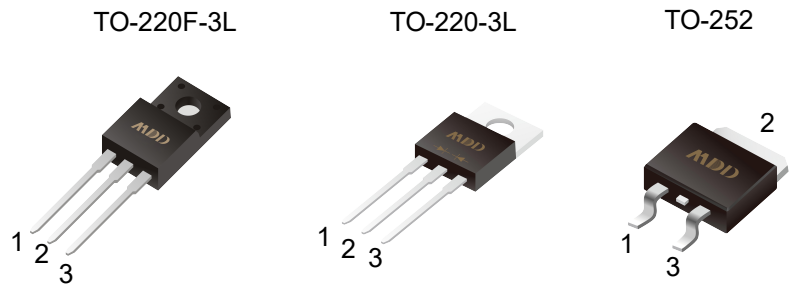


$V_{DS}$	650 V
$I_D(T_c=25^\circ C)$	2A
$R_{DS(on),max}$	5.2Ω@ $V_{GS}=10V$
$Q_{g,typ}$	10.2nC



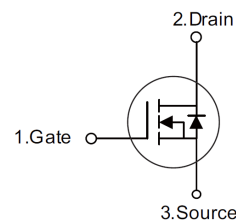
### General Features

- Ultra low gate charge
- Low reverse transfer Capacitance
- Fast switching capability
- Avalanche energy tested
- Improved dv/dt capability, high ruggedness

### Application

- High efficiency switch mode power supplies
- Electronic lamp ballasts based on half bridge
- LED power supplies

### Equivalent Circuit



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

Parameter	Symbol	Value	Unit
Drain-Source Voltage	$V_{DS}$	650	V
Gate-Source Voltage	$V_{GS}$	±30	V
Continuous Drain Current	$I_D$	2	A
Pulsed Drain Current(Note 1)	$I_{DM}$	8	A
Avalanche Energy Single Pulsed (Note 2)	$E_{AS}$	80	mJ
Continuous diode forward current	$I_S$	2	A
Diode pulse current	$I_{S,pulse}$	8	A
Peak Diode Recovery dv/dt (Note 3)	dv/dt	5	V/ns
Power Dissipation TO-220F	$P_D$	27	W
Power Dissipation TO-220/TO-252		35	W
Junction Temperature	$T_J$	150	°C
Storage Temperature	$T_{stg}$	-55 ~ 150	°C

### Thermal Characteristics

Parameter	Symbol	Value		Unit
		TO-220F	TO-220/TO-252	
Thermal resistance, Junction-to-case	$R_{\theta JC}$	4.63	3.57	°C/W
Thermal resistance, Junction-to-ambient	$R_{\theta JA}$	100	62	°C/W

- Notes:**
1. Pulse width limited by maximum junction temperature.
  2. L=10mH,  $I_{AS} = 4A$ , Starting  $T_J = 25^\circ C$ .
  3.  $I_{SD} = 2A$ ,  $di/dt \leq 100A/\mu s$ ,  $V_{DD} \leq BV_{DS}$ , Starting  $T_J = 25^\circ C$ .

**Ta = 25°C unless otherwise specified**

Symbol	Parameter	Condition	Min	Typ	Max	Unit	
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	$V_{GS}=0V, I_D=250\mu A$	650	--	--	V	
$I_{GSS}$	Gate-Source Leakage Current	Forward	$V_{GS}=30V, V_{DS}=0V$	--	--	100	nA
		Reverse	$V_{GS}=-30V, V_{DS}=0V$	--	--	-100	nA
$I_{DSS}$	Drain-Source Leakage Current	$V_{DS}=650V, V_{GS}=0V$	--	--	1	$\mu A$	
$V_{GS(TH)}$	Gate Threshold Voltage	$V_{DS}=V_{GS}, I_D=250\mu A$	2.0	--	4.0	V	
$R_{DS(ON)}$	Drain-Source On-State Resistance	$V_{GS}=10V, I_D=1A$	--	4.2	5.2	$\Omega$	

### Dynamic Electrical Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
$C_{iss}$	Input Capacitance	$V_{DS}=25V$ $V_{GS}=0V$ $f=1MHz$	--	338	--	pF
$C_{oss}$	Output Capacitance		--	36	--	pF
$C_{rss}$	Reverse Transfer Capacitance		--	3.4	--	pF
$Q_g$	Total Gate Charge	$V_{DS}=520V,$ $V_{GS}=10V,$ $I_D=2A$ (Note1,2)	--	10.2	--	nC
$Q_{gs}$	Gate Source Charge		--	2.6	--	nC
$Q_{gd}$	Gate Drain Charge		--	4.7	--	nC

### Switching Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
$t_{d(on)}$	Turn on Delay Time	$V_{DS}=325V,$ $I_D=2A,$ $R_G=10\Omega$ (Note1,2)	--	--	17.2	ns
$t_r$	Turn on Rise Time		--	--	35.6	ns
$t_{d(off)}$	Turn Off Delay Time		--	--	33.9	ns
$t_f$	Turn Off Fall Time		--	--	29	ns

### Source Drain Diode Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
$I_{SD}$	Source drain current(Body Diode)		--	--	2	A
$I_{SM}$	Pulsed Current		--	--	8	A
$V_{SD}$	Drain-Source Diode Forward Voltage	$I_S=2A, V_{GS}=0V$	--	--	1.5	V
$t_{rr}$	Body Diode Reverse Recovery Time	$V_R=400$ $I_F=2A,$ $-dI_F/dt=100A/\mu s$	--	221.8	--	ns
$Q_{rr}$	Body Diode Reverse Recovery Charge		--	0.75	--	$\mu C$

#### Notes:

- 1.Pulse test ; Pulse width $\leq 300\mu s$ , duty cycles $\leq 2\%$ .
- 2.Essentially independent of operating temperature.

