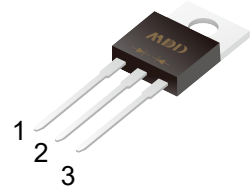
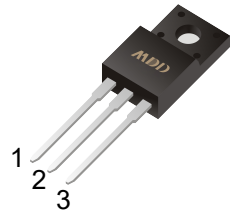


$V_{DS}$	650 V
$I_D(T_c=25^\circ\text{C})$	12A
$R_{DS(on),max}$	0.8Ω@ $V_{GS}=10V$
$Q_{g,typ}$	41.9nC

TO-220F-3L

TO-220-3L



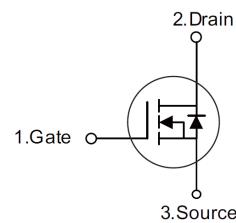
### General Features

- 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 ( $T_A=25^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Value	Unit
Drain-Source Voltage	$V_{DS}$	650	V
Gate-Source Voltage	$V_{GS}$	±30	V
Continuous Drain Current	$I_D$	12	A
Pulsed Drain Current(Note 1)	$I_{DM}$	48	A
Avalanche Energy Single Pulsed (Note 2)	$E_{AS}$	500	mJ
Continuous diode forward current	$I_S$	12	A
Diode pulse current	$I_{S,pulse}$	48	A
Peak Diode Recovery dv/dt (Note 3)	dv/dt	5	V/ns
Power Dissipation TO-220F	$P_D$	42	W
Power Dissipation TO-220		150	W
Junction Temperature	$T_J$	150	°C
Storage Temperature	$T_{stg}$	-55 ~ 150	°C

### Thermal Characteristics

Parameter	Symbol	Value		Unit
		TO-220F	TO-220	
Thermal resistance, Junction-to-case	$R_{\theta JC}$	2.98	0.83	°C/W
Thermal resistance, Junction-to-ambient	$R_{\theta JA}$	110	62.5	°C/W

- Notes:**
1. Pulse width limited by maximum junction temperature.
  2. L=10mH, IAS = 10A, Starting  $T_J=25^\circ\text{C}$ .
  3. ISD = 12A, di/dt ≤ 100A/us, VDD ≤ BVDS, Starting  $T_J=25^\circ\text{C}$ .



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

Symbol	Parameter	Condition	Min	Typ	Max	Unit	
<b>V<sub>(BR)DSS</sub></b>	Drain-Source Breakdown Voltage	<b>V<sub>GS</sub>=0V, I<sub>D</sub>=250μA</b>	650	--	--	V	
<b>I<sub>GSS</sub></b>	Gate-Source Leakage Current	Forward	<b>V<sub>GS</sub>=30V, V<sub>DS</sub>=0V</b>	--	--	100	nA
		Reverse	<b>V<sub>GS</sub>=-30V, V<sub>DS</sub>=0V</b>	--	--	-100	nA
<b>I<sub>DSS</sub></b>	Drain-Source Leakage Current	<b>V<sub>DS</sub>=650V, V<sub>GS</sub>=0V</b>	--	--	1	uA	
<b>V<sub>GS(TH)</sub></b>	Gate Threshold Voltage	<b>V<sub>DS</sub>=V<sub>GS</sub>, I<sub>D</sub>=250μA</b>	2.0	--	4.0	V	
<b>R<sub>DS(ON)</sub></b>	Drain-Source On-State Resistance	<b>V<sub>GS</sub>=10V, I<sub>D</sub>=6A</b>	--	0.64	0.8	Ω	

### Dynamic Electrical Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
<b>C<sub>iss</sub></b>	Input Capacitance	<b>V<sub>DS</sub>=25V V<sub>GS</sub>=0V f=1MHz</b>	--	2000	--	pF
<b>C<sub>oss</sub></b>	Output Capacitance		--	164	--	pF
<b>C<sub>rss</sub></b>	Reverse Transfer Capacitance		--	7.4	--	pF
<b>Q<sub>g</sub></b>	Total Gate Charge	<b>V<sub>DS</sub>=520V, V<sub>GS</sub>=10V, I<sub>D</sub>=12A (Note1,2)</b>	--	41.9	--	nC
<b>Q<sub>gs</sub></b>	Gate Source Charge		--	10.8	--	nC
<b>Q<sub>gd</sub></b>	Gate Drain Charge		--	15	--	nC

