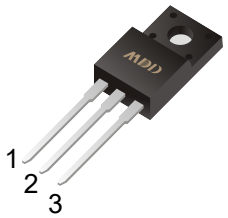
MDD4N65F/MDD4N65P/MDD4N65D

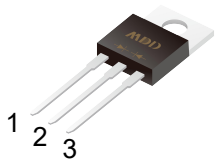
650V N-Channel Enhancement Mode MOSFET

V_{DS}	650 V
$I_{D(Tc=25℃)}$	4A
$R_{DS(on),max}$	2.8Ω@V_{GS}=10V
$Q_{g,typ}$	12nC

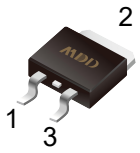
TO-220F-3L



TO-220-3L



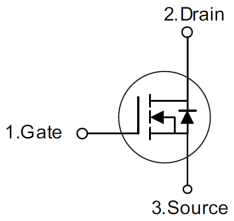
TO-252



General Features

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

Equivalent Circuit



Application

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

Absolute Maximum Ratings (T_A=25℃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	4	A
Pulsed Drain Current(Note 1)	I_{DM}	16	A
Avalanche Energy Single Pulsed (Note 2)	E_{AS}	198	mJ
Continuous diode forward current	I_S	4	A
Diode pulse current	$I_{S,pulse}$	16	A
Peak Diode Recovery dv/dt (Note 3)	dv/dt	5	V/ns
Power Dissipation TO-220F	P_D	32	W
Power Dissipation TO-220/TO-252		77	W
Junction Temperature	T_J	150	℃
Storage Temperature	T_{stg}	-55 ~150	℃

Thermal Characteristics

Parameter	Symbol	Value		Unit
		TO-220F	TO-220/TO-252	
Thermal resistance, Junction-to-case	$R_{\theta JC}$	3.8	1.62	°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 = 6.3A, Starting Tj= 25°C.
3. ISD = 4A, di/dt≤100A/us, VDD≤BVDS, Starting Tj= 25°C.

Ta = 25℃ unless otherwise specified

Symbol	Parameter		Condition	Min	Typ	Max	Unit
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage		V_{GS}=0V, I_D=250μA	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	uA
$V_{GS(TH)}$	Gate Threshold Voltage		V_{DS}=VGS, I_D=250μA	2.0	--	4.0	V
$R_{DS(ON)}$	Drain-Source On-State Resistance		V_{GS}=10V, I_D=2A	--	2.5	2.8	Ω

Dynamic Electrical Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
C_{iss}	Input Capacitance	V_{DS}=25V V_{GS}=0V f=1MHz	--	600		pF
C_{oss}	Output Capacitance		--	55		pF
C_{rss}	Reverse Transfer Capacitance		--	3.2		pF
Q_g	Total Gate Charge	V_{DS}=520V, V_{GS}=10V, I_D=4A (Note1,2)	--	12	--	nC
Q_{gs}	Gate Source Charge		--	3.2	--	nC
Q_{gd}	Gate Drain Charge		--	5.1	--	nC

Switching Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
$t_{d(on)}$	Turn on Delay Time	V_{DS}=325V, I_D=4A, R_G=10Ω (Note1,2)	--	--	12	ns
t_r	Turn on Rise Time		--	--	31	ns
$t_{d(off)}$	Turn Off Delay Time		--	--	42	ns
t_f	Turn Off Fall Time		--	--	15	ns

Source Drain Diode Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
I_{SD}	Source drain current(Body Diode)		--	--	4	A
I_{SM}	Pulsed Current		--	--	16	A
V_{SD}	Drain-Source Diode Forward Voltage	I_S=4A, V_{GS}=0V	--	0.8	1.5	V
t_{rr}	Body Diode Reverse Recovery Time	V_R=400 I_F=4A, -di/dt =100A/μs	--	282	--	ns
Q_{rr}	Body Diode Reverse Recovery Charge		--	1.4	--	uC

Notes:

1.Pulse test ; Pulse width≤300us, duty cycle≤2%.

2.Essentially independent of operating temperature.