### Electrical Characteristics Diagrams

Figure 1. Typical Output Characteristics

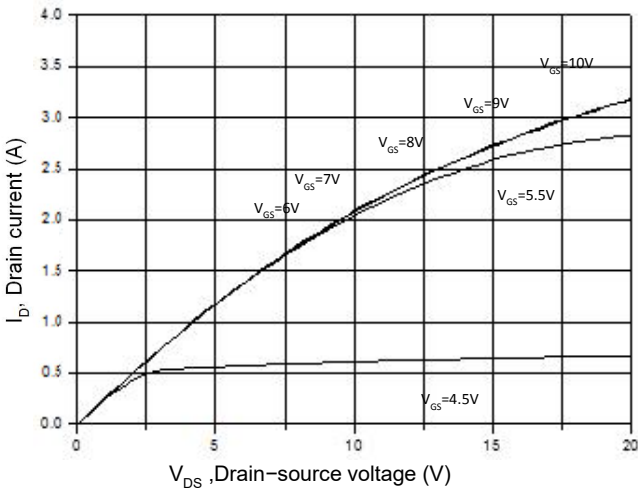


Figure 2. Transfer Characteristics

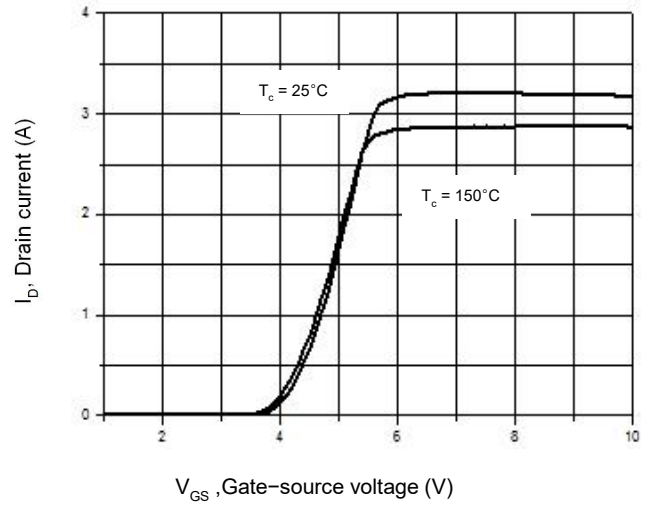


Figure 3. On-Resistance Variation vs. Drain Current

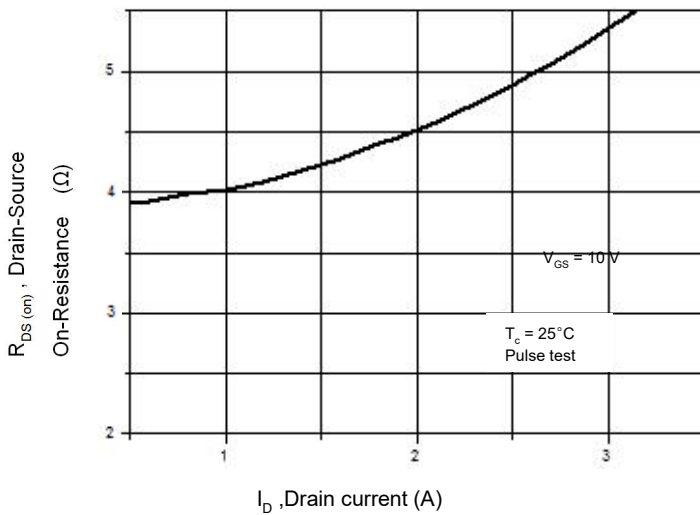