### Switching Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
<b>t<sub>d(on)</sub></b>	Turn on Delay Time	<b>V<sub>DS</sub>=325V, I<sub>D</sub>=12A, R<sub>G</sub>=10Ω (Note1,2)</b>	--	--	14.6	ns
<b>t<sub>r</sub></b>	Turn on Rise Time		--	--	37.8	ns
<b>t<sub>d(off)</sub></b>	Turn Off Delay Time		--	--	69.3	ns
<b>t<sub>f</sub></b>	Turn Off Fall Time		--	--	15.8	ns

### Source Drain Diode Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
<b>I<sub>SD</sub></b>	Source drain current(Body Diode)		--	--	12	A
<b>I<sub>SM</sub></b>	Pulsed Current		--	--	48	A
<b>V<sub>SD</sub></b>	Drain-Source Diode Forward Voltage	<b>I<sub>S</sub>=12A, V<sub>GS</sub>=0V</b>	--	--	1.5	v
<b>t<sub>rr</sub></b>	Body Diode Reverse Recovery Time	<b>V<sub>R</sub>=325 I<sub>F</sub>=12A, -dI<sub>F</sub>/dt =100A/μs</b>	--	450.4	--	ns
<b>Q<sub>rr</sub></b>	Body Diode Reverse Recovery Charge		--	4.75	--	uC

#### Notes:

- 1.Pulse test ; Pulse width≤300us, duty cycles≤2%.
- 2.Essentially independent of operating temperature.