Electrical Characteristics Diagrams

Figure 1. Typical Output Characteristics

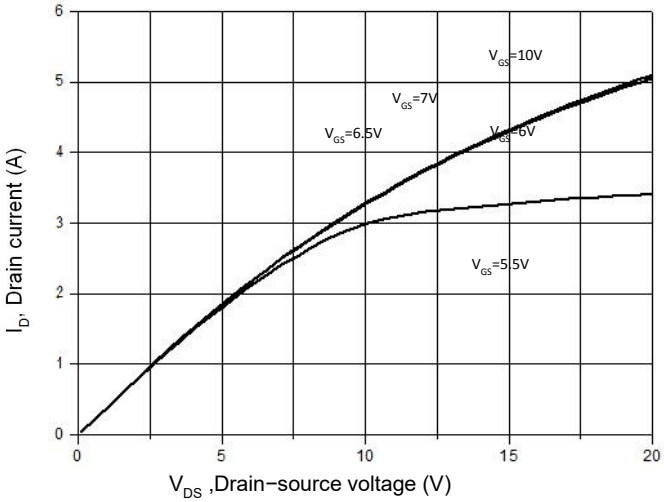


Figure 2. Transfer Characteristics

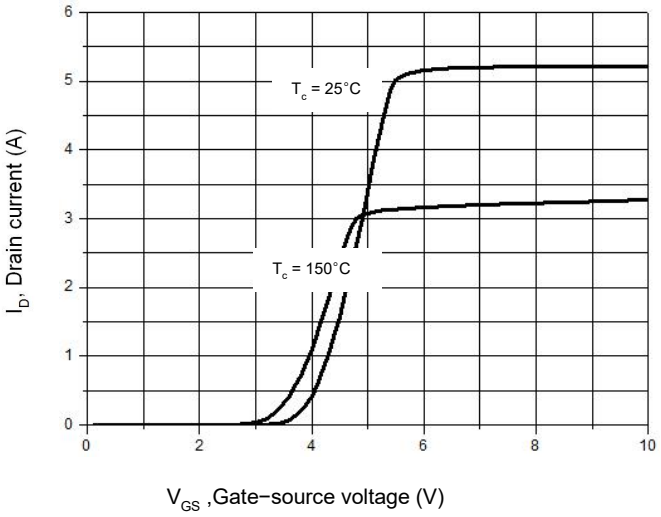


Figure 3. On-Resistance Variation vs. Drain Current

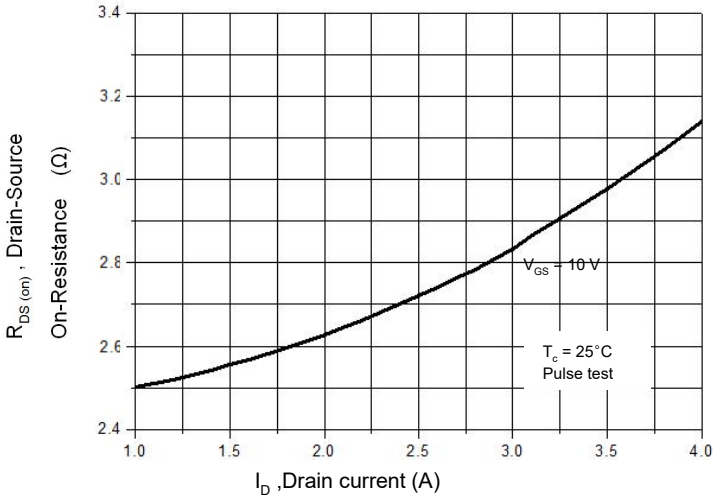


Figure 4. Threshold Voltage vs. Temperature

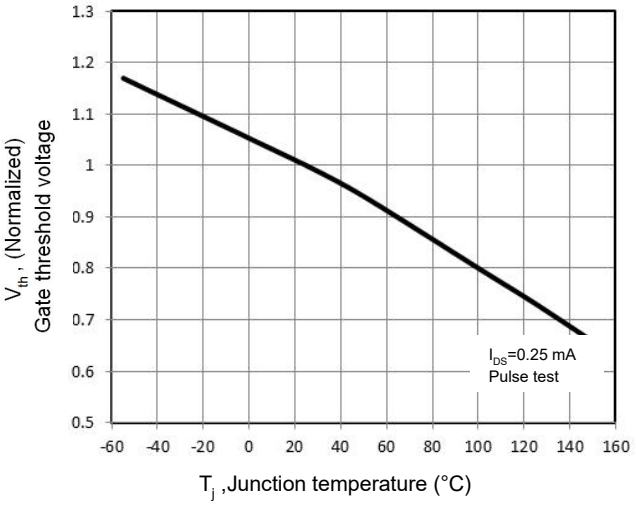


