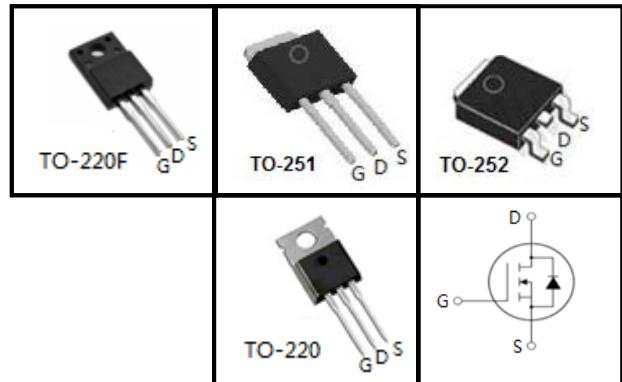


### FEATURES

- Very low FOM  $R_{DS(on)} \times Q_g$
- 100% avalanche tested
- RoHS compliant



### APPLICATIONS

- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply (UPS)
- Power Factor Correction (PFC)

Device Marking and Package Information				
Device	SP70R1K4	SP70R1K4	SP70R1K4	SP70R1K4
Package	TO-220	TO-220F	TO-251	TO-252
Marking	SP70R1K4P	SP70R1K4F	SP70R1K4U	SP70R1K4T

### Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ , unless otherwise noted

Parameter	Symbol	Value		Unit
		TO-220, TO-251, TO-252	TO-220F	
Drain-Source Voltage ( $V_{GS} = 0\text{V}$ )	$V_{DSS}$	700		V
Continuous Drain Current	$I_D$	4		A
Pulsed Drain Current (note1)	$I_{DM}$	12		A
Gate-Source Voltage	$V_{GSS}$	$\pm 30$		V
Single Pulse Avalanche Energy (note2)	$E_{AS}$	52.8		mJ
Avalanche Current (note1)	$I_{AR}$	0.8		A
Repetitive Avalanche Energy (note1)	$E_{AR}$	0.09		mJ
MOSFET dv/dt Ruggedness( $V_{DS} = 0 \dots 480\text{V}$ )	dv/dt	50		V/ns
Power Dissipation ( $T_C = 25^\circ\text{C}$ )	$P_D$	28	23	W
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	$-55 \sim +150$		°C

Thermal Resistance				
Parameter	Symbol	Value		Unit
		TO-220, TO-251, TO-252	TO-220F	
Thermal Resistance, Junction-to-Case	$R_{thJC}$	4.4	5.5	°C/W
Thermal Resistance, Junction-to-Ambient	$R_{thJA}$	62	80	

