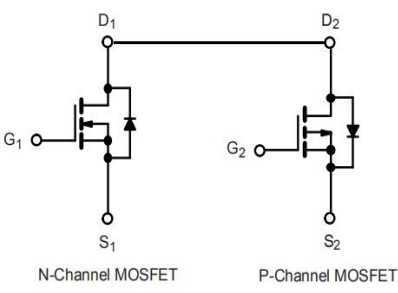


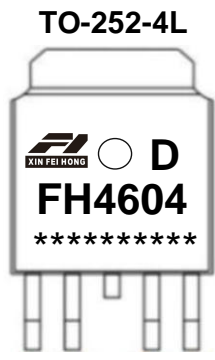
# FH4604D

# N&P-Channel complementary Power MOSFET

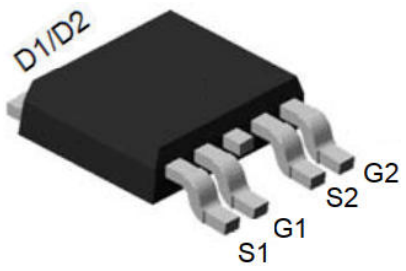
<p><b>Description</b></p> <p>The FH4604D uses advanced trench technology and design to provide excellent <math>R_{DS(ON)}</math> with low gate charge. It can be used in a wide variety of applications.</p> <p><b>Application</b></p> <ul style="list-style-type: none"> <li>● H-bridge</li> <li>● Inverters</li> <li>● <b>Brushless motor</b></li> </ul>	<p><b>General Features</b></p> <p><b>N channel</b></p> <ul style="list-style-type: none"> <li>● <math>V_{DS} = 40V, I_D = 25A</math></li> <li>● <math>R_{DS(ON)} &lt; 19m\Omega @ V_{GS} = 10V</math></li> <li>● <math>R_{DS(ON)} &lt; 24m\Omega @ V_{GS} = 4.5V</math></li> </ul> <p><b>p channel</b></p> <ul style="list-style-type: none"> <li>● <math>V_{DS} = -40V, I_D = -21A</math></li> <li>● <math>R_{DS(ON)} &lt; 34m\Omega @ V_{GS} = -10V</math></li> <li>● <math>R_{DS(ON)} &lt; 47m\Omega @ V_{GS} = -4.5V</math></li> </ul> <ul style="list-style-type: none"> <li>● High density cell design for ultra low Rdson</li> <li>● Fully characterized avalanche voltage and current</li> <li>● Good stability and uniformity with high <math>E_{AS}</math></li> <li>● Excellent package for good heat dissipation</li> </ul>
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**Schematic diagram**



**Marking and pin assignment**



**TO-252-4L top view**

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

Parameter	Symbol	N-Channel	P-Channel	Unit	
Drain-Source Voltage	$V_{DS}$	40	-40	V	
Gate-Source Voltage	$V_{GS}$	$\pm 20$	$\pm 20$	V	
Continuous Drain Current <sup>(Note 1)</sup>	$I_D$	$T_C=25^\circ C$	25	-21	A
		$T_C=100^\circ C$	13	-11	
Pulsed Drain Current <sup>(Note 1) (Note 3)</sup>	$I_{DM}$	75	-63	A	
Maximum Power Dissipation	$P_D$	23		W	
Operating Junction and Storage Temperature Range	$T_J, T_{STG}$	-55 TO +150		$^\circ C$	

**Thermal Characteristic**

Thermal Resistance, Junction-to-Case <sup>(Note 2)</sup>	$R_{\theta JC}$	9	$^\circ C/W$
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**N-Channel Electrical Characteristics ( $T_C=25^\circ\text{C}$  unless otherwise noted)**

Parameter	Symbol	Condition	Min	Typ	Max	Unit
<b>Off Characteristics</b>						
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=250\mu A$	40	45	-	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS}=40V, V_{GS}=0V$	-	-	1	$\mu A$
Gate-Body Leakage Current	$I_{GSS}$	$V_{GS}=\pm 20V, V_{DS}=0V$	-	-	$\pm 100$	nA
<b>On Characteristics</b> (Note 3)						
Gate Threshold Voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=250\mu A$	1.0	1.5	2.0	V
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS}=10V, I_D=6A$	-	14	19	$m\Omega$
		$V_{GS}=4.5V, I_D=4A$	-	19	24	$m\Omega$
Forward Transconductance	$g_{FS}$	$V_{DS}=10V, I_D=6A$	-	25	-	S
<b>Dynamic Characteristics</b> (Note 4)						
Input Capacitance	$C_{iss}$	$V_{DS}=20V, V_{GS}=0V,$ $F=1.0MHz$	-	520	-	PF
Output Capacitance	$C_{oss}$		-	120	-	PF
Reverse Transfer Capacitance	$C_{rss}$		-	60	-	PF
<b>Switching Characteristics</b> (Note 4)						
Turn-on Delay Time	$t_{d(on)}$	$V_{DD}=20V, R_L=2.5\Omega$ $V_{GS}=10V, R_G=3\Omega$	-	5	-	nS
Turn-on Rise Time	$t_r$		-	11	-	nS
Turn-Off Delay Time	$t_{d(off)}$		-	16	-	nS
Turn-Off Fall Time	$t_f$		-	6	-	nS
Total Gate Charge	$Q_g$	$V_{DS}=20V, I_D=6A,$ $V_{GS}=10V$	-	8.7	-	nC
Gate-Source Charge	$Q_{gs}$		-	1.9	-	nC
Gate-Drain Charge	$Q_{gd}$		-	1.8	-	nC
<b>Drain-Source Diode Characteristics</b>						
Diode Forward Voltage (Note 3)	$V_{SD}$	$V_{GS}=0V, I_S=6A$	-	-	1.2	V
Diode Forward Current (Note 2)	$I_S$		-	-	20	A