Figure 5. Breakdown Voltage vs. Temperature

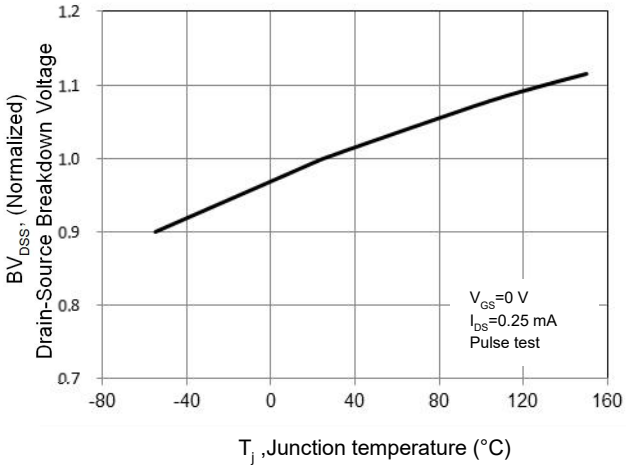


Figure 6. On-Resistance vs. Temperature

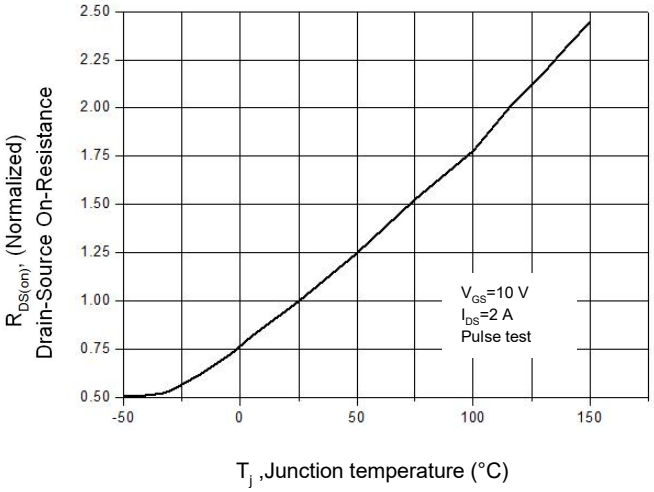
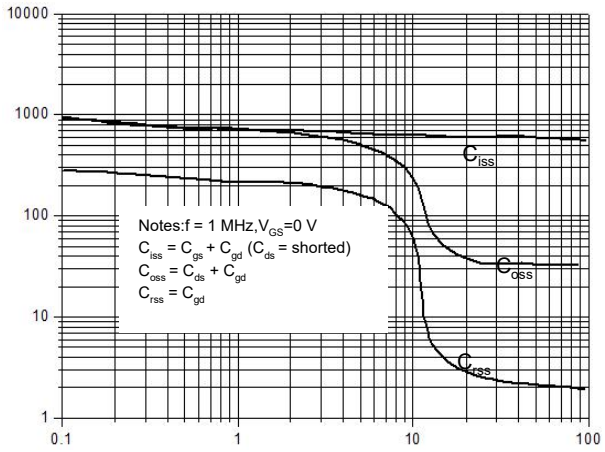
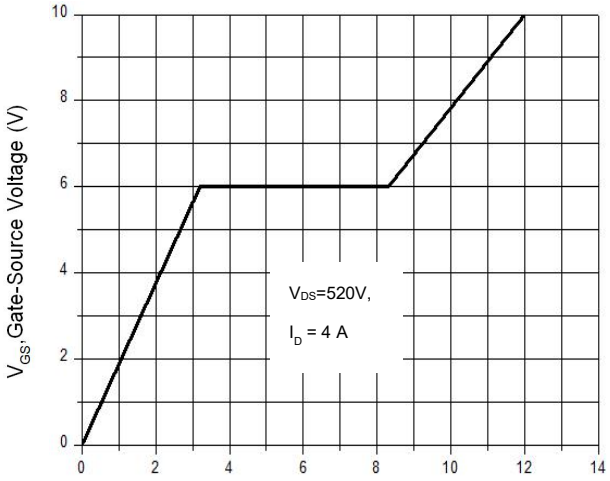


Figure 7. Capacitance Characteristics



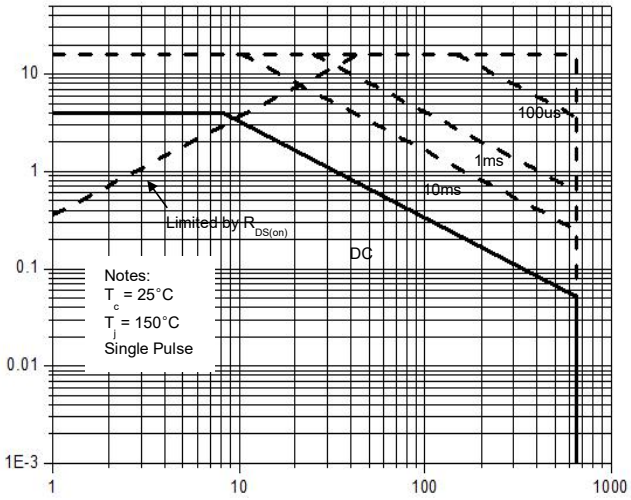
V_{DS} ,Drain-Source Voltage (V)

