub>D</sub> =-9A	-	-	210	mΩ
		V <sub>GS</sub> =-4.5V, I <sub>D</sub> =-4A	-	-	220	mΩ
Forward Transconductance	g <sub>FS</sub>	V <sub>DS</sub> =-5V, I <sub>D</sub> =-9A	-	3	-	S
<b>Dynamic Characteristics</b> (Note4)						
Input Capacitance	C <sub>iss</sub>	V <sub>DS</sub> =-30V, V <sub>GS</sub> =0V, F=1.0MHz	-	444.2	-	PF
Output Capacitance	C <sub>oss</sub>		-	19.6	-	PF
Reverse Transfer Capacitance	C <sub>rss</sub>		-	17.9	-	PF
<b>Switching Characteristics</b> (Note 4)						
Turn-on Delay Time	t <sub>d(on)</sub>	V <sub>DD</sub> =-30V, I <sub>D</sub> =-9A, V <sub>GS</sub> =-10V, R <sub>G</sub> =3Ω	-	40	-	nS
Turn-on Rise Time	t <sub>r</sub>		-	35	-	nS
Turn-Off Delay Time	t <sub>d(off)</sub>		-	15	-	nS
Turn-Off Fall Time	t <sub>f</sub>		-	10	-	nS
Total Gate Charge	Q <sub>g</sub>	V <sub>DS</sub> =-30, I <sub>D</sub> =-9A, V <sub>GS</sub> =-10V	-	11.3	-	nC
Gate-Source Charge	Q <sub>gs</sub>		-	2.7	-	nC
Gate-Drain Charge	Q <sub>gd</sub>		-	1.6	-	nC
<b>Drain-Source Diode Characteristics</b>						
Diode Forward Voltage (Note 3)	V <sub>SD</sub>	V <sub>GS</sub> =0V, I <sub>S</sub> =-9A	-	-	-1.2	V
Diode Forward Current (Note 2)	I <sub>S</sub>		-	-	-9	A
Reverse Recovery Time	t <sub>rr</sub>	T <sub>J</sub> = 25°C, I <sub>F</sub> = -9A	-	25		nS
Reverse Recovery Charge	Q <sub>rr</sub>	di/dt = -100A/μs (Note3)	-	31		nC

### Notes:

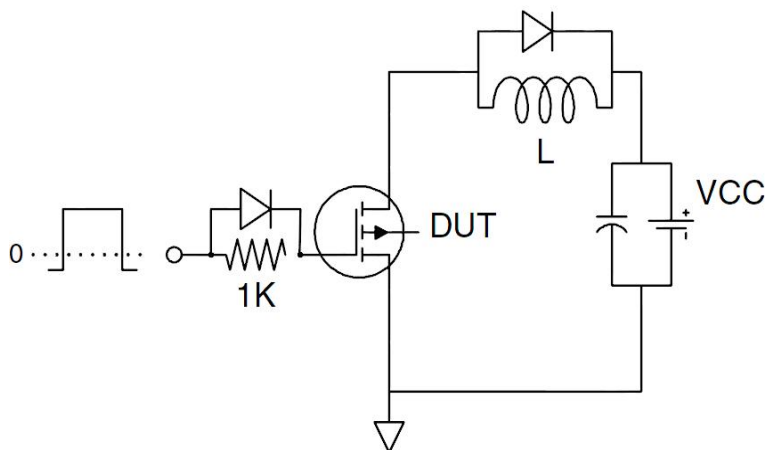
1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board, t ≤ 10 sec.
3. Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2%.
4. Guaranteed by design, not subject to production
5. EAS condition : T<sub>J</sub>=25°C, V<sub>DD</sub>=-30V, V<sub>G</sub>=-10V, L=0.5mH, R<sub>G</sub>=25Ω