### Electrical Characteristics Diagrams

Figure 1. Typical Output Characteristics

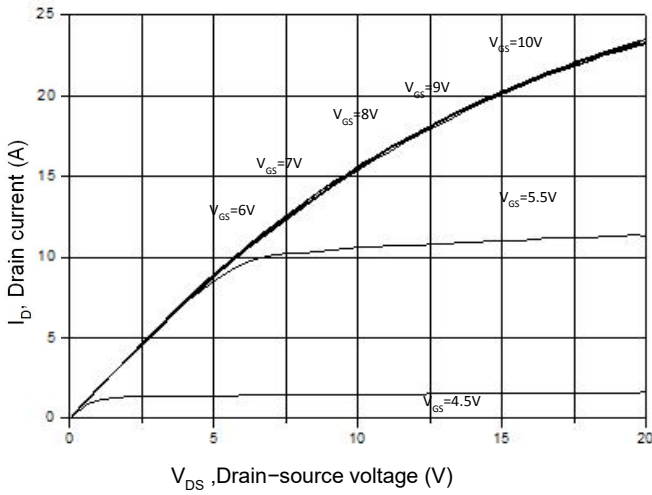


Figure 2. Transfer Characteristics

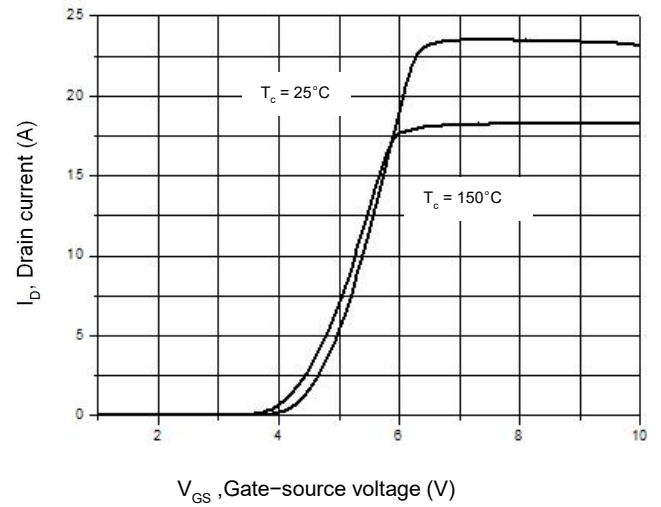


Figure 3. On-Resistance Variation vs. Drain Current

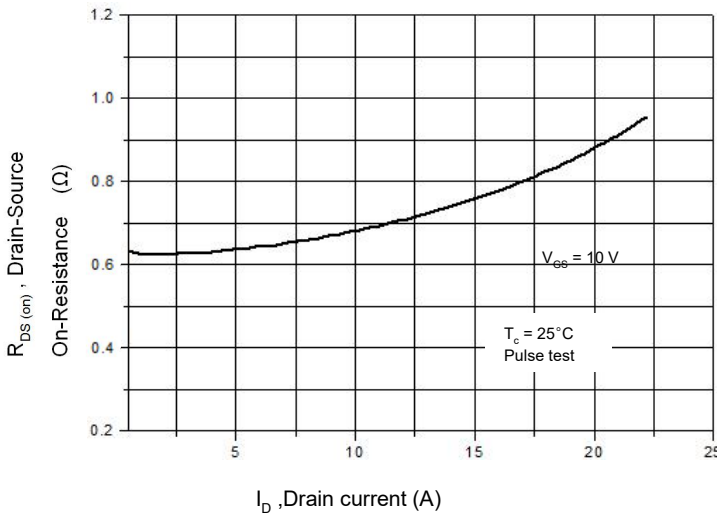


Figure 4. Threshold Voltage vs. Temperature

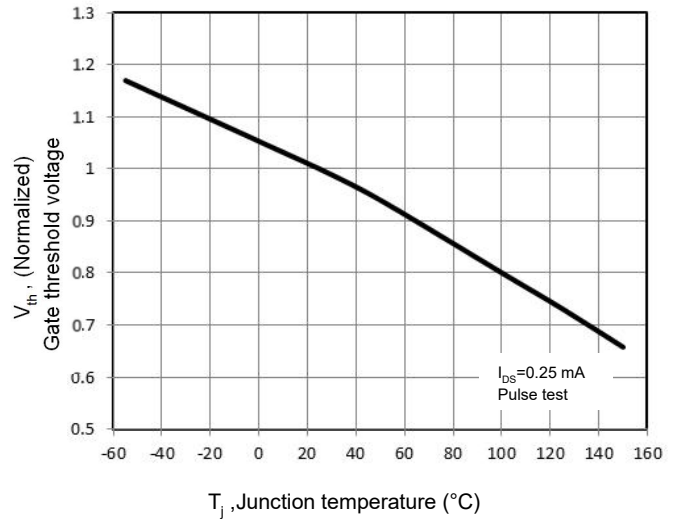


Figure 5. Breakdown Voltage vs. Temperature

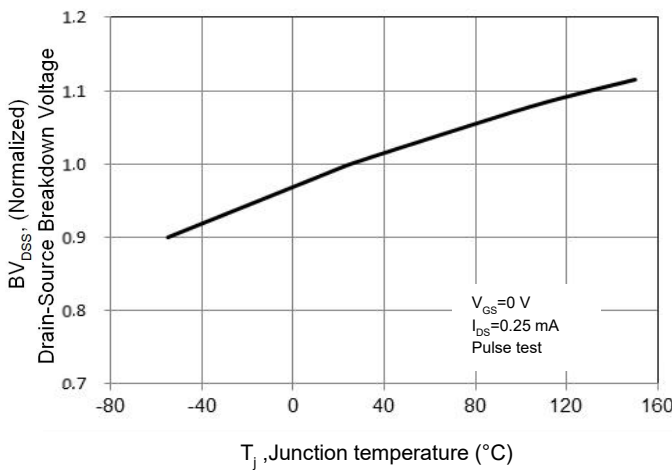
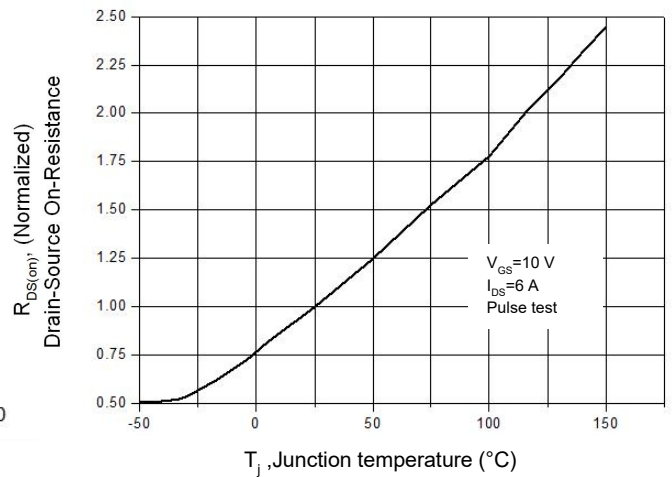