Figure 8. Gate Charge Characterist



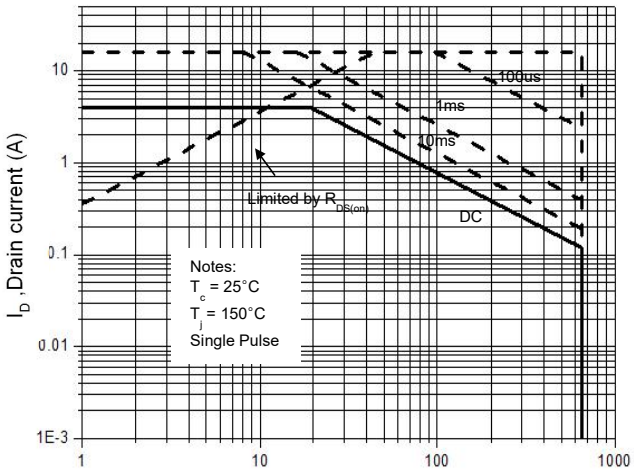
Q_G ,Total Gate Charge (nC)

Figure 9. Maximum Safe Operating Area TO-220F



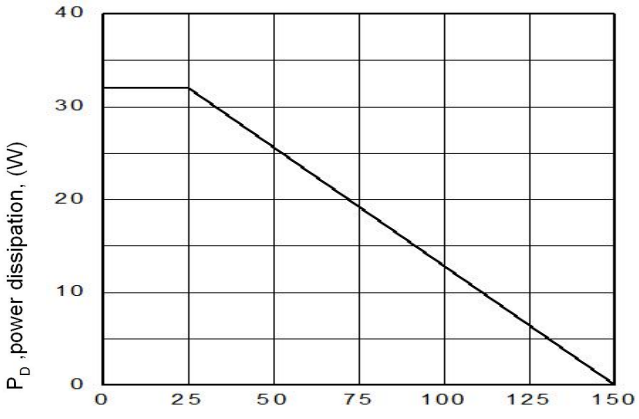
V_{DS} ,Drain-Source Voltage (V)

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



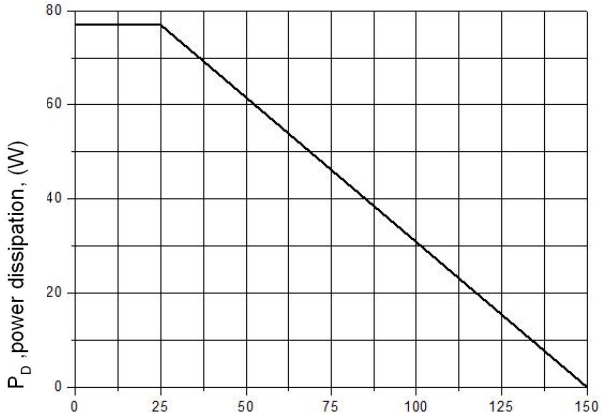
V_{DS} ,Drain-Source Voltage (V)

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



T_c ,Case temperature (°C)

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



T_c ,Case temperature (°C)