Figure 4. Threshold Voltage vs. Temperature

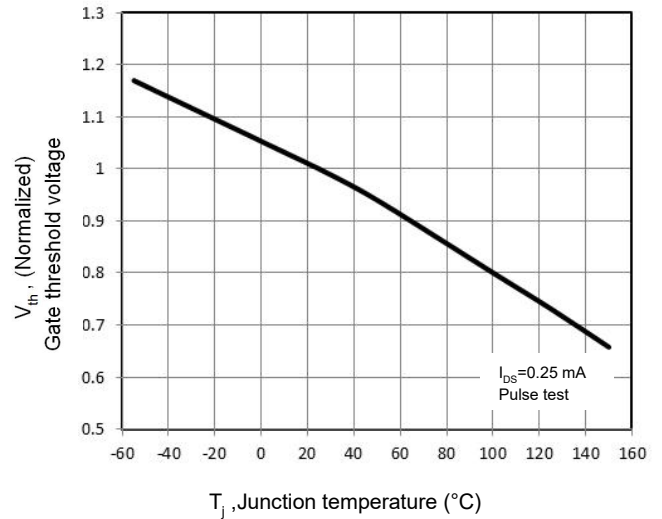


Figure 5. Breakdown Voltage vs. Temperature

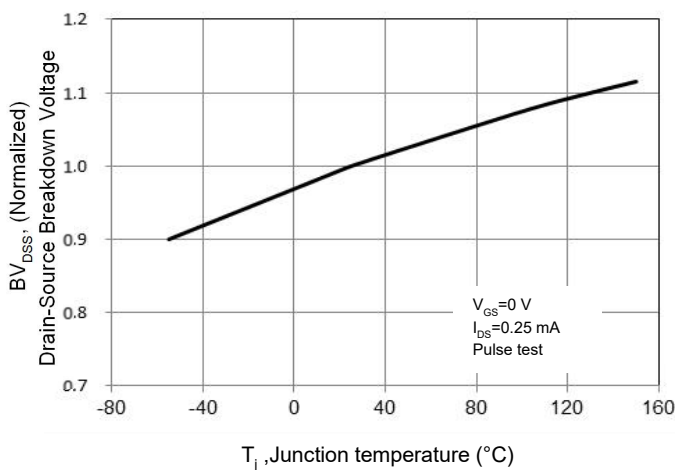


Figure 6. On-Resistance vs. Temperature

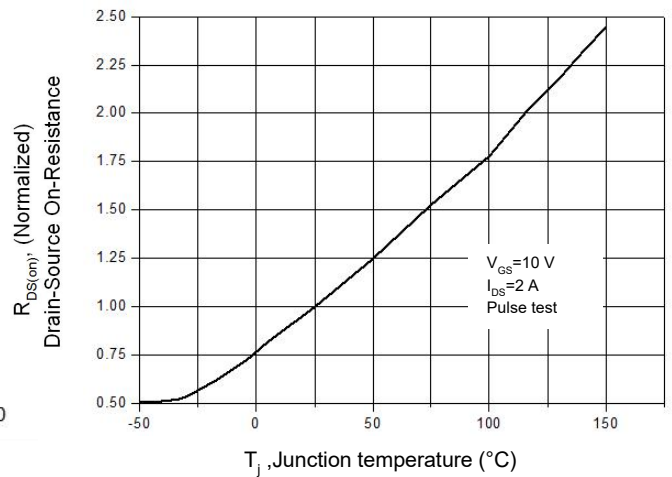


Figure 7. Capacitance Characteristics