**Specifications**  $T_J = 25^\circ\text{C}$ , unless otherwise noted

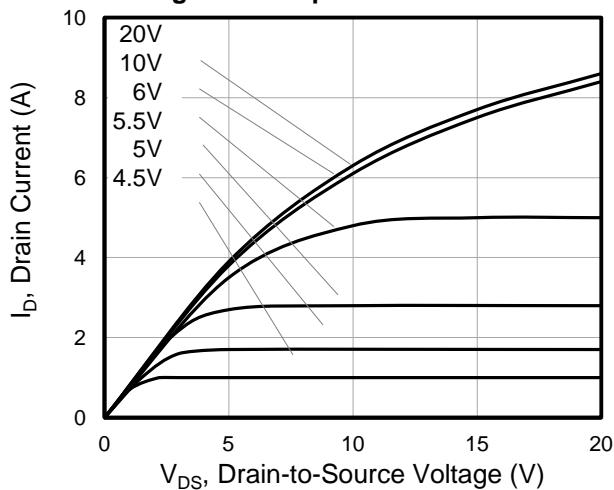
Parameter	Symbol	Test Conditions	Value			Unit
			Min.	Typ.	Max.	
<b>Static</b>						
Drain-Source Breakdown Voltage	$V_{(\text{BR})\text{DSS}}$	$V_{\text{GS}} = 0\text{V}, I_D = 250\mu\text{A}$	700	--	--	V
Zero Gate Voltage Drain Current	$I_{\text{DSS}}$	$V_{\text{DS}} = 700\text{V}, V_{\text{GS}} = 0\text{V}, T_J = 25^\circ\text{C}$	--	--	1	$\mu\text{A}$
		$V_{\text{DS}} = 700\text{V}, V_{\text{GS}} = 0\text{V}, T_J = 150^\circ\text{C}$	--	--	100	
Gate-Source Leakage	$I_{\text{GSS}}$	$V_{\text{GS}} = \pm 30\text{V}$	--	--	$\pm 100$	nA
Gate-Source Threshold Voltage	$V_{\text{GS}(\text{th})}$	$V_{\text{DS}} = V_{\text{GS}}, I_D = 250\mu\text{A}$	2.5	--	4.0	V
Drain-Source On-Resistance (Note3)	$R_{\text{DS}(\text{on})}$	$V_{\text{GS}} = 10\text{V}, I_D = 1\text{A}$	--	1.26	1.4	$\Omega$
Forward Transconductance (Note3)	$g_{\text{fs}}$	$V_{\text{DS}} = 10\text{V}, I_D = 1\text{A}$	--	3	--	S
<b>Dynamic</b>						
Input Capacitance	$C_{\text{iss}}$	$V_{\text{GS}} = 0\text{V}, V_{\text{DS}} = 50\text{V}, f = 1.0\text{MHz}$	--	350	--	pF
Output Capacitance	$C_{\text{oss}}$		--	20	--	
Reverse Transfer Capacitance	$C_{\text{rss}}$		--	2.6	--	
Total Gate Charge	$Q_g$	$V_{\text{DD}} = 560\text{V}, I_D = 4\text{A}, V_{\text{GS}} = 10\text{V}$	--	7	--	nC
Gate-Source Charge	$Q_{\text{gs}}$		--	1.5	--	
Gate-Drain Charge	$Q_{\text{gd}}$		--	2.5	--	
Turn-on Delay Time	$t_{\text{d}(\text{on})}$	$V_{\text{DD}} = 400\text{V}, I_D = 4\text{A}, R_G = 25\Omega$	--	36	--	ns
Turn-on Rise Time	$t_r$		--	27	--	
Turn-off Delay Time	$t_{\text{d}(\text{off})}$		--	79	--	
Turn-off Fall Time	$t_f$		--	29	--	
<b>Drain-Source Body Diode Characteristics</b>						
Continuous Body Diode Current	$I_S$	$T_C = 25^\circ\text{C}$	--	--	4	A
Pulsed Diode Forward Current	$I_{\text{SM}}$		--	--	12	
Reverse Diode dv/dt	$dv/dt$	$V_{\text{DS}} = 0 \dots 400\text{V}, I_{\text{SD}} \leq I_D$	--	--	15	V/ns
Body Diode Voltage	$V_{\text{SD}}$	$T_J = 25^\circ\text{C}, I_{\text{SD}} = 4\text{A}, V_{\text{GS}} = 0\text{V}$	--	0.9	1.2	V
Reverse Recovery Time	$t_{\text{rr}}$	$V_R = 560\text{V}, I_F = I_S, di_F/dt = 100\text{A}/\mu\text{s}$	--	220	--	ns
Reverse Recovery Charge	$Q_{\text{rr}}$		--	0.9	--	$\mu\text{C}$
Peak Reverse Recovery Current	$I_{\text{rrm}}$		--	8	--	A

**Notes**

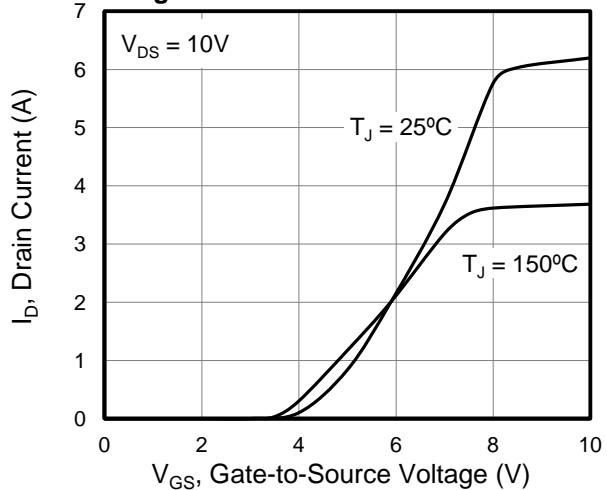
- Repetitive Rating: Pulse Width limited by maximum junction temperature
- $I_{\text{AS}} = 0.8\text{A}, V_{\text{DD}} = 50\text{V}, R_G = 25\Omega$ , Starting  $T_J = 25^\circ\text{C}$
- Pulse Test: Pulse Width  $\leq 300\mu\text{s}$ , Duty Cycle  $\leq 1\%$