Figure 13. Continuous Drain Current vs. Temperature

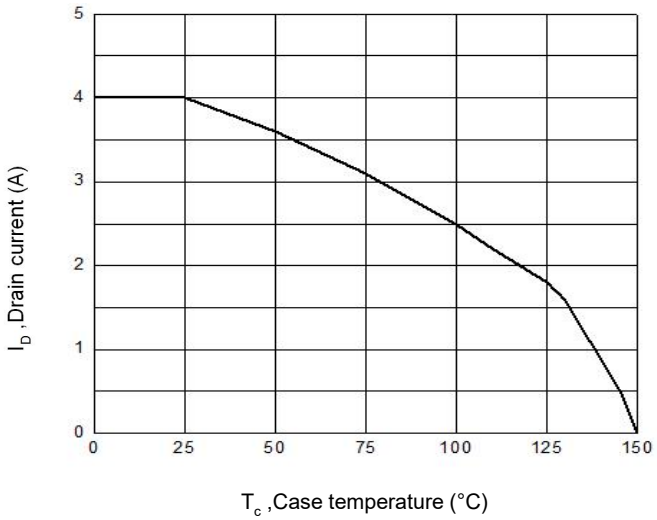


Figure 14. Body Diode Transfer Characteristics

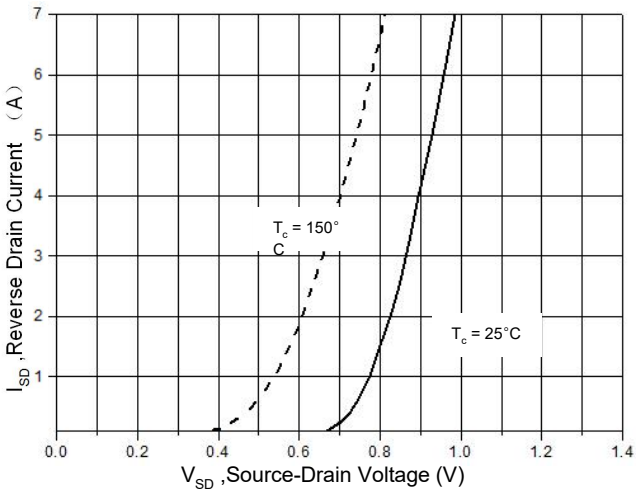