## Test Circuit

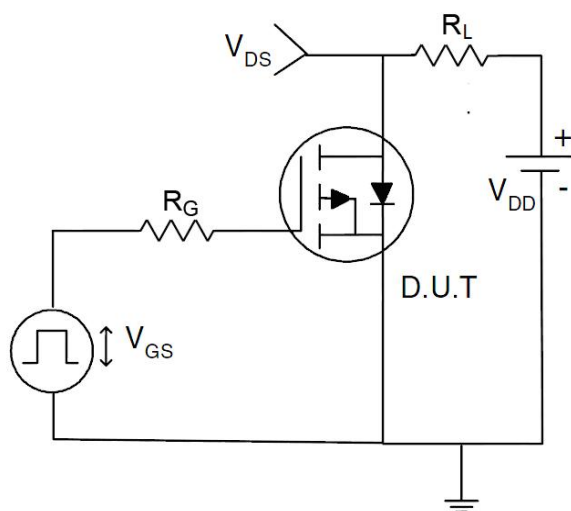
### 1) E<sub>AS</sub> Test Circuit



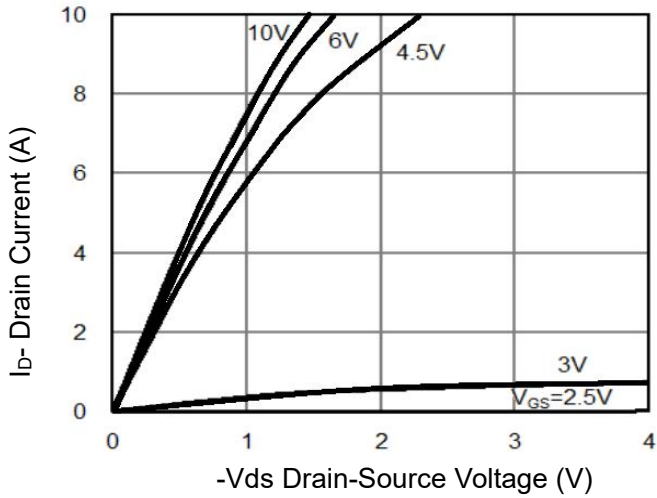
### 2) Gate Charge Test Circuit



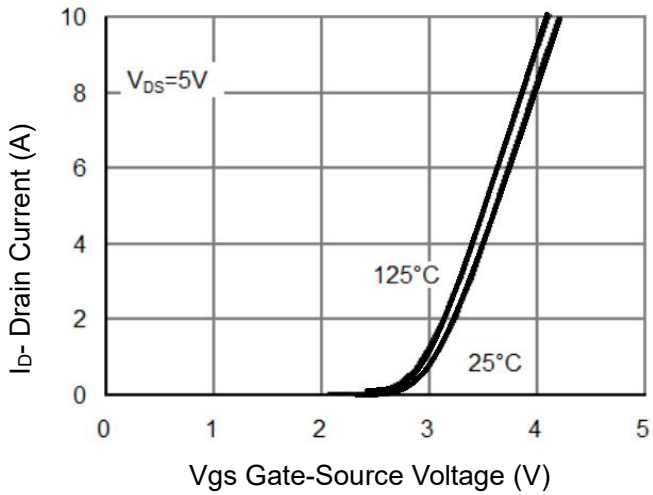
### 3) Switch Time Test Circuit



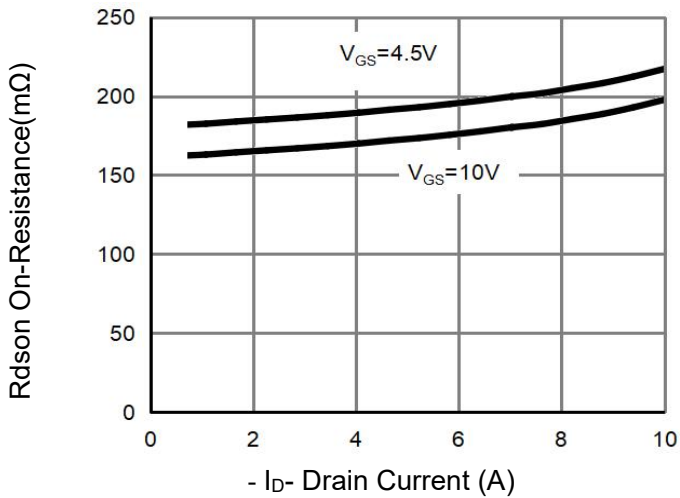
**Typical Electrical and Thermal Characteristics (Curves)**