**Typical Characteristics**  $T_J = 25^\circ\text{C}$ , unless otherwise noted

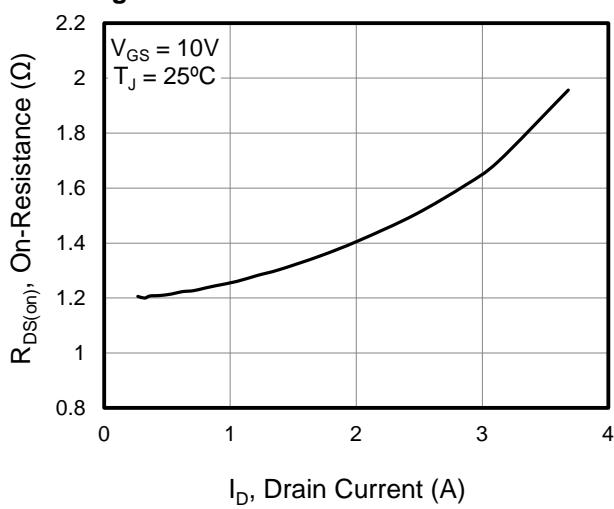
**Figure 1. Output Characteristics**



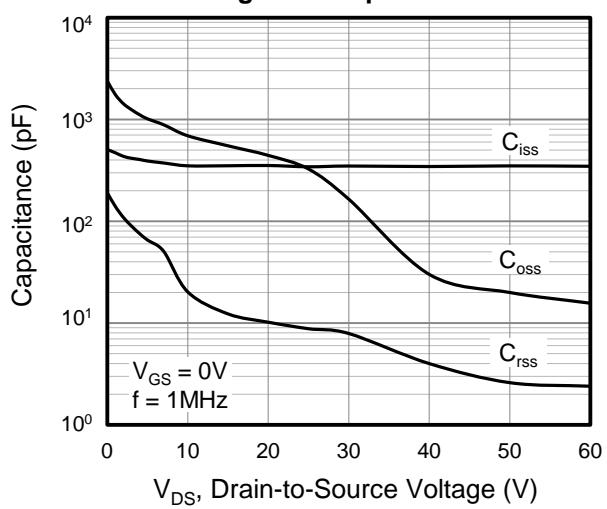
**Figure 2. Transfer Characteristics**



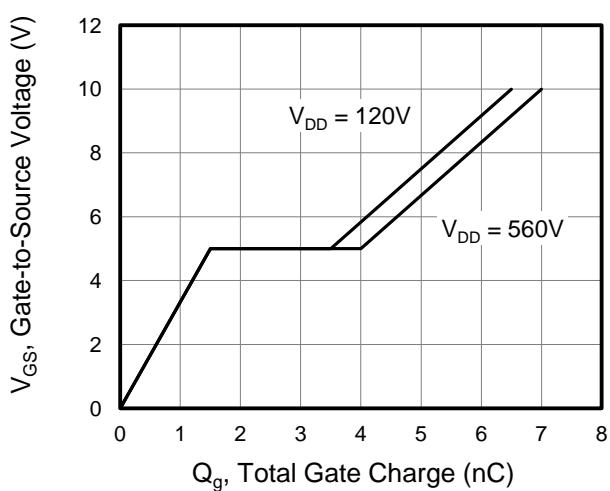
**Figure 3. On-Resistance vs. Drain Current**