Figure 15 Transient Thermal Impendance,Junction to Case, TO-220F

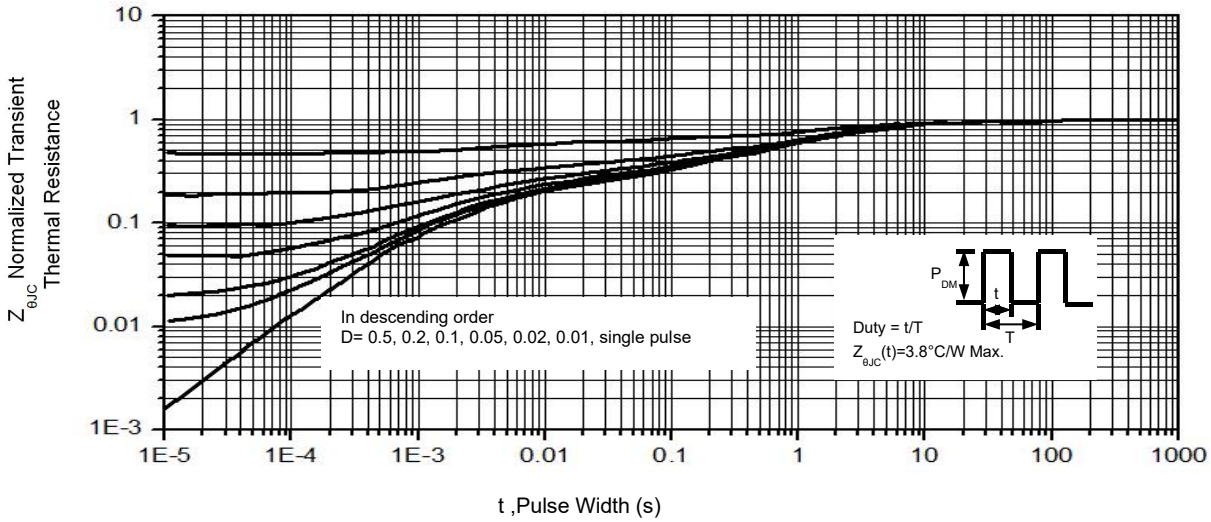
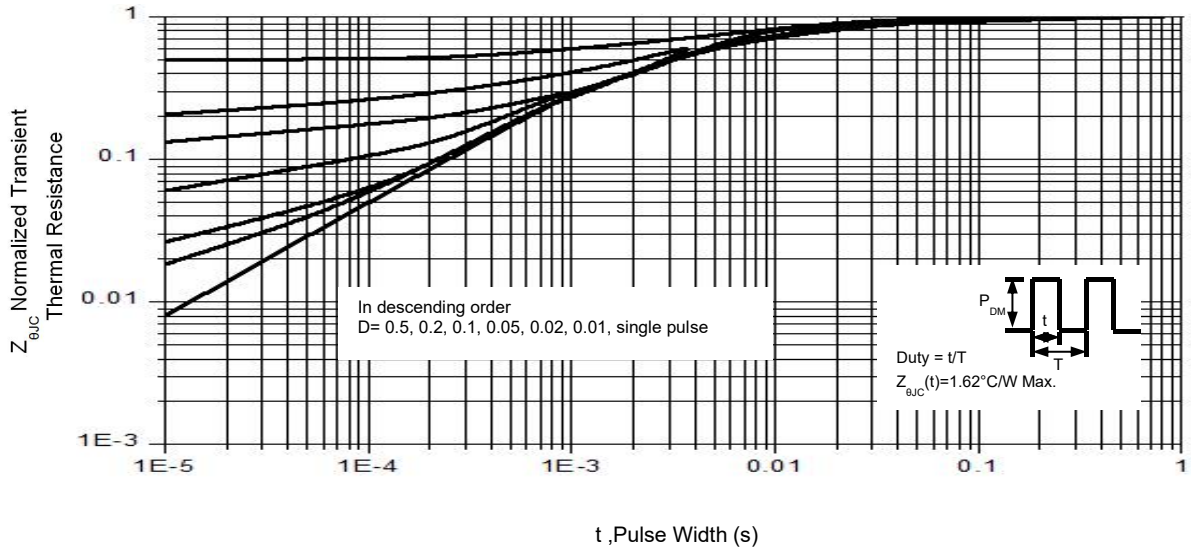
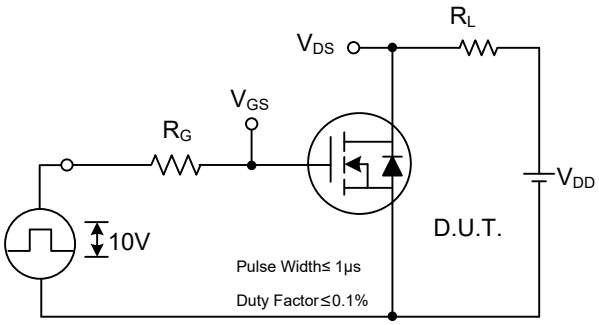
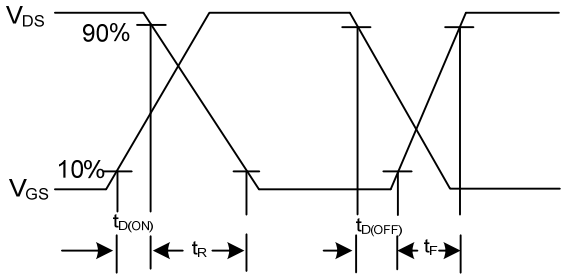