**Notes:**

1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
4. Guaranteed by design, not subject to production
5. EAS condition:  $T_J=25^\circ C, V_{DD}=40V, V_G=10V, L=0.5mH, R_G=25\Omega$

N-Channel Typical Electrical and Thermal Characteristics (Curves)

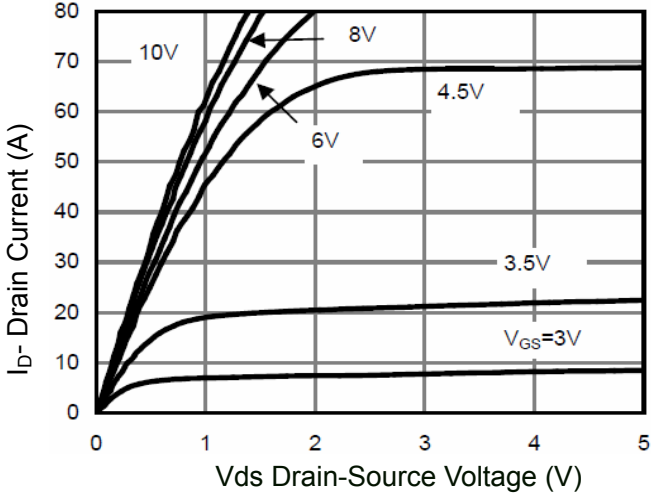


Figure 1 Output Characteristics

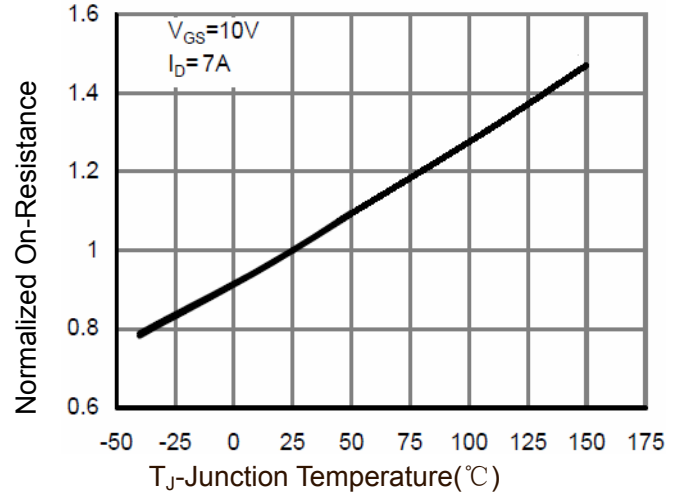


Figure 4  $R_{dson}$ -Junction Temperature

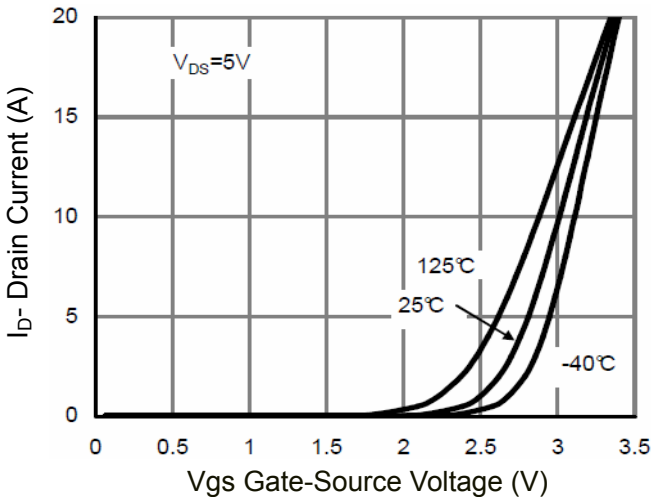


Figure 2 Transfer Characteristics

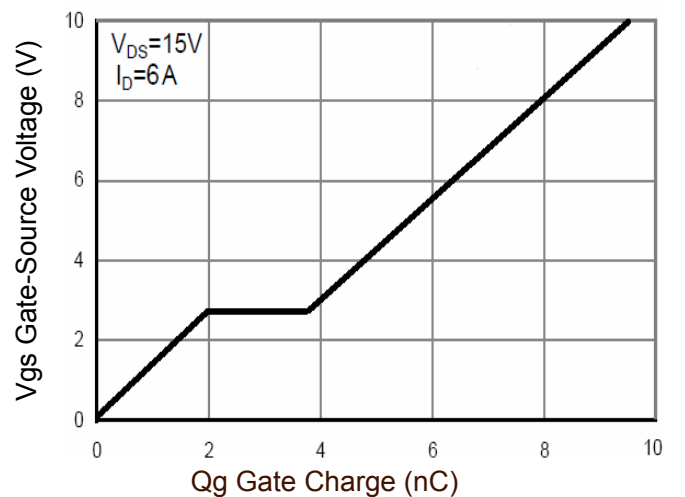


Figure 5 Gate Charge

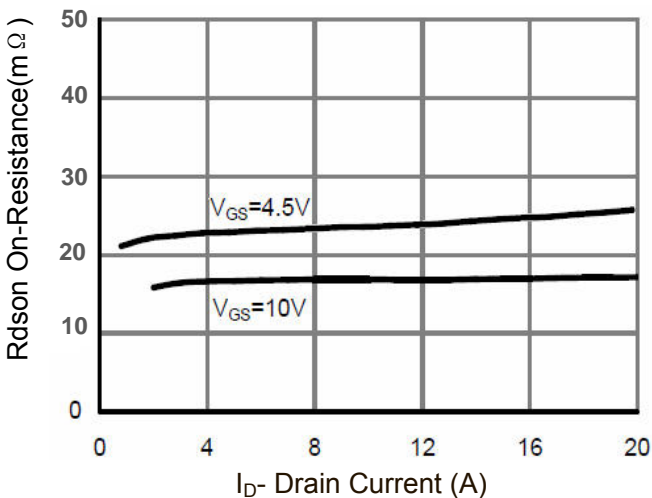


Figure 3  $R_{dson}$ - Drain Current

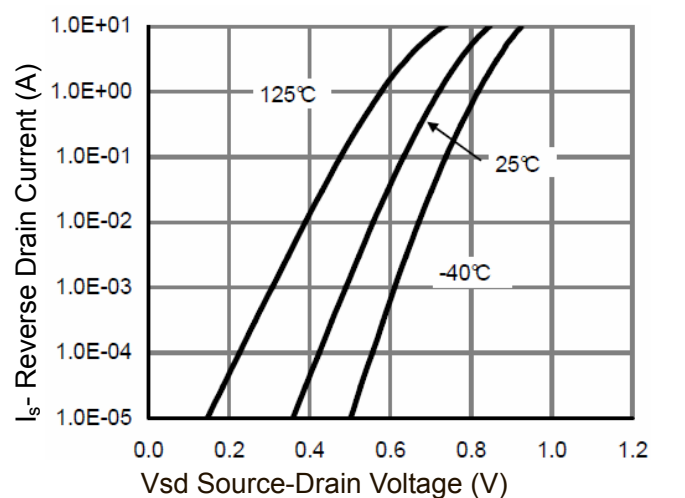


Figure 6 Source- Drain Diode Forward

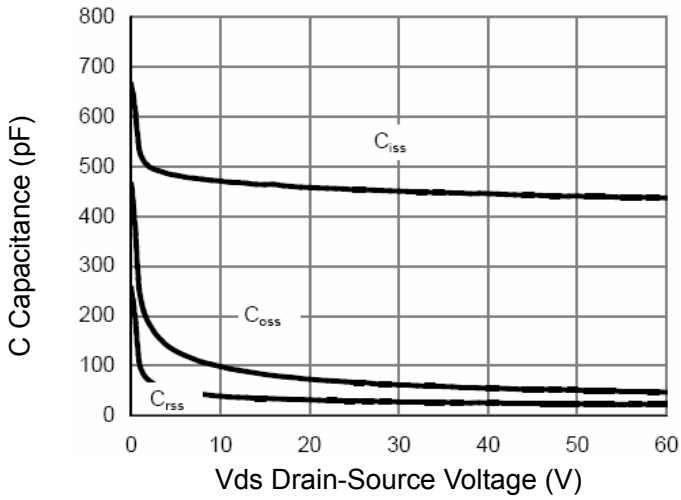