Figure 6. On-Resistance vs. Temperature





# MDD12N65F/MDD12N65P

## 650V N-Channel Enhancement Mode MOSFET

Figure 7. Capacitance Characteristics

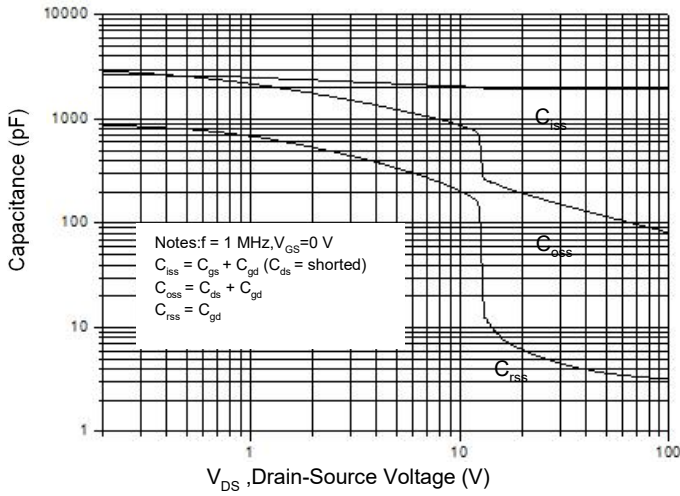


Figure 9. Maximum Safe Operating Area  
TO-220F

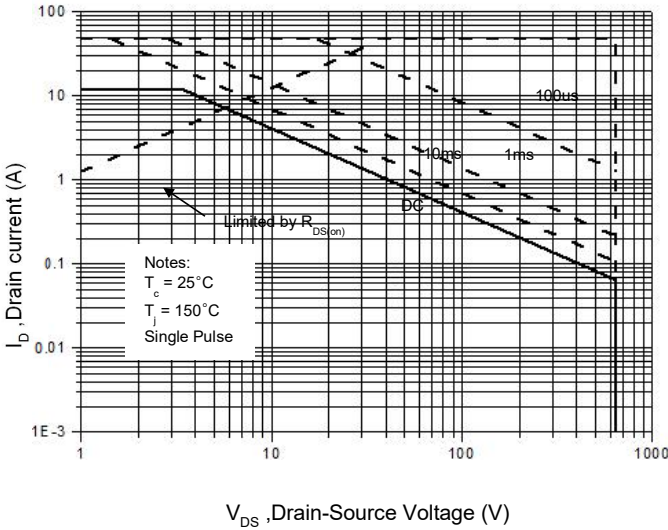


Figure 11. Power Dissipation vs. Temperature  
TO-220F