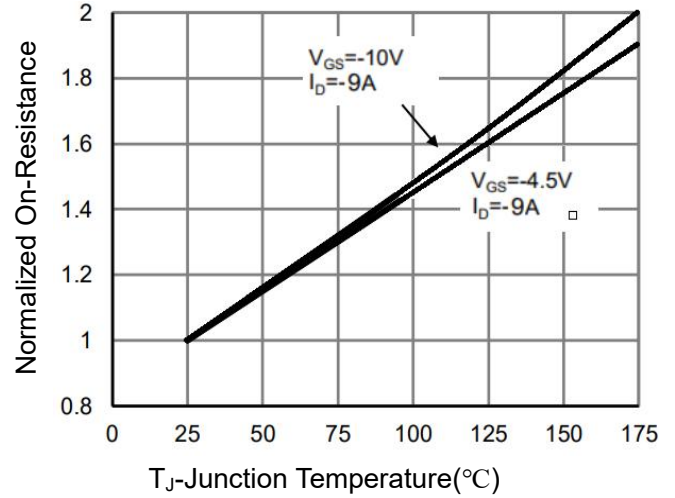
**Figure 1 Output Characteristics**



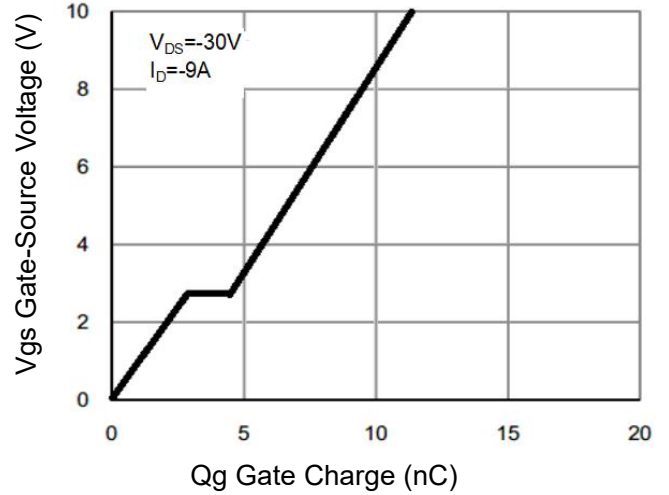
**Figure 2 Transfer Characteristics**



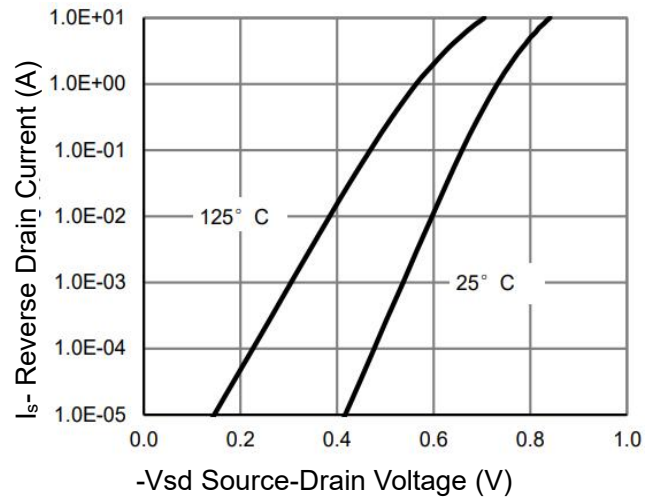
**Figure 3 Rdson- Drain Current**