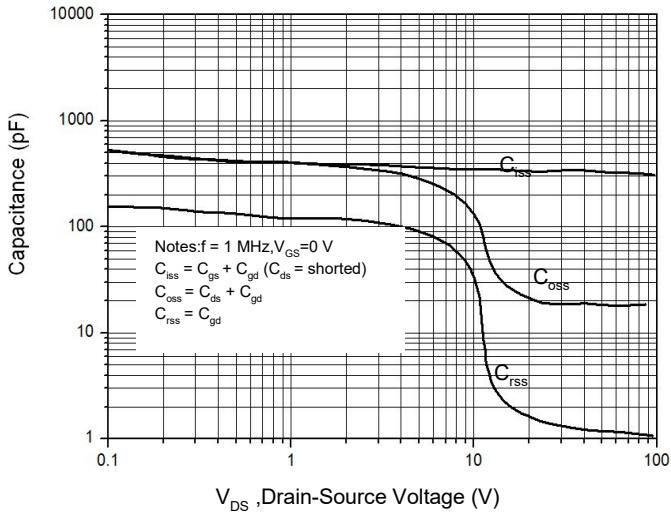


Figure 8. Gate Charge Characteristic

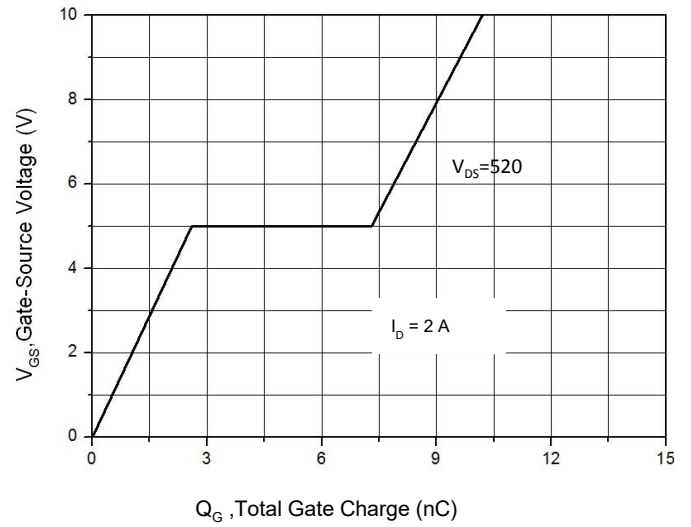


Figure 9. Maximum Safe Operating Area  
TO-220F

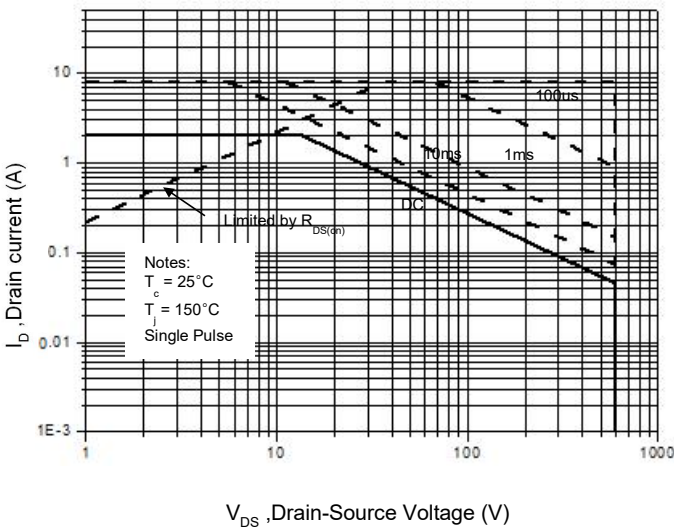


Figure 10. Maximum Safe Operating Area  
TO-220/ TO-252

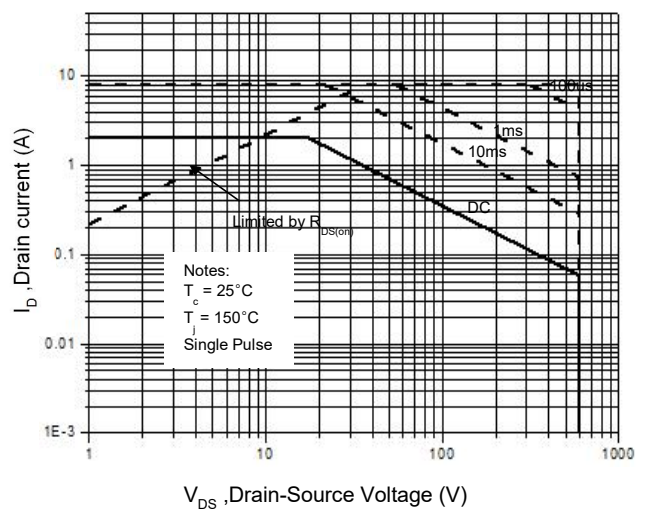