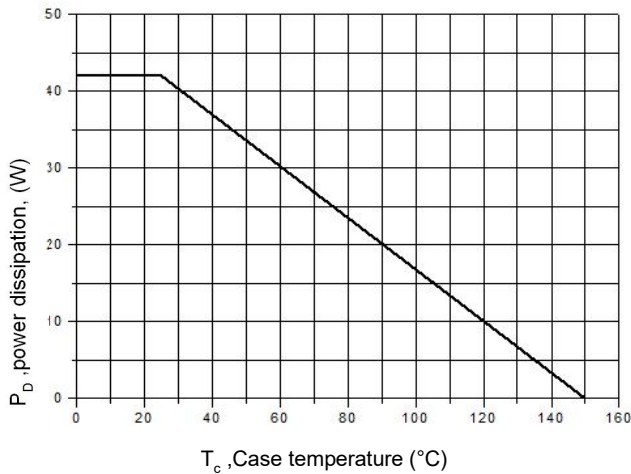


Figure 8. Gate Charge Characteristics

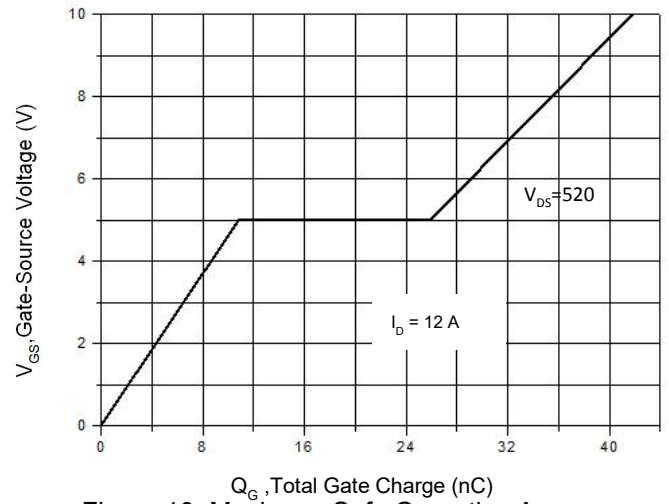


Figure 10. Maximum Safe Operating Area  
TO-220

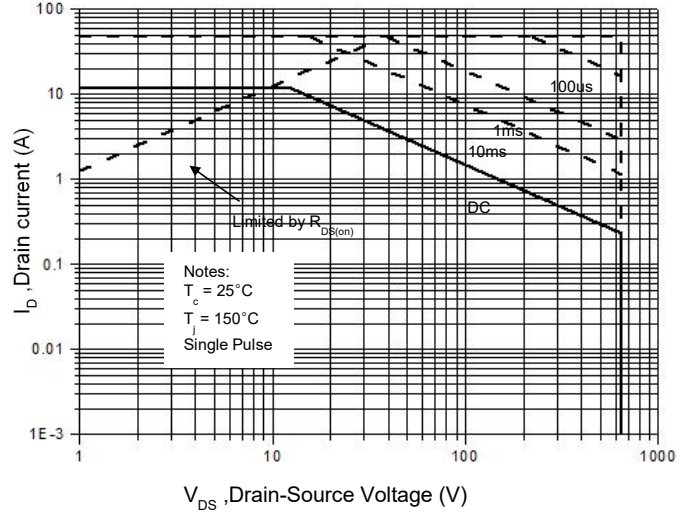


Figure 12. Power Dissipation vs. Temperature  
TO-220

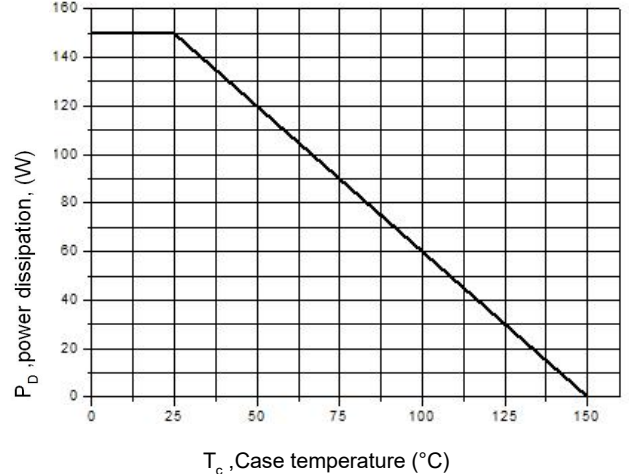


Figure 13. Continuous Drain Current vs. Temperature