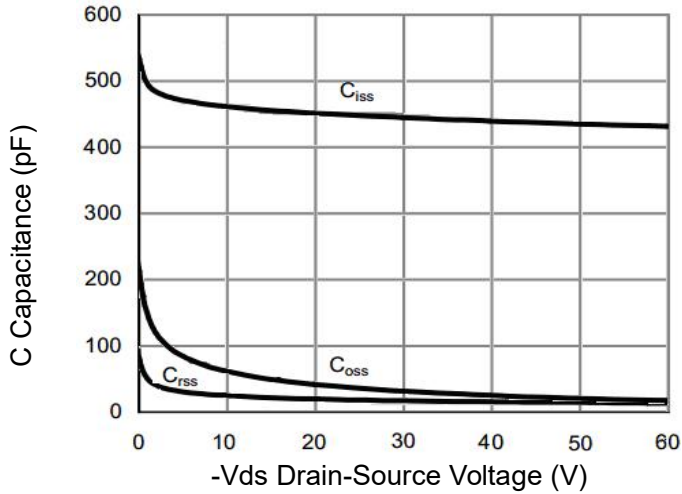
**Figure 4 Rdson-Junction Temperature**



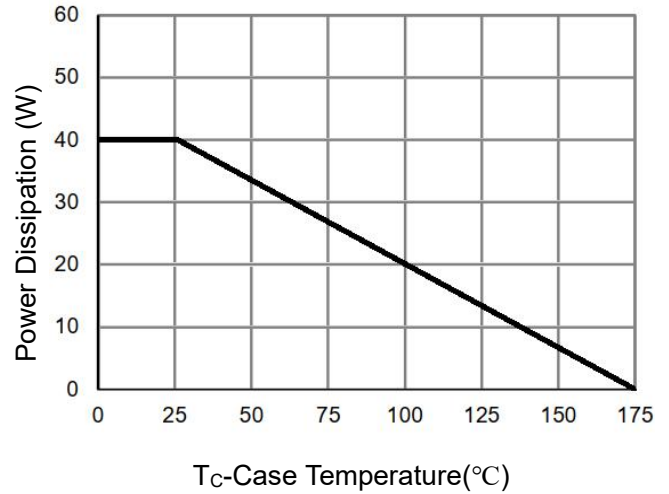
**Figure 5 Gate Charge**



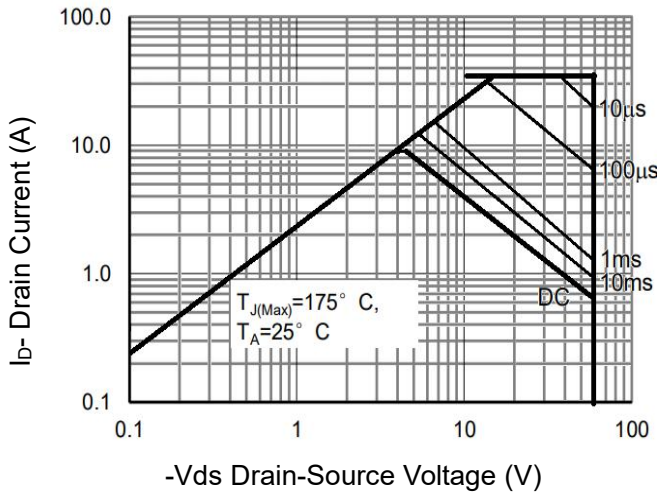
**Figure 6 Source- Drain Diode Forward**