Figure 11. Power Dissipation vs. Temperature  
TO-220F

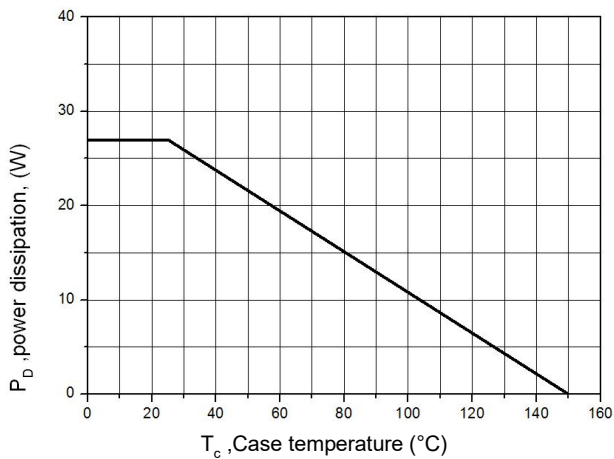


Figure 12. Power Dissipation vs. Temperature  
TO-220/ TO-252

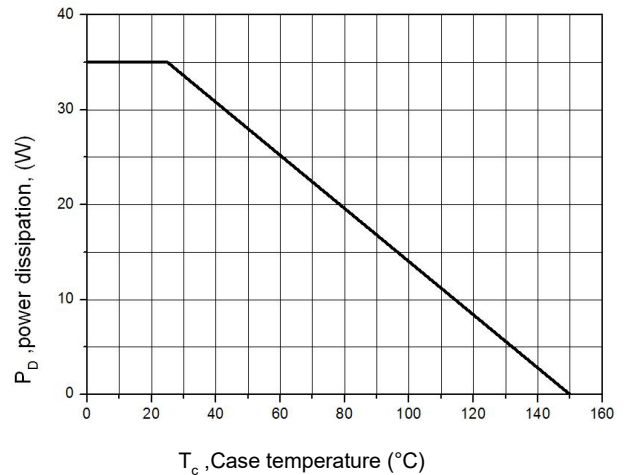


Figure 13. Continuous Drain Current vs. Temperature

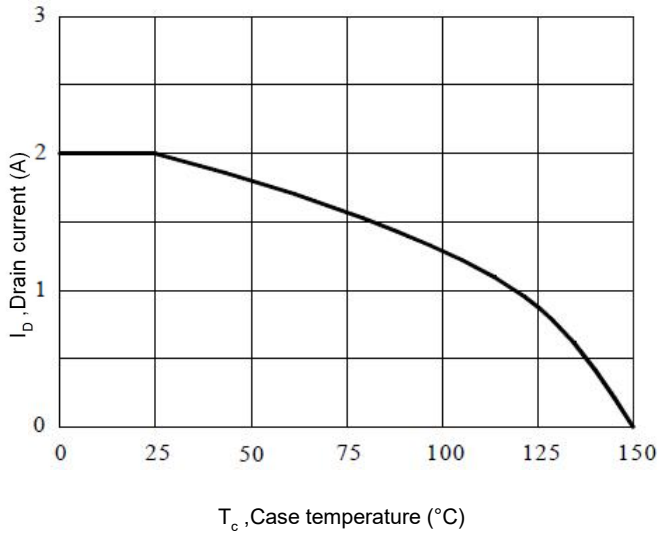