Figure 16. Transient Thermal Impendance,Junction to Case, TO-220/ TO-252

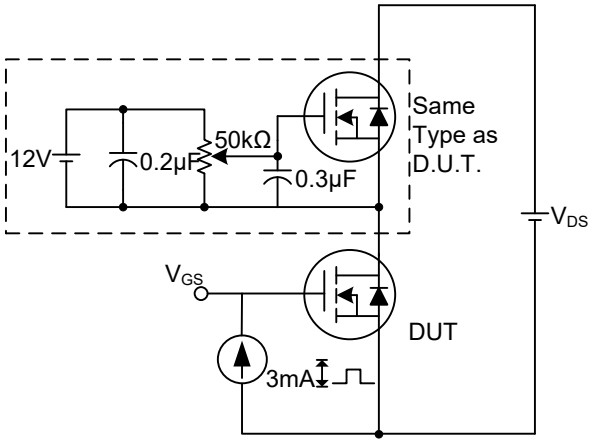




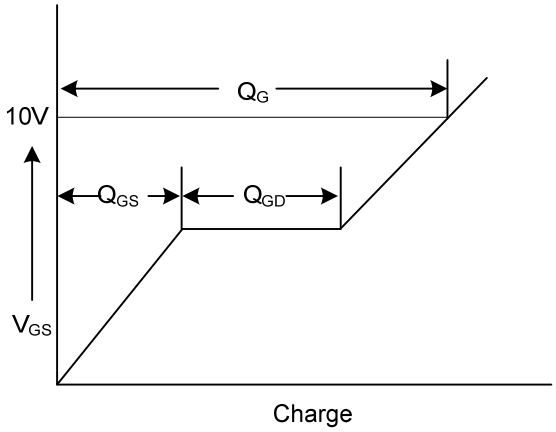
Switching Test Circuit



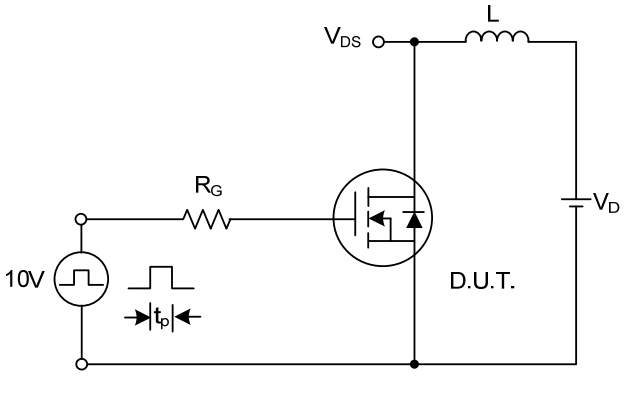
Switching Waveforms



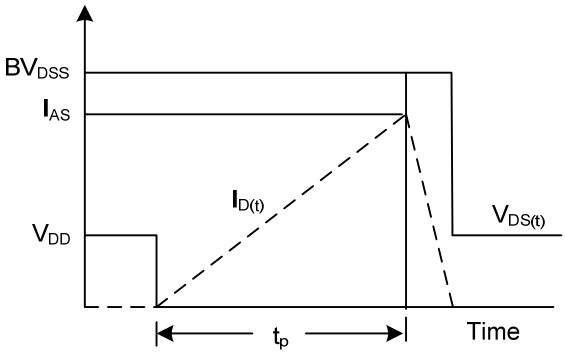
Gate Charge Test Circuit



Gate Charge Waveform



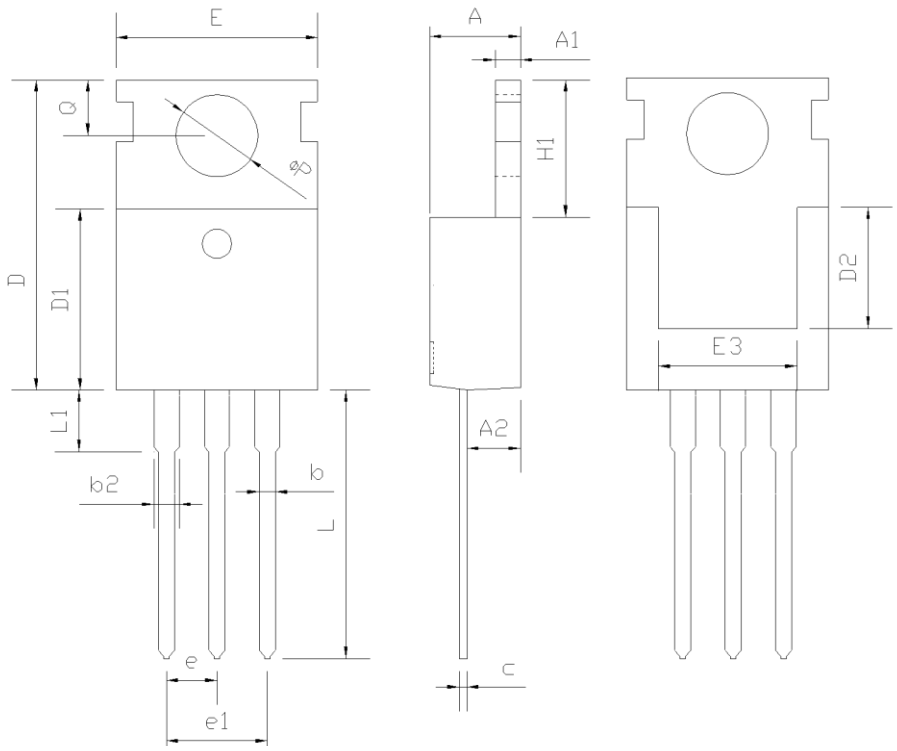
Unclamped Inductive Switching Test Circuit