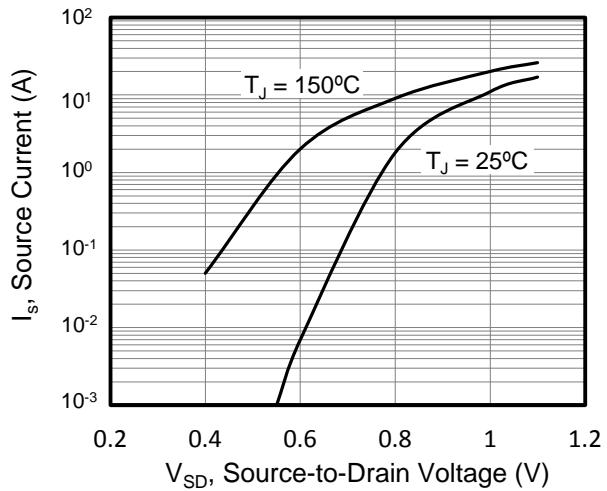
**Figure 4. Capacitance**



**Figure 5. Gate Charge**

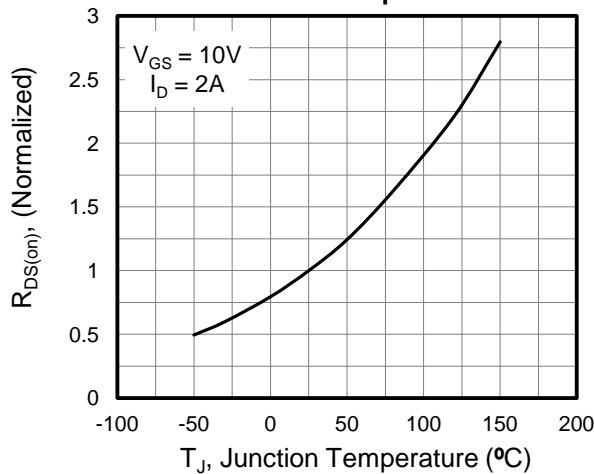


**Figure 6. Body Diode Forward Voltage**

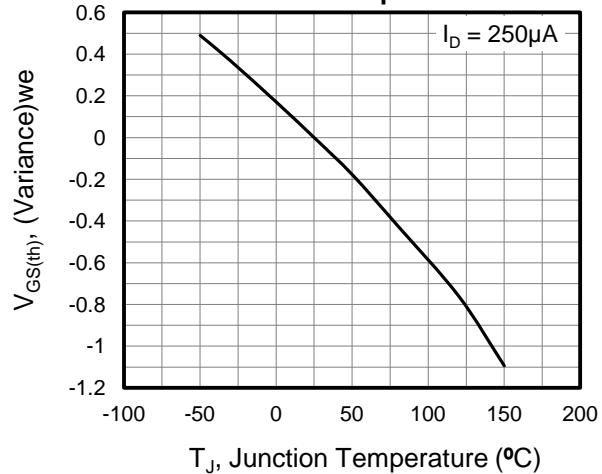


**Typical Characteristics**  $T_J = 25^\circ\text{C}$ , unless otherwise noted

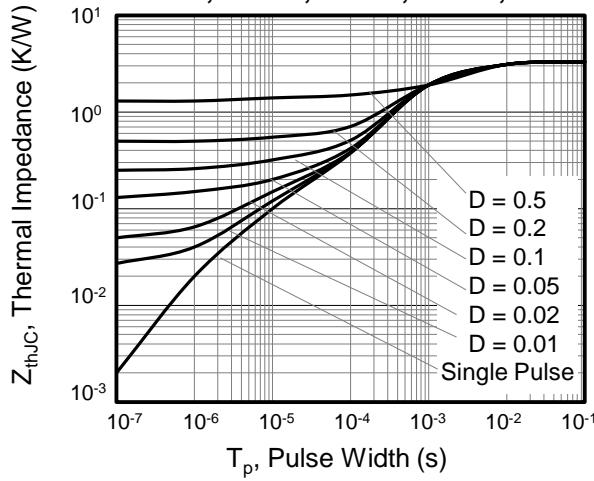
**Figure 7. On-Resistance vs.  
Junction Temperature**



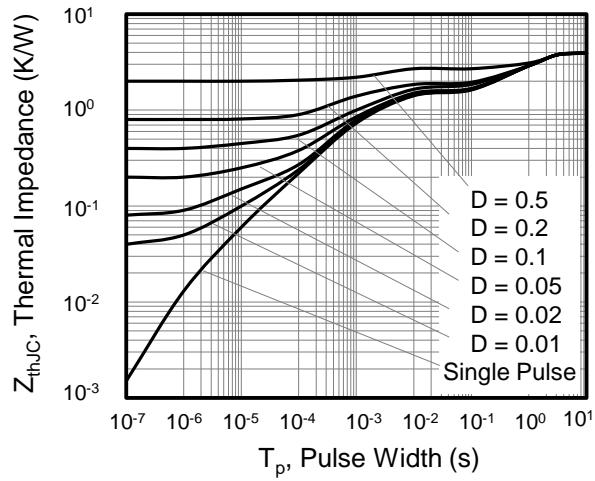
**Figure 8. Threshold Voltage vs.  
Junction Temperature**