Figure 14. Body Diode Transfer Characteristics

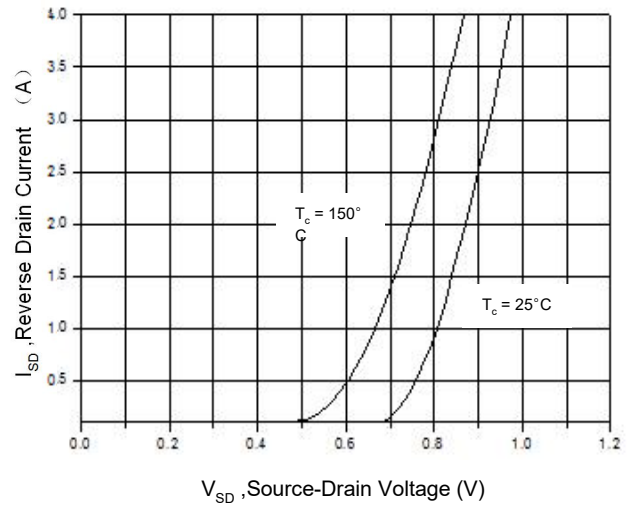


Figure 15 Transient Thermal Impedance, Junction to Case, TO-220F

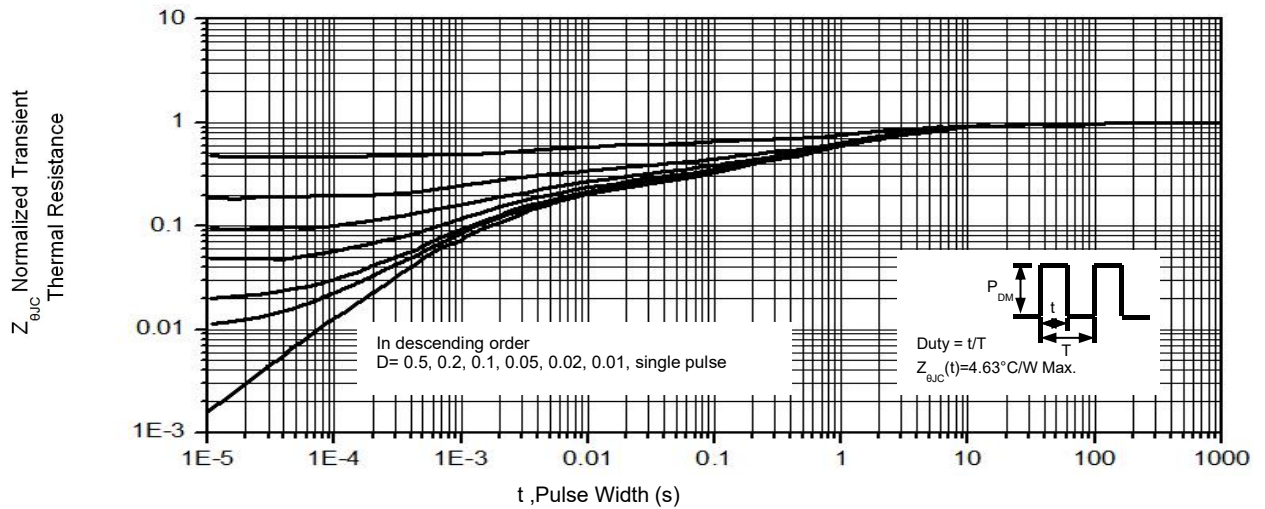
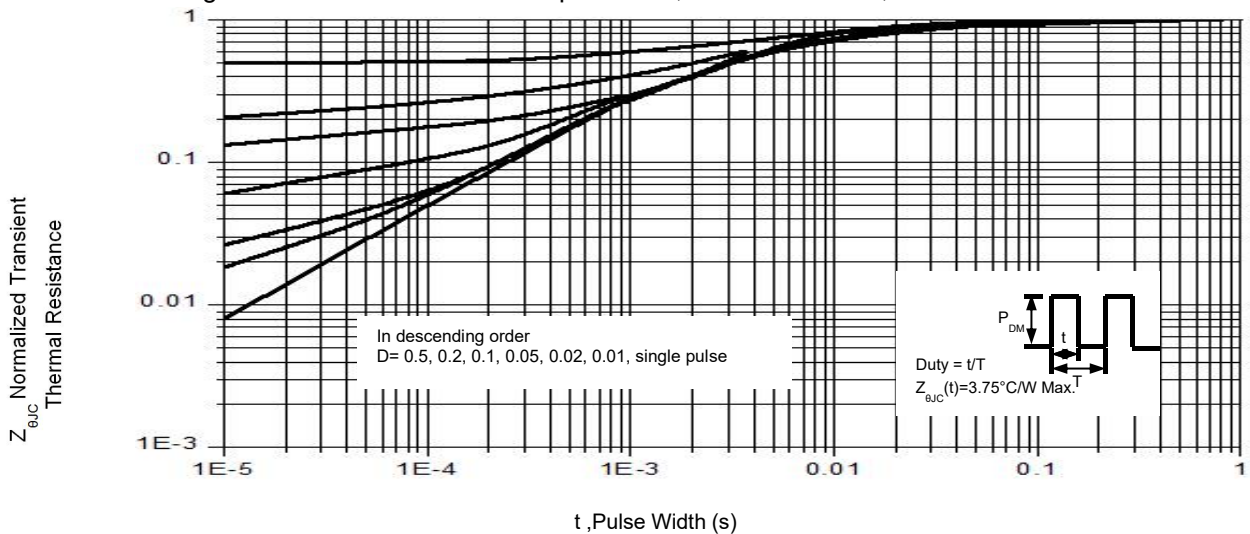
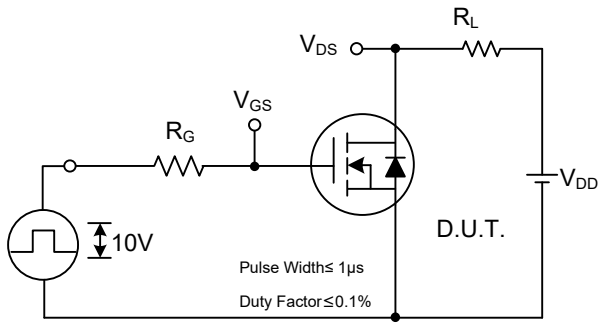
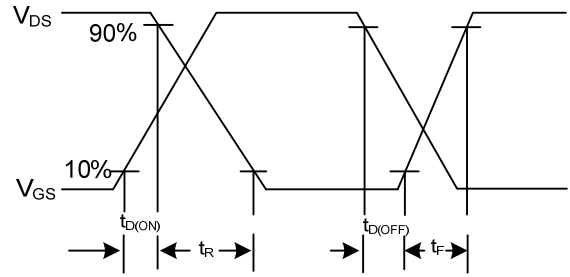