Unclamped Inductive Switching Waveforms

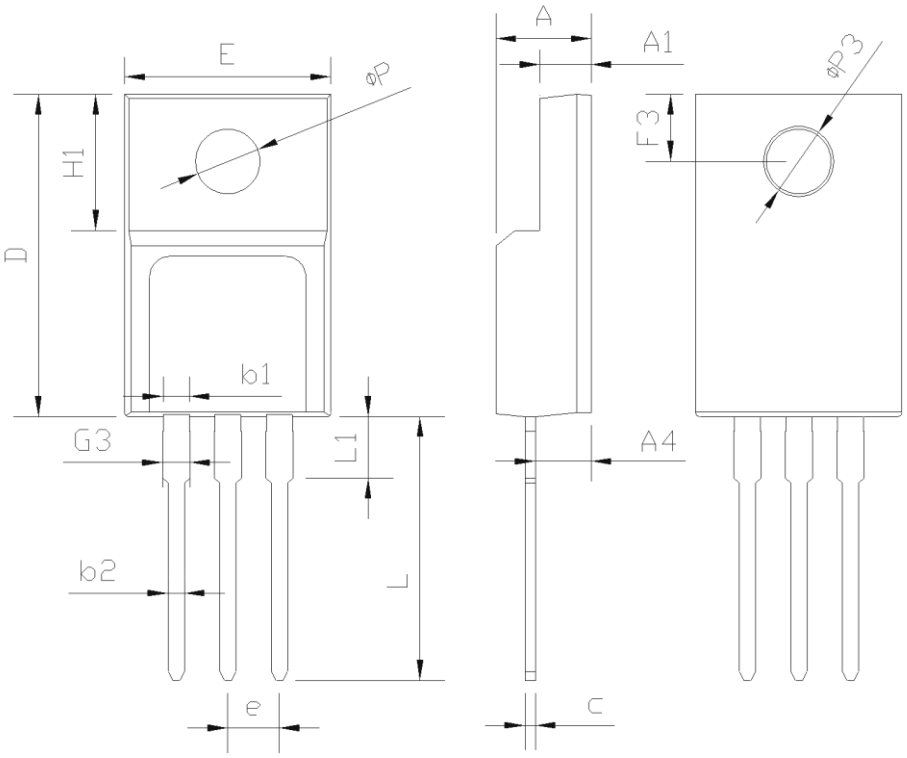
The curve above is for reference only.

Mechanical Dimensions for TO-220



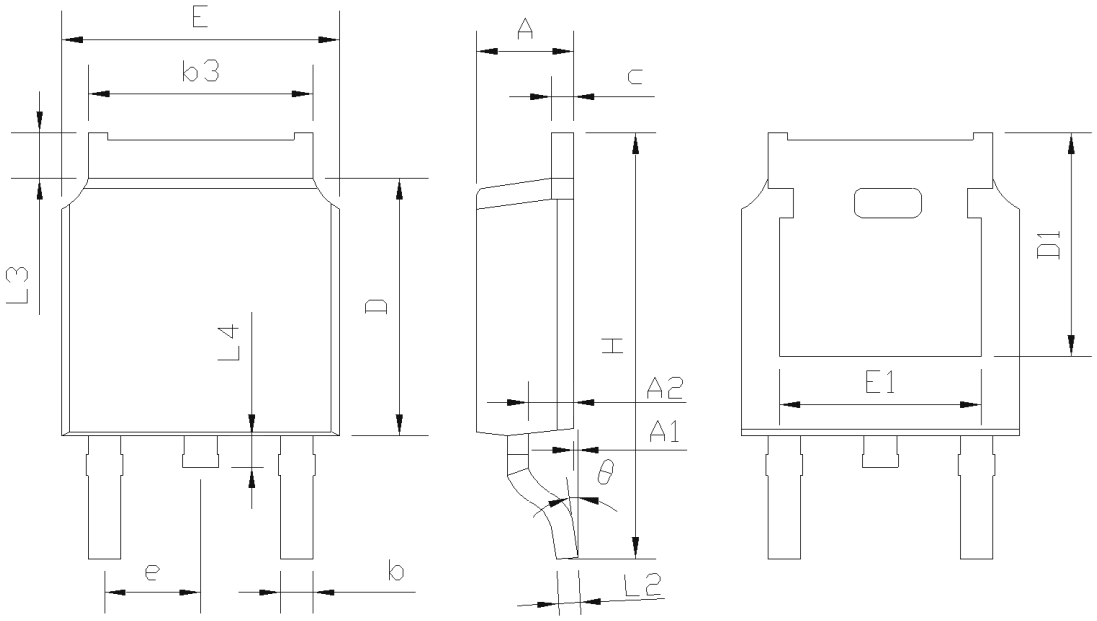
SYMBOL	mm		
	MIN	NOM	MAX
A	4.37	4.57	4.70
A1	1.25	1.30	1.40
A2	2.20	2.40	2.60
b	0.70	0.80	0.95
b2	1.17	1.27	1.47
c	0.45	0.50	0.60
D	15.10	15.60	16.10
D1	8.80	9.10	9.40
D2	5.50	-	-
E	9.70	10.00	10.30
E3	7.00	-	-
e	2.54 BSC		
e1	5.08 BSC		
H1	6.25	6.50	6.85
L	12.75	13.50	13.80
L1	-	3.10	3.40
ΦP	3.40	3.60	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
θ	0°	-	8°

Package Marking and Ordering Information

Part Number	Marking	Package	Units/Tube	Units/Reel
MDD4N65F	4N65F	TO-220F	50	
MDD4N65P	4N65P	TO-220-3L	50	
MDD4N65D	4N65D	TO-252		2500