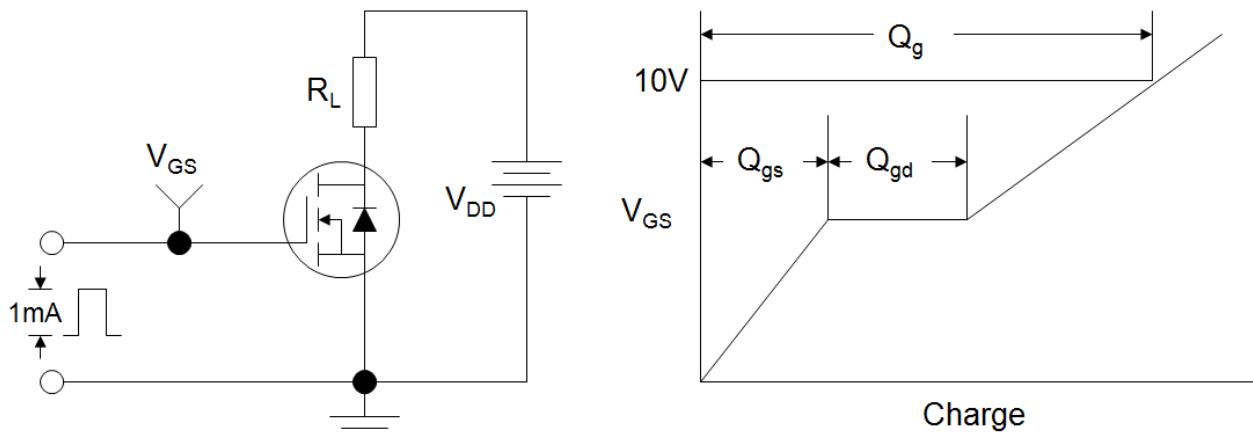
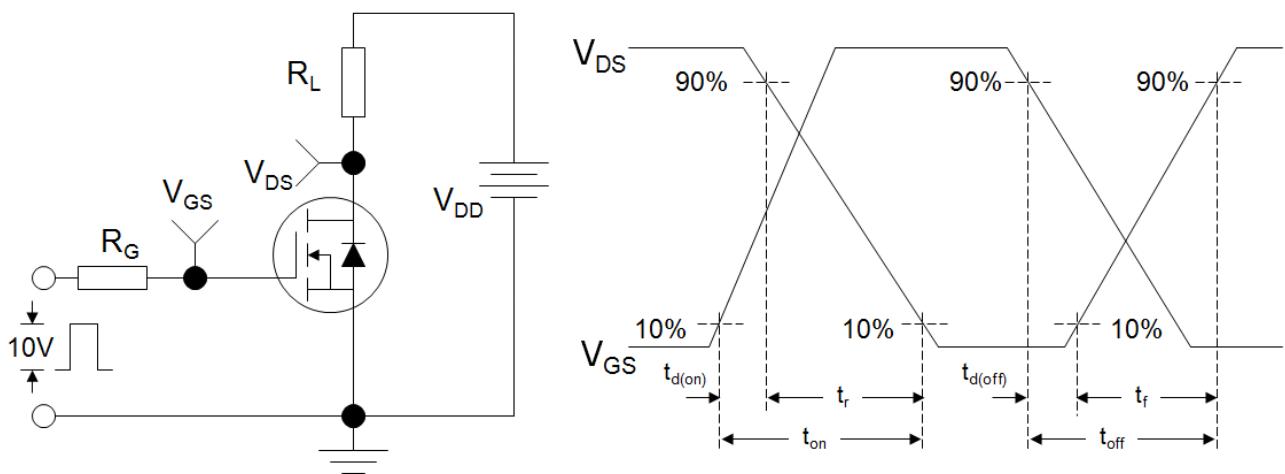
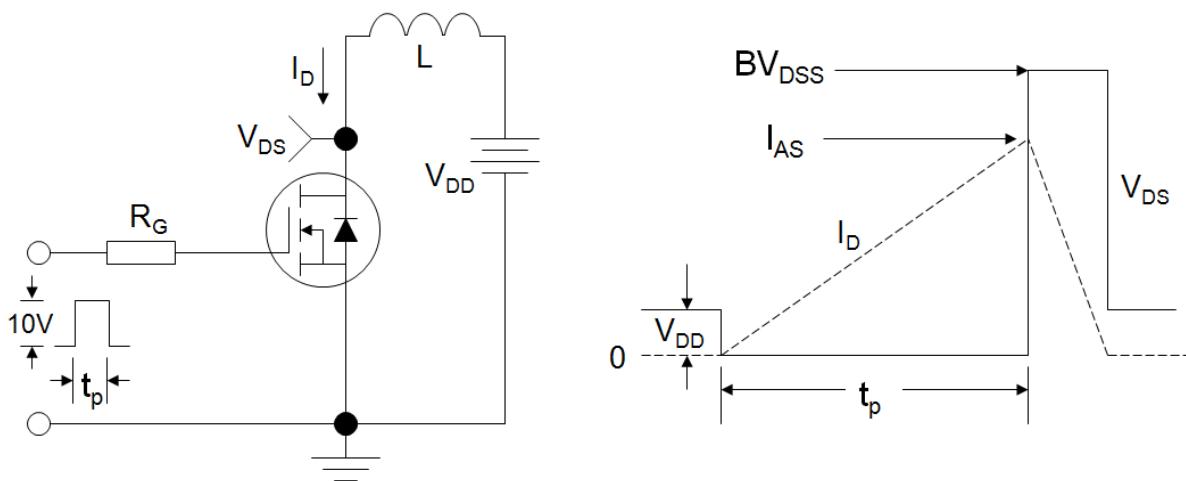