Figure 7 Capacitance vs Vds

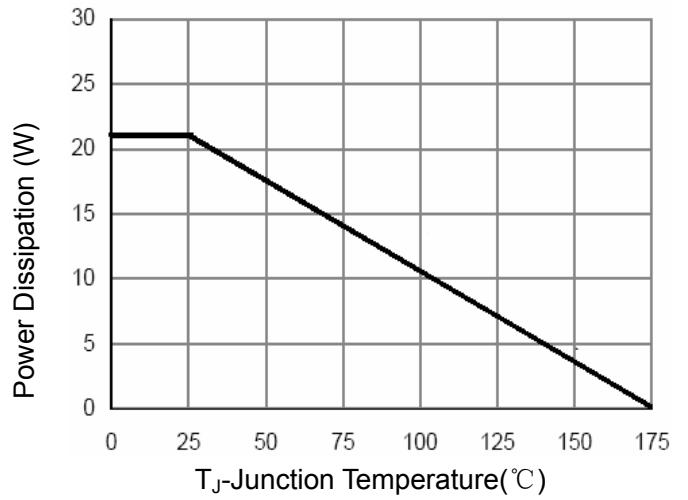


Figure 9 Power De-rating

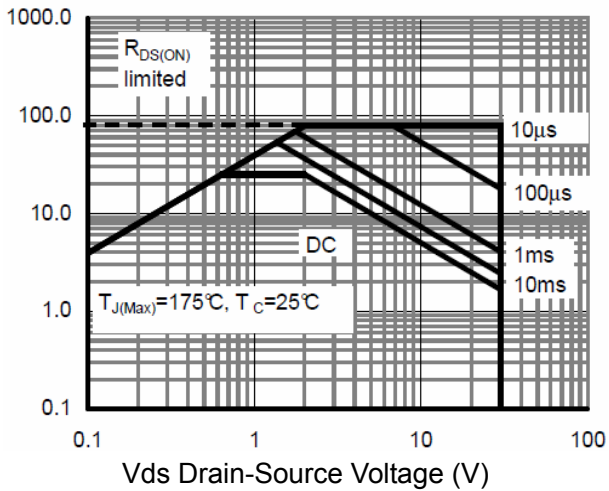


Figure 8 Safe Operation Area

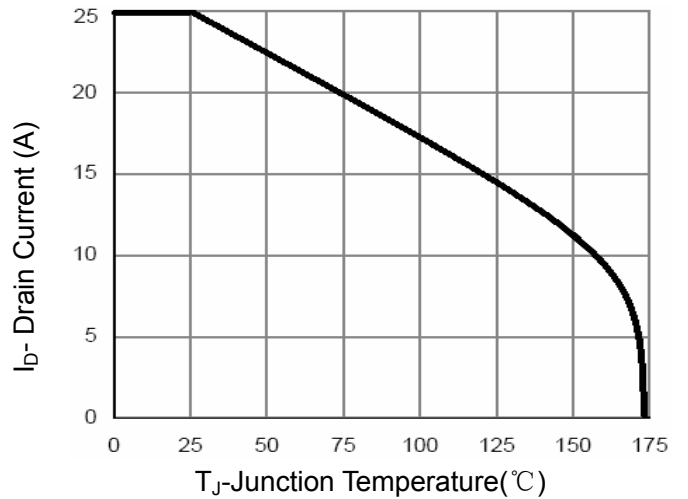


Figure 10 Current De-rating

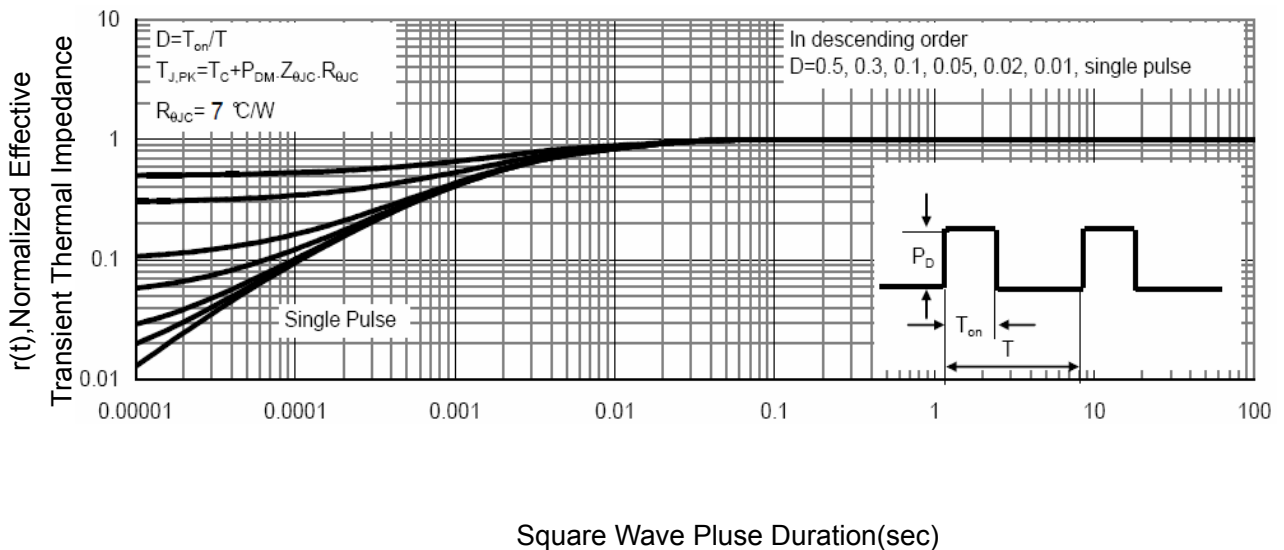


Figure 11 Normalized Maximum Transient Thermal Impedance

**P-Channel 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	-40	-45	-	V
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> =-40V, 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> <sup>(Note 3)</sup>						
Gate Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =-250μA	-1.0	-1.5	-2.0	V
Drain-Source On-State Resistance	R <sub>DS(ON)</sub>	V <sub>GS</sub> =-10V, I <sub>D</sub> =-5A	-	28	34	mΩ