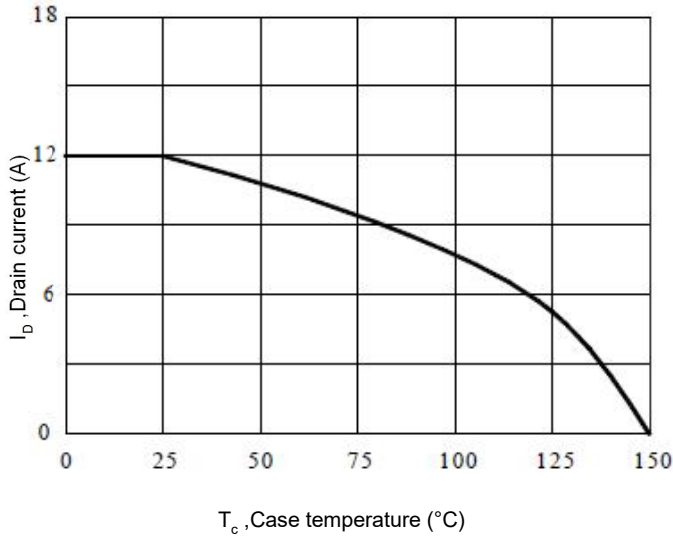


Figure 14. Body Diode Transfer Characteristics

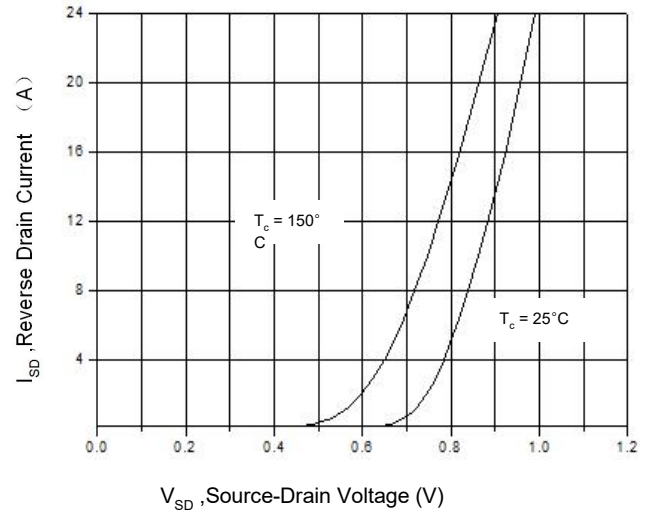


Figure 15 Transient Thermal Impedance, Junction to Case, TO-220F

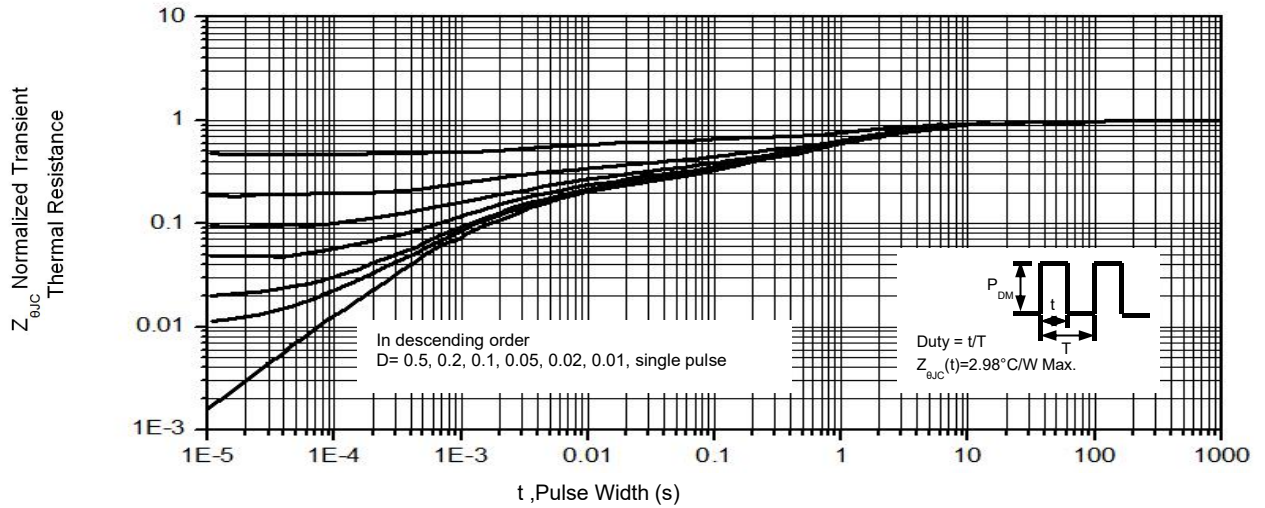
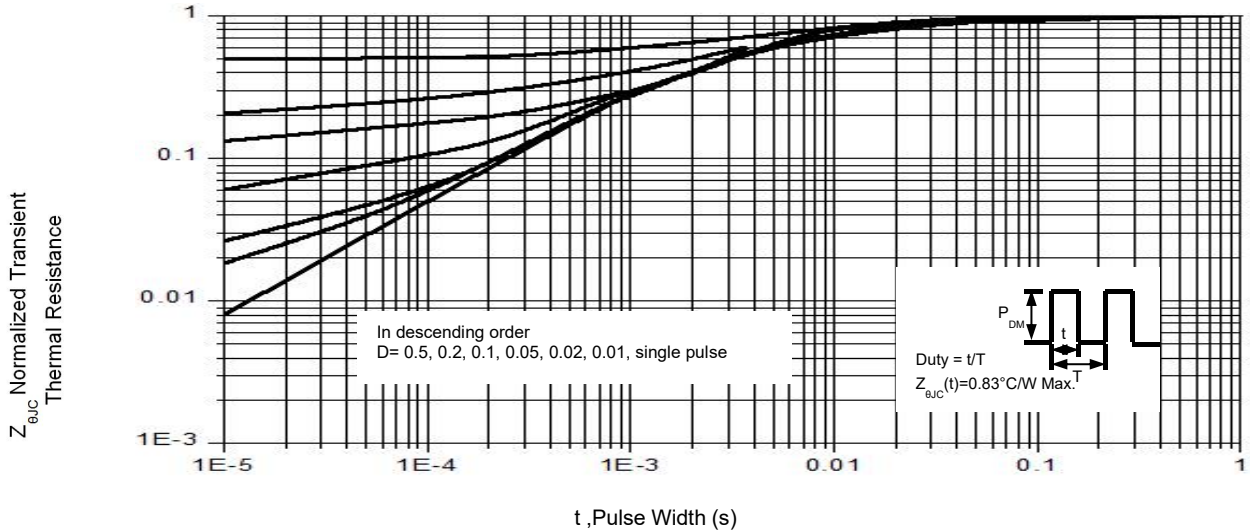
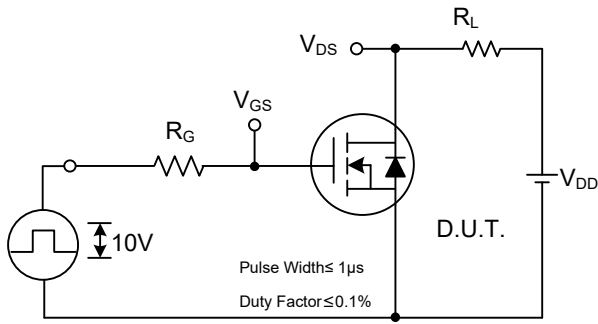
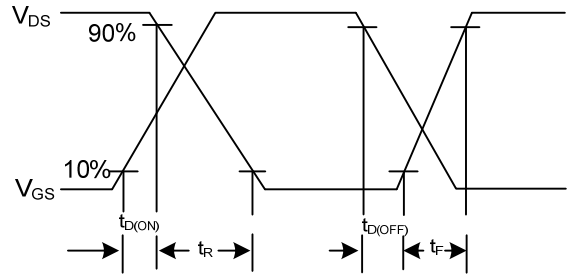