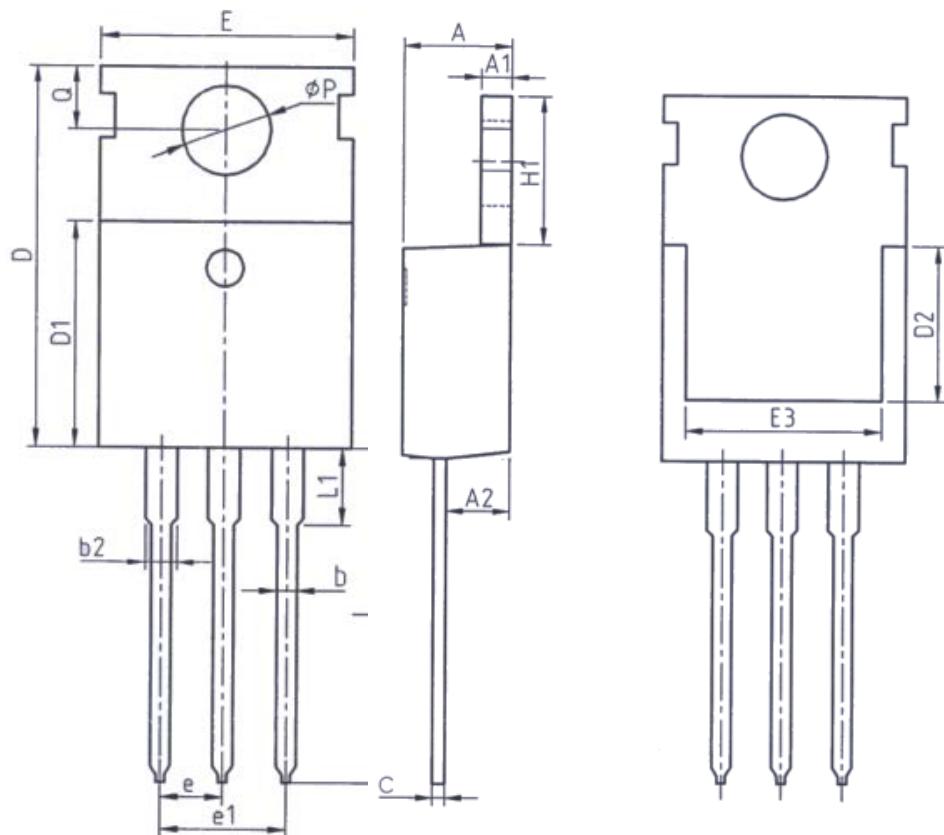
**Figure 9. Transient Thermal Impedance  
TO-220, TO-251, TO-252, TO-262, TO-263**



**Figure 10. Transient Thermal Impedance  
TO-220F**



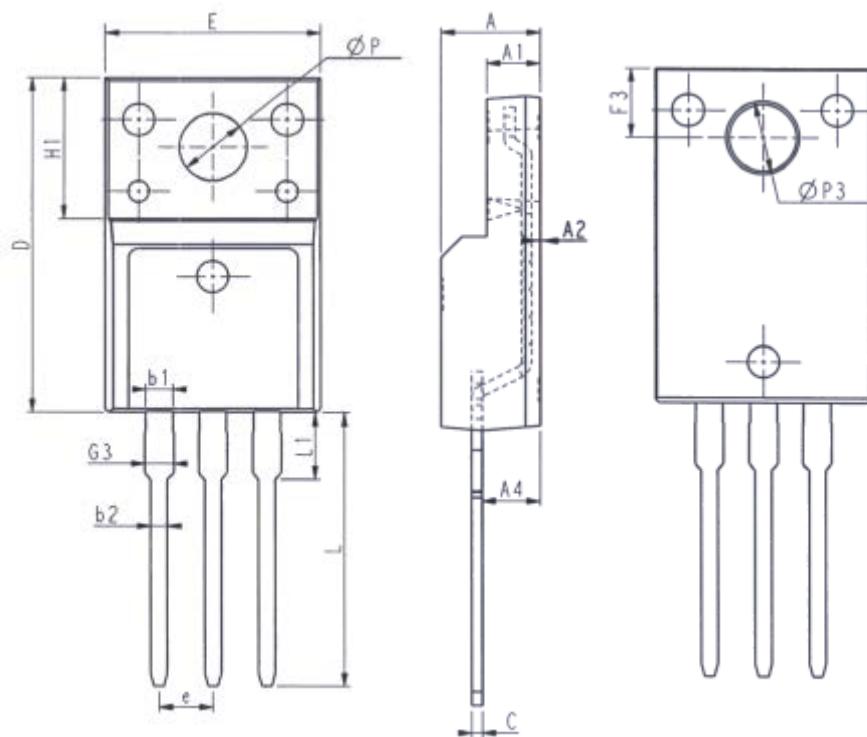
**Figure A: Gate Charge Test Circuit and Waveform**