		V <sub>GS</sub> =-4.5V, I <sub>D</sub> =-4A	-	39	47	
Forward Transconductance	g <sub>FS</sub>	V <sub>DS</sub> =-5V, I <sub>D</sub> =-5	-	17	-	S
<b>Dynamic Characteristics</b> <sup>(Note 4)</sup>						
Input Capacitance	C <sub>ISS</sub>	V <sub>DS</sub> =-20V, V <sub>GS</sub> =0V, F=1.0MHz	-	1160	-	PF
Output Capacitance	C <sub>OSS</sub>		-	178	-	PF
Reverse Transfer Capacitance	C <sub>rSS</sub>		-	97	-	PF
<b>Switching Characteristics</b> <sup>(Note 4)</sup>						
Turn-on Delay Time	t <sub>d(on)</sub>	V <sub>DD</sub> =-20V, R <sub>L</sub> =2.5Ω V <sub>GS</sub> =-10V, R <sub>G</sub> =3Ω	-	8	-	nS
Turn-on Rise Time	t <sub>r</sub>		-	18	-	nS
Turn-Off Delay Time	t <sub>d(off)</sub>		-	24	-	nS
Turn-Off Fall Time	t <sub>f</sub>		-	17	-	nS
Total Gate Charge	Q <sub>g</sub>	V <sub>DS</sub> =-20V, I <sub>D</sub> =-5, V <sub>GS</sub> =-10V	-	14	-	nC
Gate-Source Charge	Q <sub>gs</sub>		-	2.9	-	nC
Gate-Drain Charge	Q <sub>gd</sub>		-	3.6	-	nC
<b>Drain-Source Diode Characteristics</b>						
Diode Forward Voltage <sup>(Note 3)</sup>	V <sub>SD</sub>	V <sub>GS</sub> =0V, I <sub>S</sub> =-5	-	-	-1.2	V
Diode Forward Current <sup>(Note 2)</sup>	I <sub>S</sub>		-	-	-15	A
Reverse Recovery Time	t <sub>rr</sub>	T <sub>J</sub> = 25°C, I <sub>F</sub> = -5	-	23	-	nS
Reverse Recovery Charge	Q <sub>rr</sub>	di/dt = 100A/μs <sup>(Note 3)</sup>	-	14	-	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>=40V, V<sub>G</sub>=10V, L=0.5mH, R<sub>G</sub>=25Ω

P-Channel Typical Electrical and Thermal Characteristics (Curves)