Figure 16. Transient Thermal Impedance, Junction to Case, TO-220

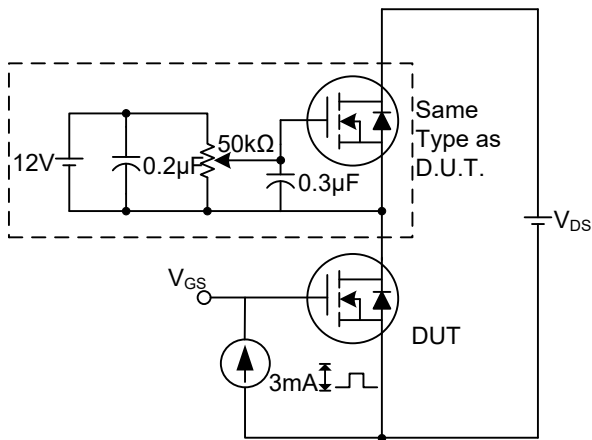




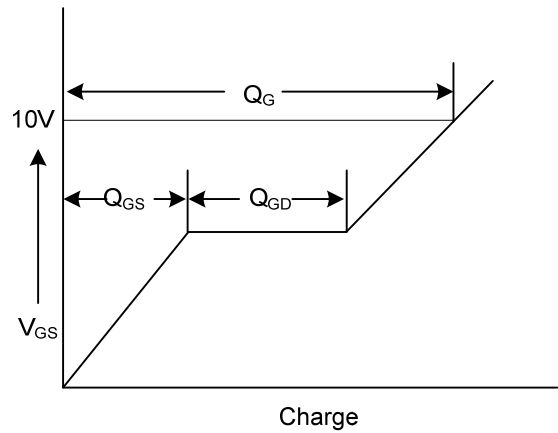
**Switching Test Circuit**



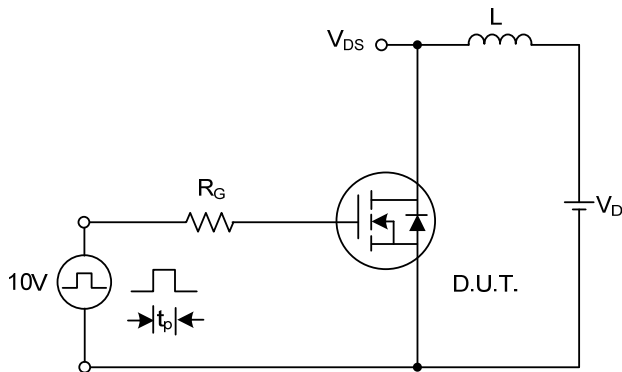
**Switching Waveforms**



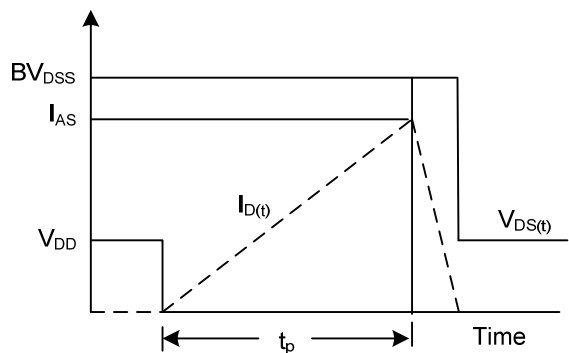
**Gate Charge Test Circuit**



**Gate Charge Waveform**



**Unclamped Inductive Switching Test Circuit**

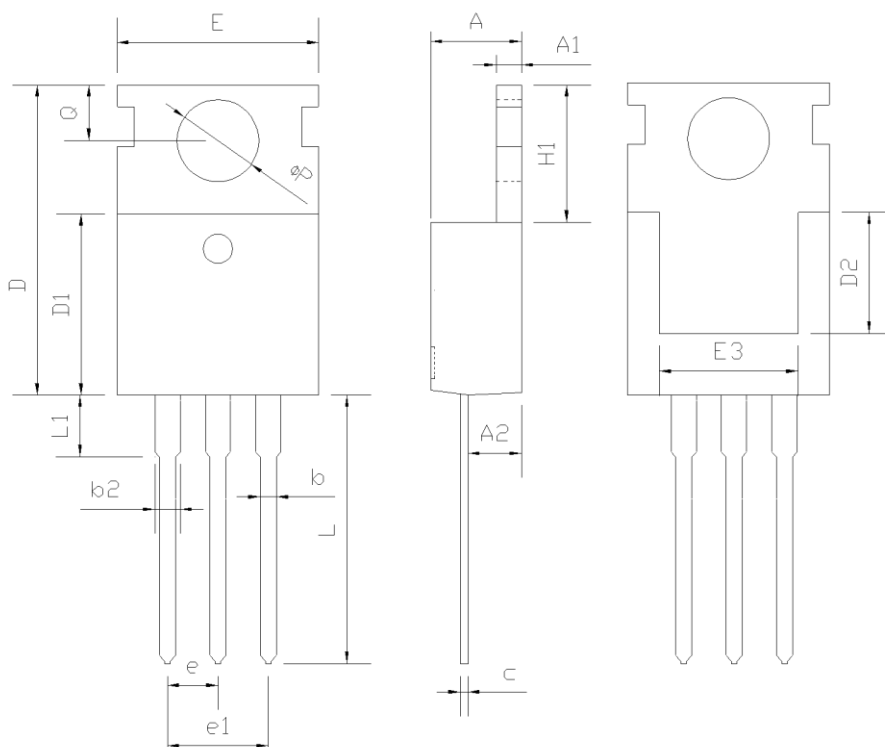