**Figure B: Resistive Switching Test Circuit and Waveform**

**Figure C: Unclamped Inductive Switching Test Circuit and Waveform**


**TO-220**


Unit: mm		
Symbol	Min.	Max.
A	4.37	4.77
A1	1.25	1.45
A2	2.20	2.60
b	0.70	0.95
b2	1.17	1.47
c	0.40	0.65
D	15.10	16.10
D1	8.80	9.40
D2	5.50	-

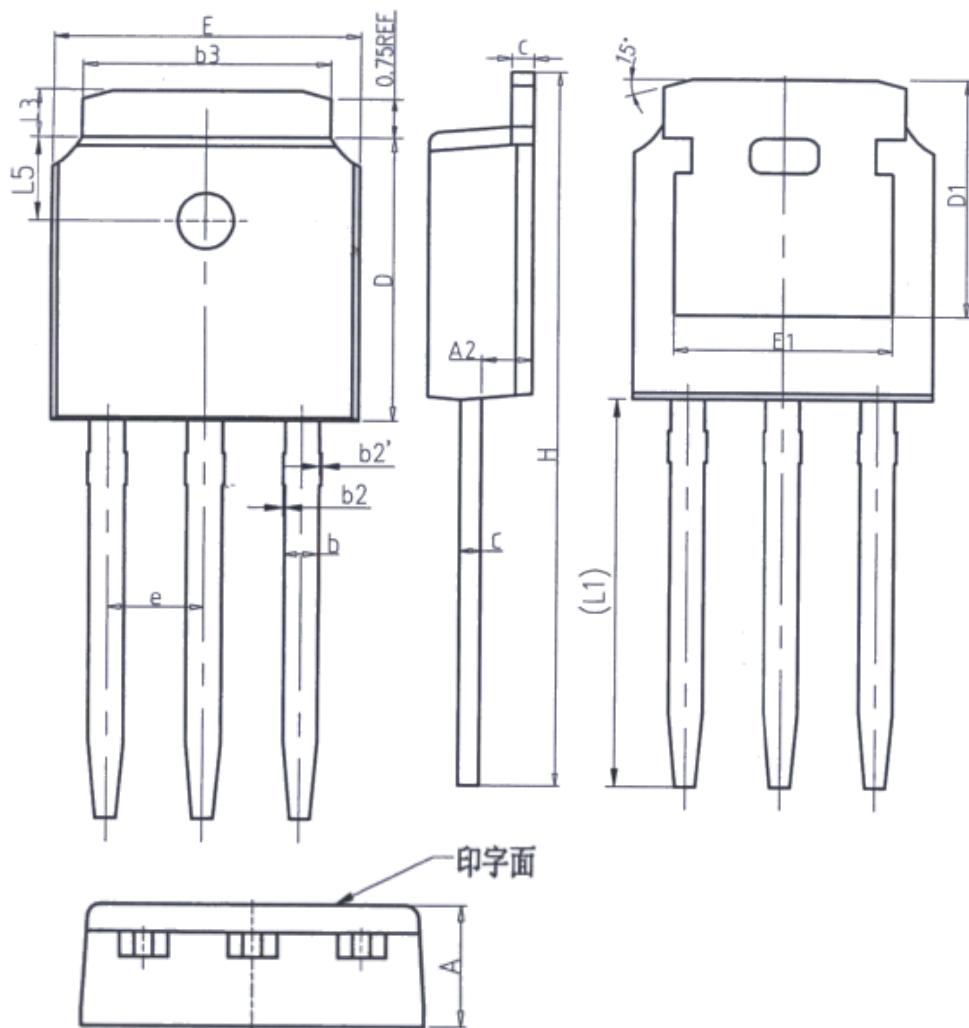
Unit: mm		
Symbol	Min.	Max.
E	9.70	10.30
E3	7.00	-
e	2.54BSC	
e1	5.08BSC	
H1	6.25	6.85
L	12.75	13.80
L1	-	3.40
P	3.40	3.80
Q	2.60	3.00