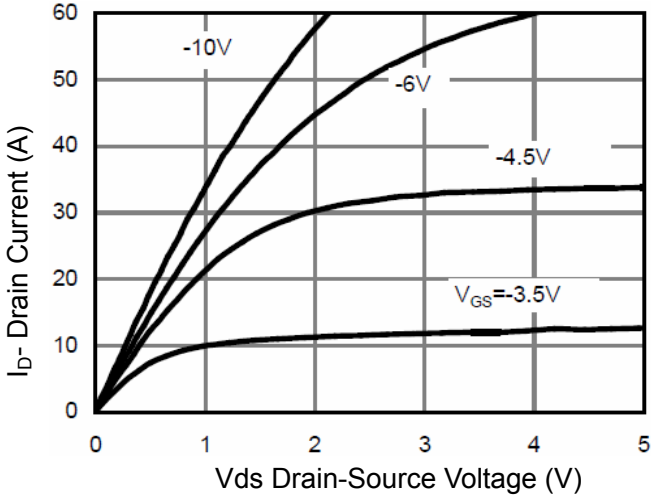


Figure 1 Output Characteristics

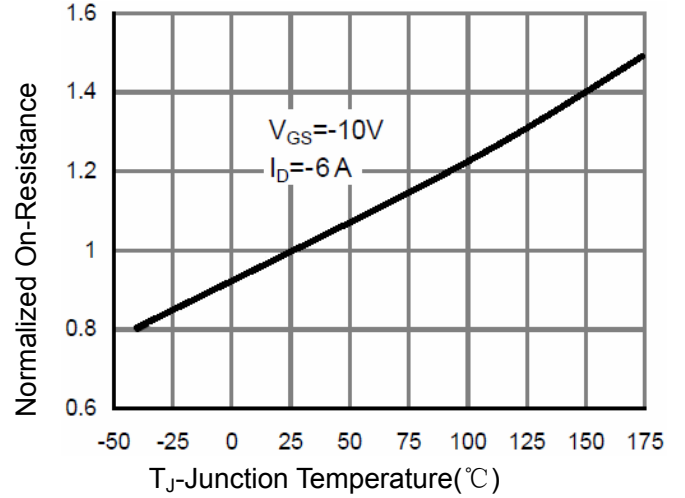


Figure 4 Rdson-Junction Temperature

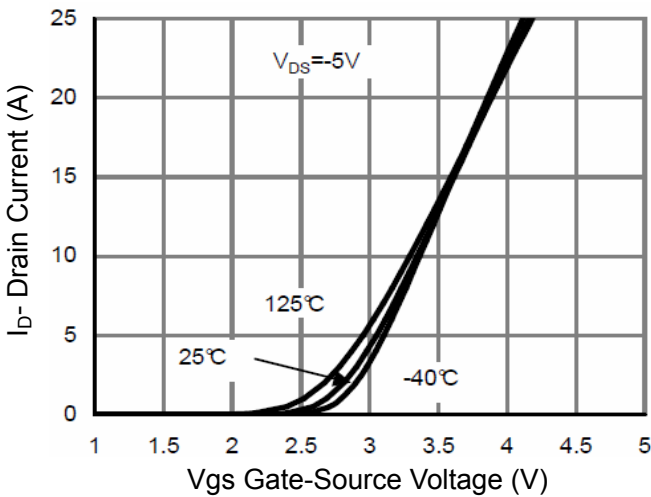


Figure 2 Transfer Characteristics

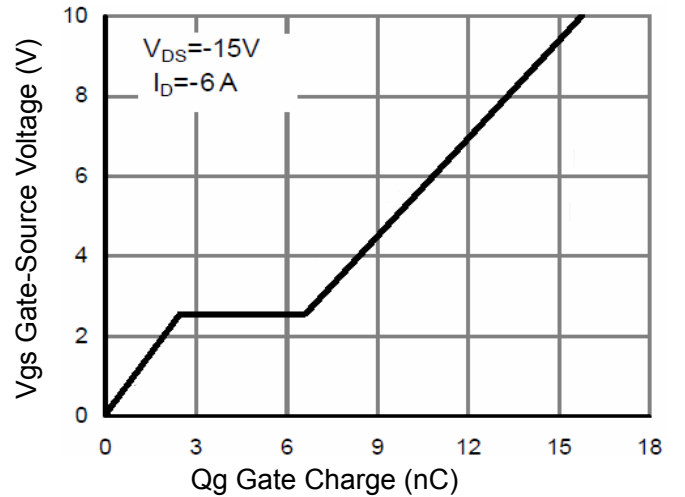


Figure 5 Gate Charge

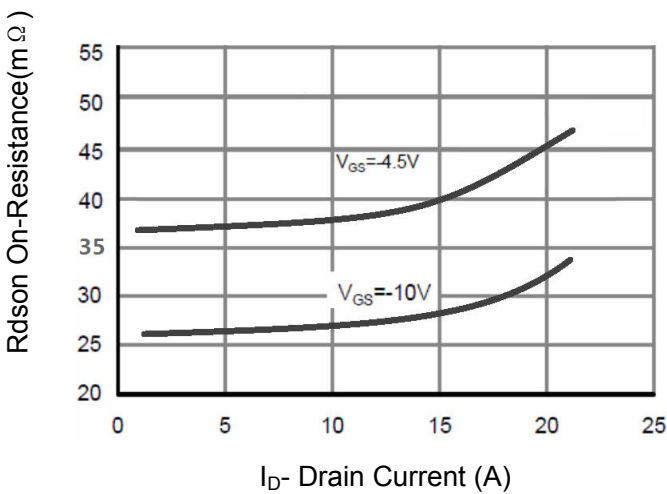


Figure 3 Rdson- Drain Current

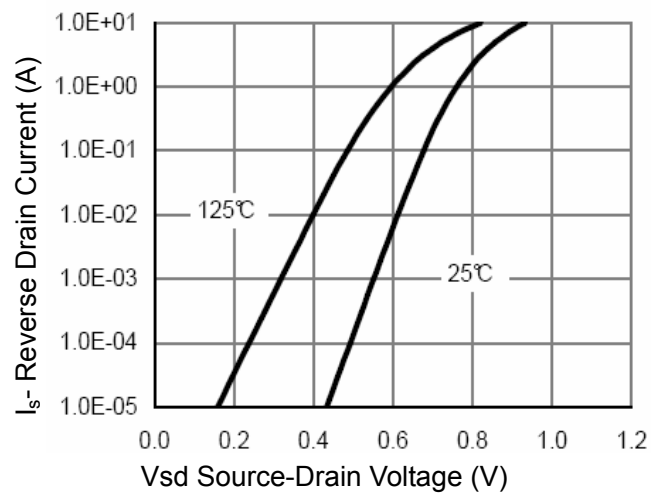


Figure 6 Source- Drain Diode Forward