Figure 16. Transient Thermal Impedance, Junction to Case, TO-220/ TO-252

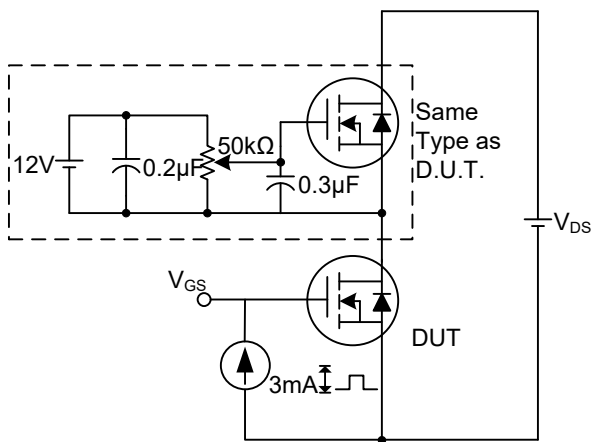




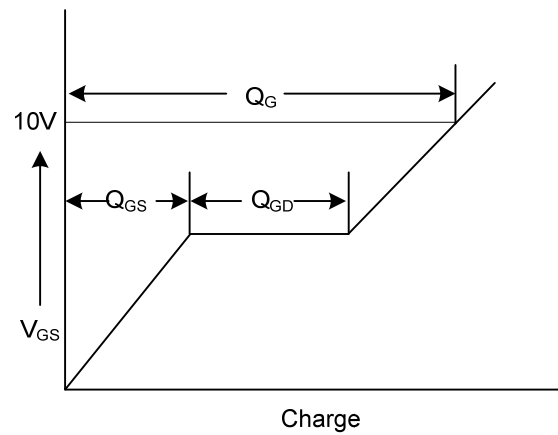
**Switching Test Circuit**



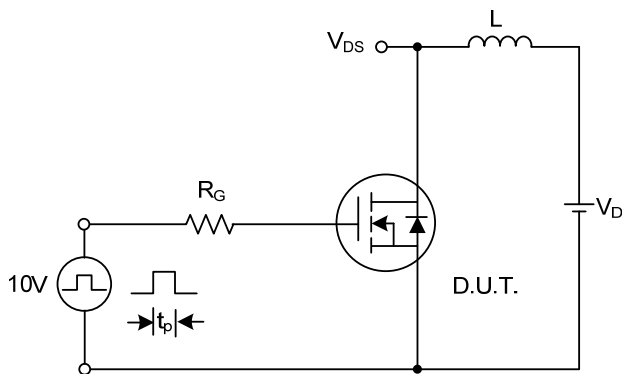
**Switching Waveforms**



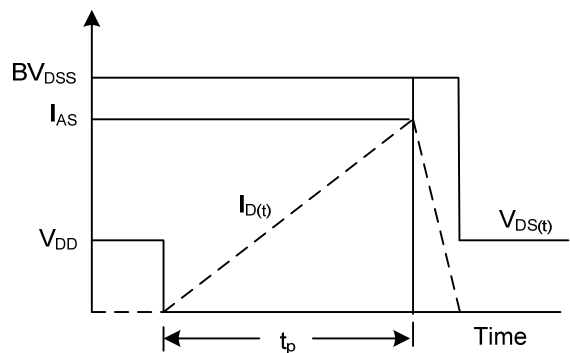
**Gate Charge Test Circuit**



**Gate Charge Waveform**



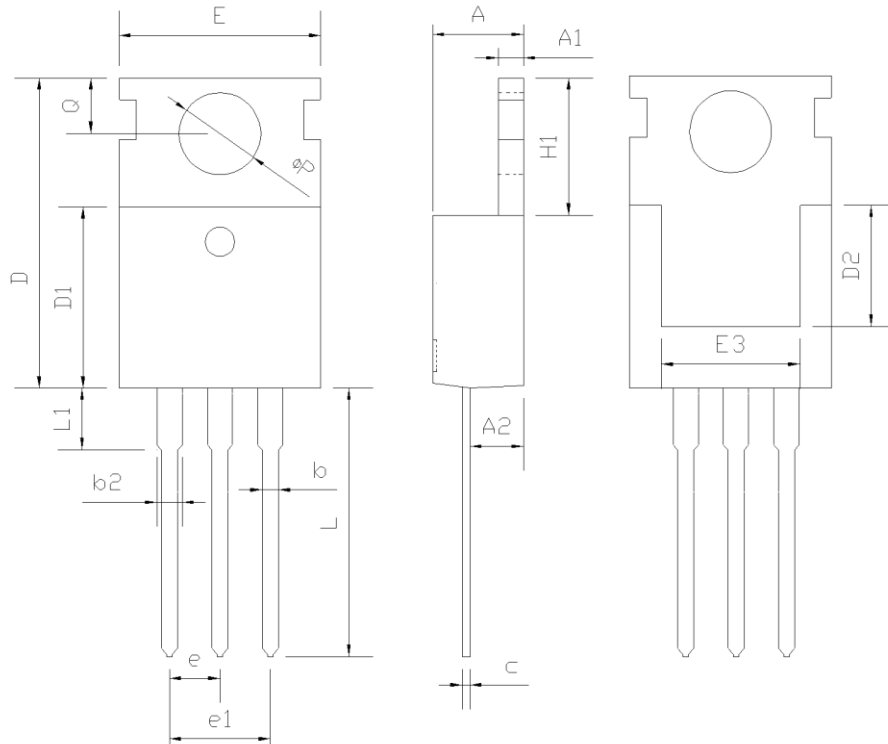
**Unclamped Inductive Switching Test Circuit**



**Unclamped Inductive Switching Waveforms**

The curve above is for reference only.