**Unclamped Inductive Switching Waveforms**

The curve above is for reference only.

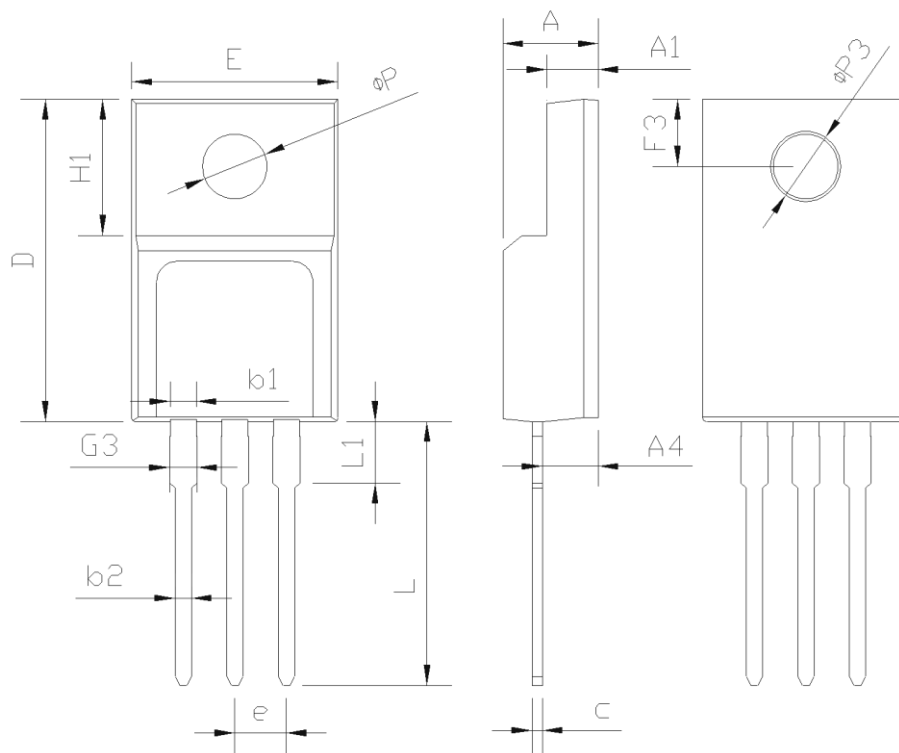


### Mechanical Dimensions for TO-220-3L



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-3L



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

### Package Marking and Ordering Information

Part Number	Marking	Package	Units/Tube	Units/Reel
MDD12N65F	12N65F	TO-220F	50	
MDD12N65P	12N65P	TO-220-3L	50	