## TO-220F



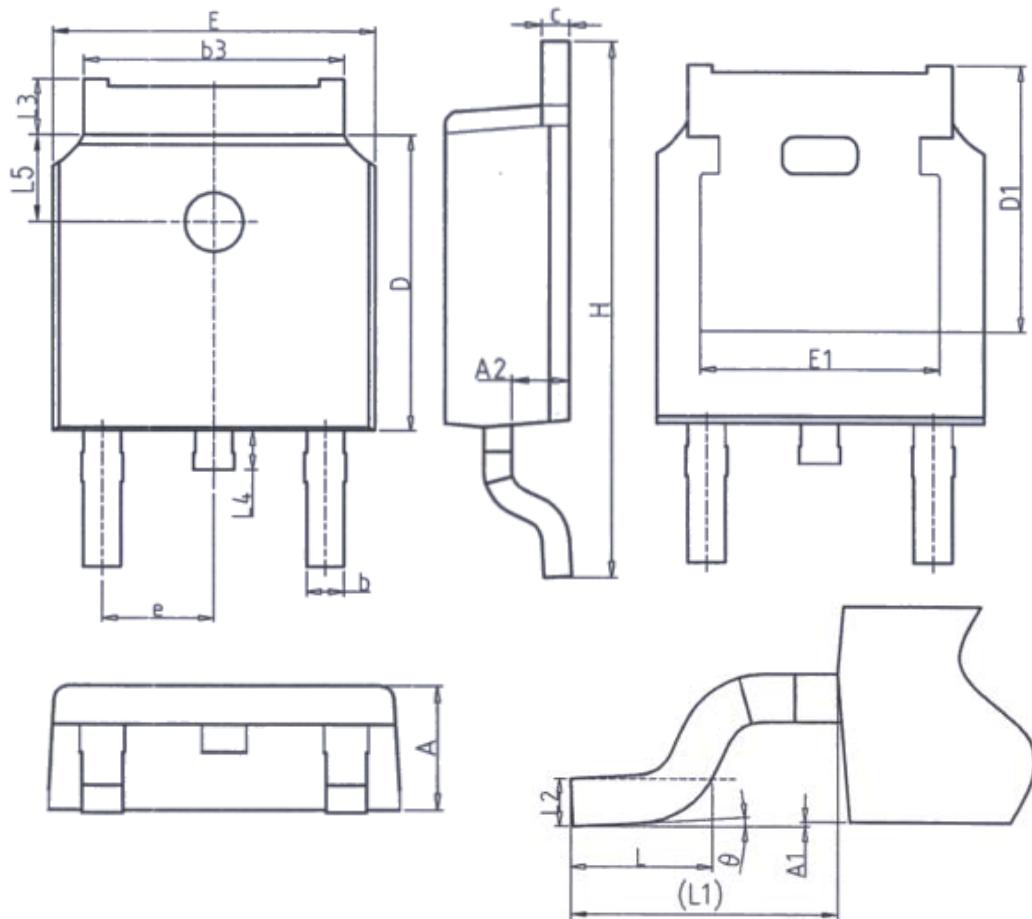
Unit: mm		
Symbol	Min.	Max.
E	9.96	10.36
A	4.50	4.90
A1	2.34	2.74
A2	0.30	0.60
A4	2.56	2.96
c	0.40	0.65
D	15.57	16.17
H1	6.70REF	
e	2.54BSC	

Unit: mm		
Symbol	Min.	Max.
L	12.68	13.28
L1	2.93	3.13
P	3.03	3.38
P3	3.15	3.65
F3	3.15	3.45
G3	1.25	1.55
b1	1.18	1.43
b2	0.70	0.95

**TO-251**


Unit: mm		
Symbol	Min.	Max.
A	2.20	2.40
A2	0.97	1.17
b	0.68	0.90
b2	0.00	0.10
b2'	0.00	0.10
b3	5.20	5.50
c	0.43	0.63
D	5.98	6.22

Unit: mm		
Symbol	Min.	Max.
D1	5.30REF	
E	6.40	6.80
E1	4.63	-
e	2.286BSC	
H	16.22	16.82
L1	9.15	9.65
L3	0.88	1.28
L5	1.65	1.95

**TO-252**


Unit: mm		
Symbol	Min.	Max.
A	2.20	2.40
A1	0.00	0.20
A2	0.97	1.17
b	0.68	0.90
b3	5.20	5.50
c	0.43	0.63
D	5.98	6.22
D1	5.30REF	
E	6.40	6.80
E1	4.63	-

Unit: mm		
Symbol	Min.	Max.
e	2.286BSC	
H	9.40	10.50
L	1.38	1.75
L1	2.90REF	
L2	0.51BSC	
L3	0.88	1.28
L4	-	1.00
L5	1.65	1.95
θ	0°	8°