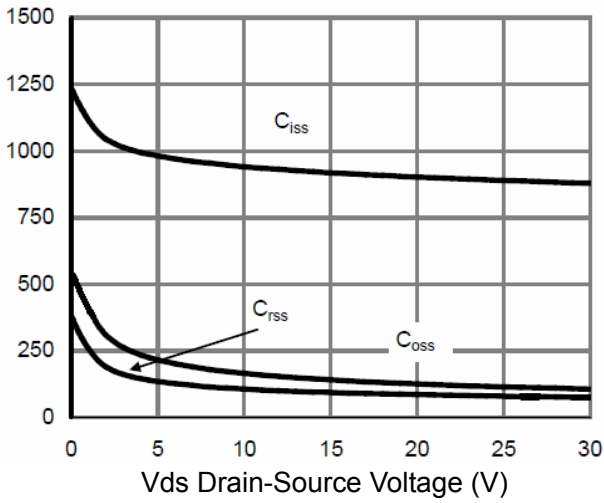


Figure 7 Capacitance vs Vds

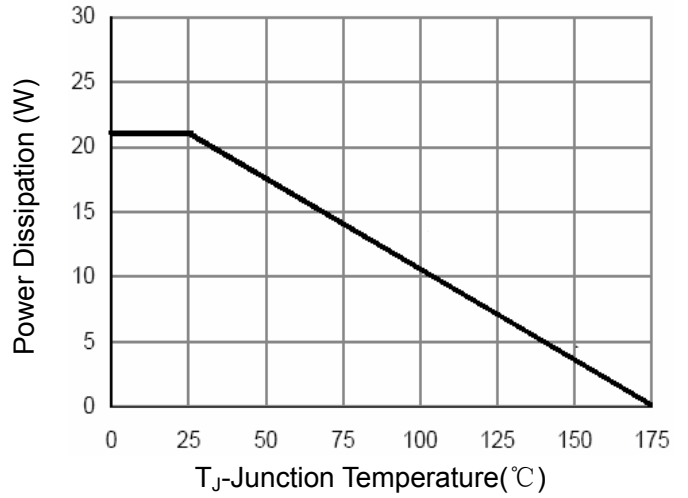


Figure 9 Power De-rating

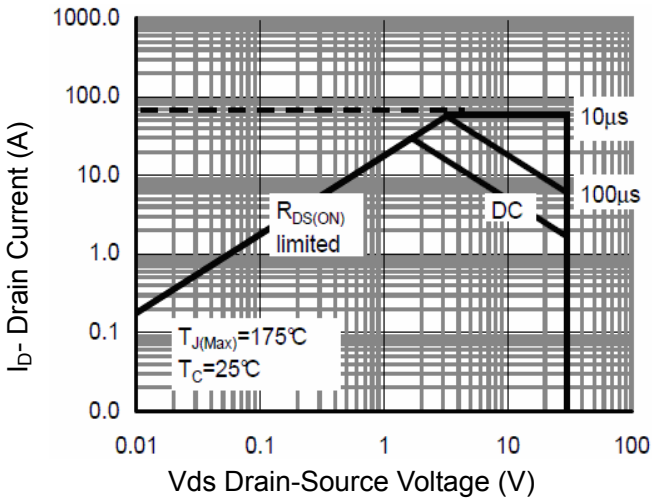


Figure 8 Safe Operation Area

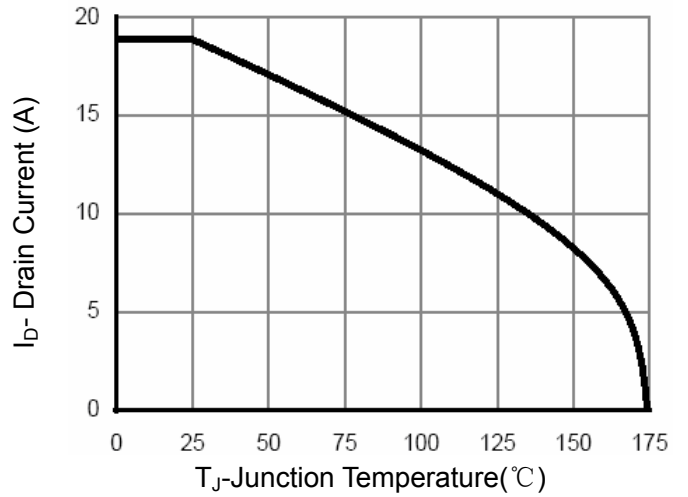


Figure 10 Current De-rating

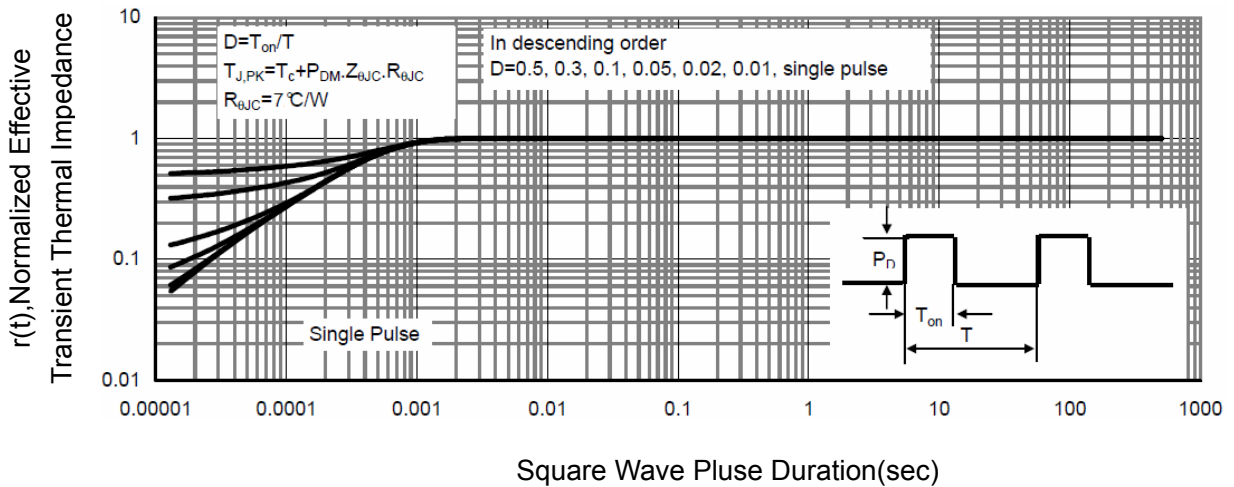
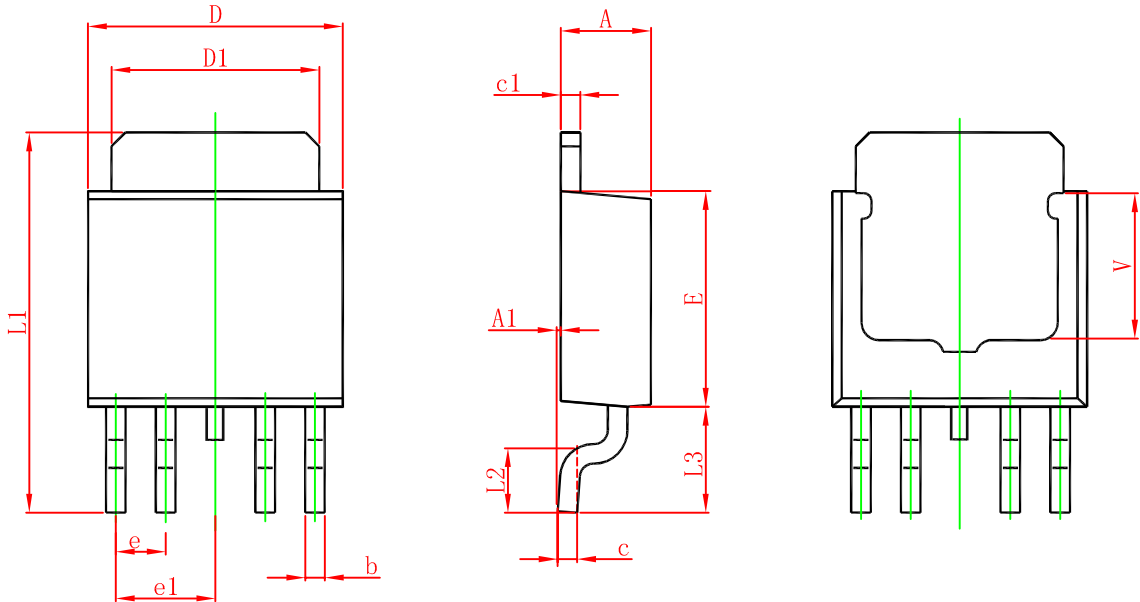


Figure 11 Normalized Maximum Transient Thermal Impedance

Package Information : TO-252-4L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	2.200	2.400	0.087	0.094
A1	0.000	0.127	0.000	0.005
b	0.400	0.600	0.016	0.024
c	0.430	0.580	0.017	0.023
c1	0.430	0.580	0.017	0.023
D	6.350	6.650	0.250	0.262
D1	5.200	5.400	0.205	0.213
E	5.400	5.700	0.213	0.224
e	1.270 TYP		0.050 TYP	
e1	2.540 TYP		1.000 TYP	
L1	9.500	9.900	0.374	0.390
L2	1.400	1.780	0.055	0.070
L3	2.550	2.900	0.100	0.114
V	3.45 REF		0.136 REF	