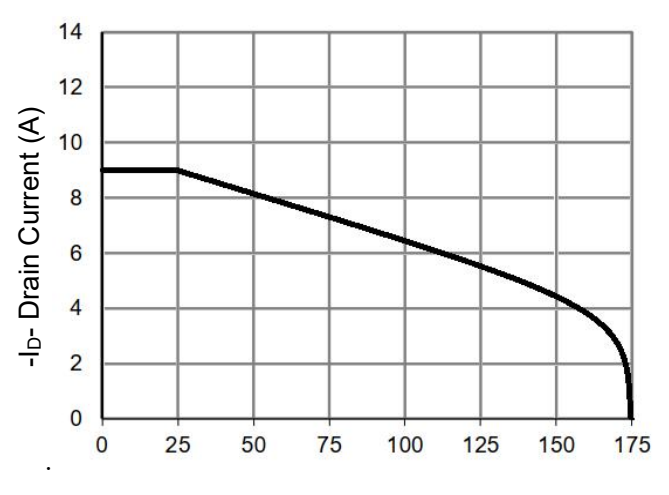
**Figure 7 Capacitance vs Vds**



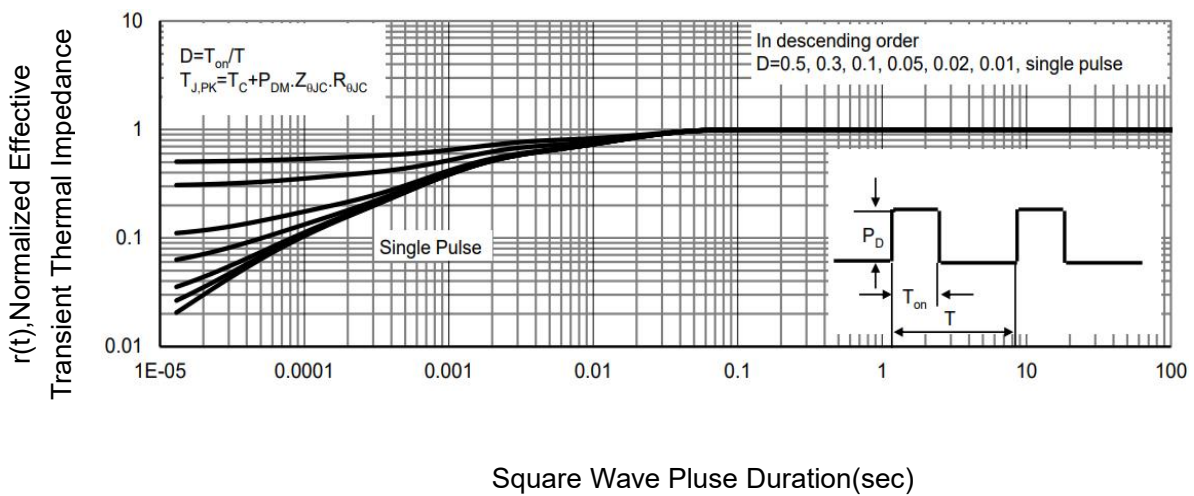
**Figure 9 Power De-rating**



**Figure 8 Safe Operation Area**

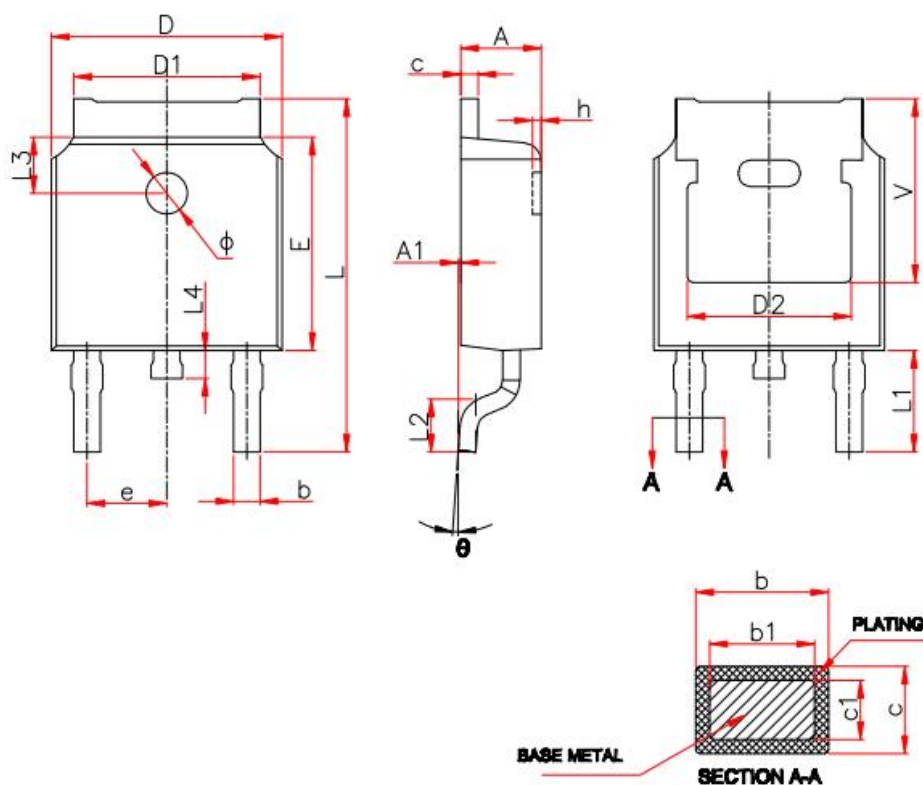


**Figure 10 ID Current De-rating**



**Figure 11 Normalized Maximum Transient Thermal Impedance**

## TO-252 Package Information



Symbol	Millimeters	
	Min.	Max.
A	2.20	2.40
A1	0.00	0.13
b	0.66	0.86
b1	0.73	0.79
c	0.46	0.58
c1	0.50	0.52
D	6.50	6.70
D1	5.10	5.46
D2	4.83 REF.	
E	6.00	6.20
e	2.19	2.39
L	9.80	10.40
L1	2.90 REF.	
L2	1.40	1.70
L3	1.60 REF.	
L4	0.60	1.00
φ	1.10	1.30
θ	0°	8°

### **Attention**

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