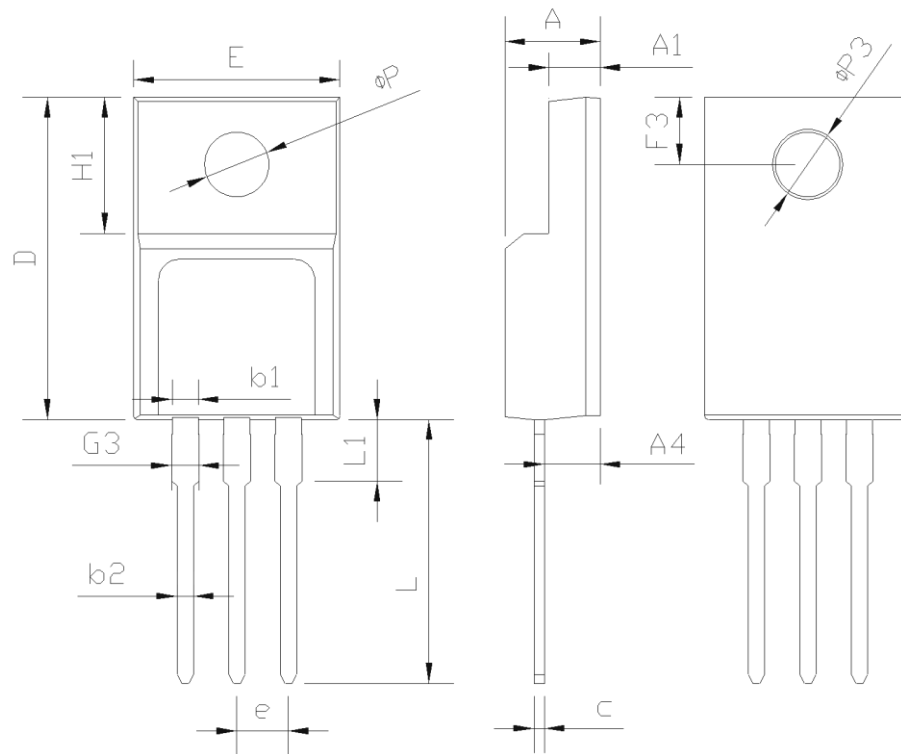
### Mechanical Dimensions for TO-220



SYMBOL	mm		
	MIN	NOM	MAX
A	4.37	4.57	4.70
A1	1.25	1.30	1.40
A2	2.20	2.40	2.60
b	0.70	0.80	0.95
b2	1.17	1.27	1.47
c	0.45	0.50	0.60
D	15.10	15.60	16.10
D1	8.80	9.10	9.40
D2	5.50	-	-
E	9.70	10.00	10.30
E3	7.00	-	-
e	2.54 BSC		
e1	5.08 BSC		
H1	6.25	6.50	6.85
L	12.75	13.50	13.80
L1	-	3.10	3.40
ΦP	3.40	3.60	3.80
Q	2.60	2.80	3.00



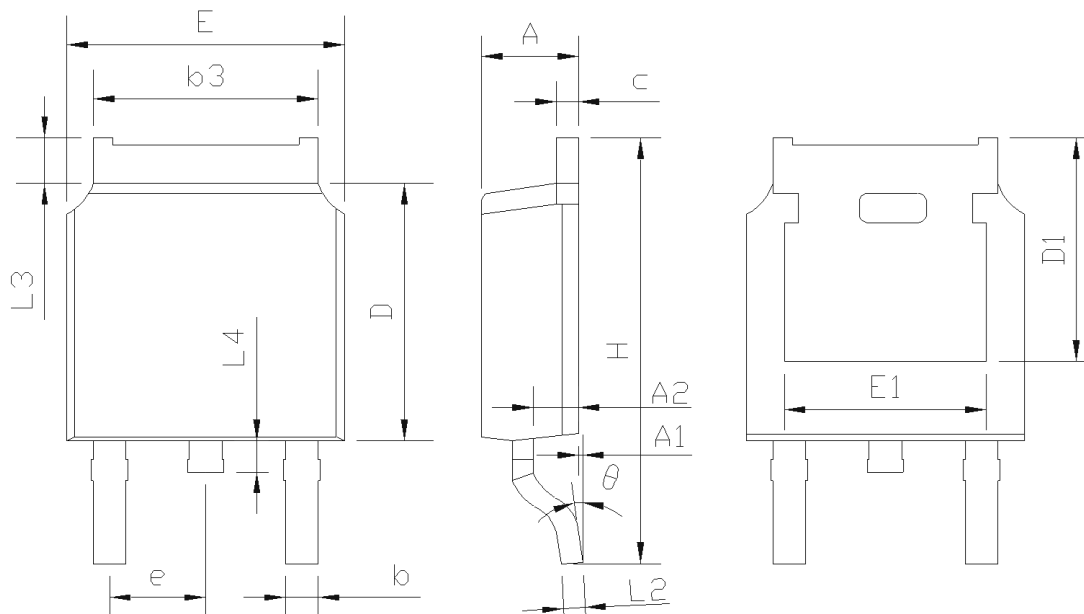
### Mechanical Dimensions for TO-220F



SYMBOL	mm		
	MIN	NOM	MAX
E	9.96	10.16	10.36
A	4.50	4.70	4.90
A1	2.34	2.54	2.74
A4	2.56	2.76	2.96
c	0.40	0.50	0.65
D	15.57	15.87	16.17
H1	6.70REF		
e	2.54BSC		
L	12.68	12.98	13.28
L1	2.88	3.03	3.18
ΦP	3.03	3.18	3.38
ΦP3	3.15	3.45	3.65
F3	3.15	3.30	3.45
G3	1.25	1.35	1.55
b1	1.18	1.28	1.43
b2	0.70	0.80	0.95



### Mechanical Dimensions for TO-252



SYMBOL	mm		
	MIN	NOM	MAX
A	2.20	2.30	2.38
A1	0.00	-	0.20
A2	0.97	1.07	1.17
b	0.68	0.78	0.90
b3	5.20	5.33	5.46
c	0.43	0.53	0.61
D	5.98	6.10	6.22
D1	5.30REF		
E	6.40	6.60	6.73
E1	4.63	-	-
e	2.286BSC		
H	9.40	10.10	10.50
L2	0.51BSC		
L3	0.88	-	1.28
L4	0.50	-	1.00
$\theta$	0°	-	8°

### Package Marking and Ordering Information

Part Number	Marking	Package	Units/Tube	Units/Reel
MDD2N65F	2N65F	TO-220F	50	
MDD2N65P	2N65P	TO-220-3L	50	
MDD2N65D	2N65D	TO-252		2500