

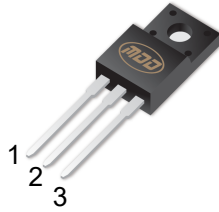


MDD4N65F/MDD4N65P/MDD4N65D

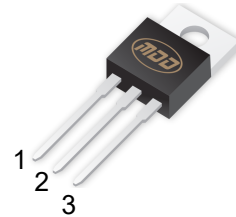
650V N-Channel Enhancement Mode MOSFET

V_{DS}	650 V
$I_D(T_c=25^\circ\text{C})$	4A
$R_{DS(on),max}$	2.8Ω@ $V_{GS}=10V$
$Q_{g,typ}$	12nC

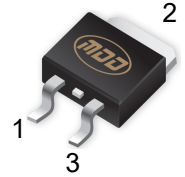
TO-220F-3L



TO-220-3L



TO-252



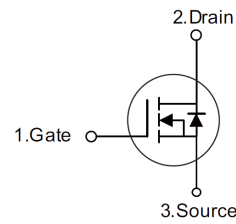
General Features

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

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	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	°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	$R_{\theta JC}$	3.8	1.62	°C/W
Thermal resistance, Junction-to-ambient	$R_{\theta JA}$	62.5	110	°C/W

- Notes:**
1. Pulse width limited by maximum junction temperature.
 2. L=10mH, $I_{AS} = 6.3A$, Starting $T_J = 25^\circ\text{C}$.
 3. $I_{SD} = 4A$, $di/dt \leq 100A/\mu s$, $V_{DD} \leq BV_{DS}$, Starting $T_J = 25^\circ\text{C}$.



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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	μA	
$V_{GS(TH)}$	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	$V_{GS}=10V, I_D=2A$	--	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	$V_{DS}=325V,$ $I_D=4A,$ $R_G=10\Omega$ (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	$V_R=400$ $I_F=4A,$ $-dI_F/dt=100A/\mu s$	--	282	--	ns
Q_{rr}	Body Diode Reverse Recovery Charge		--	1.4	--	μC

Notes:

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



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Electrical Characteristics Diagrams

Figure 1. Typical Output Characteristics

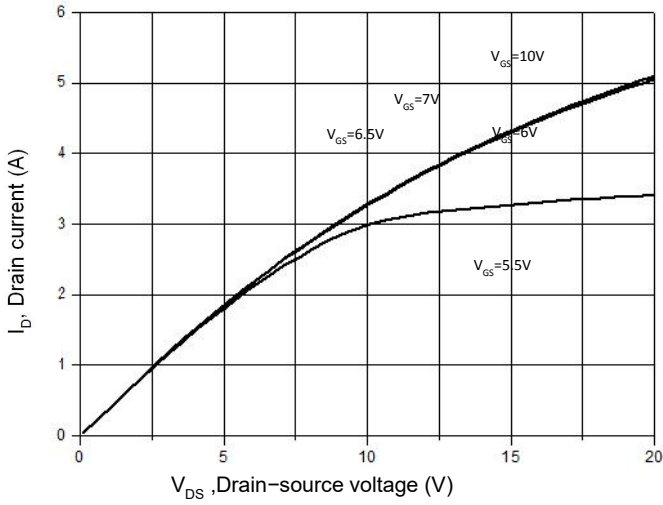


Figure 2. Transfer Characteristics

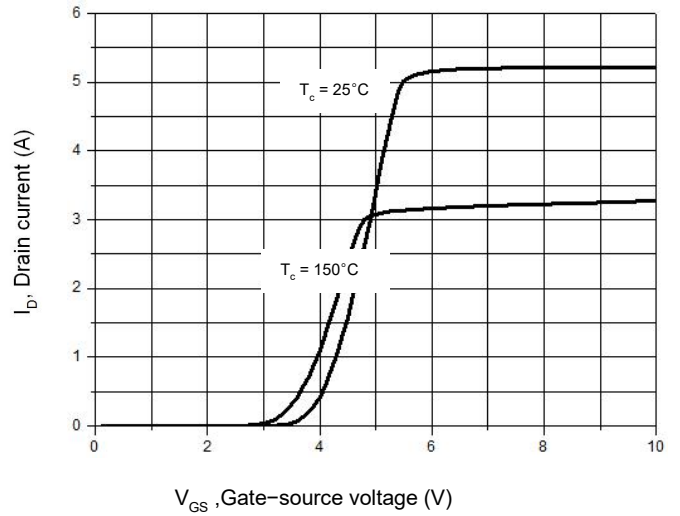


Figure 3. On-Resistance Variation vs. Drain Current

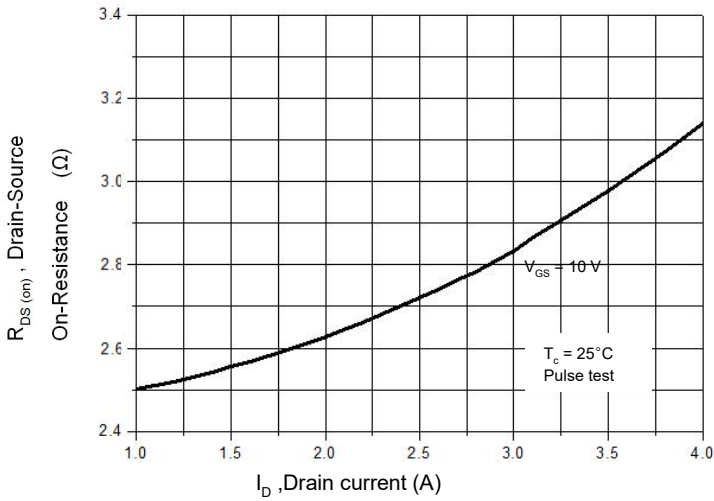


Figure 4. Threshold Voltage vs. Temperature

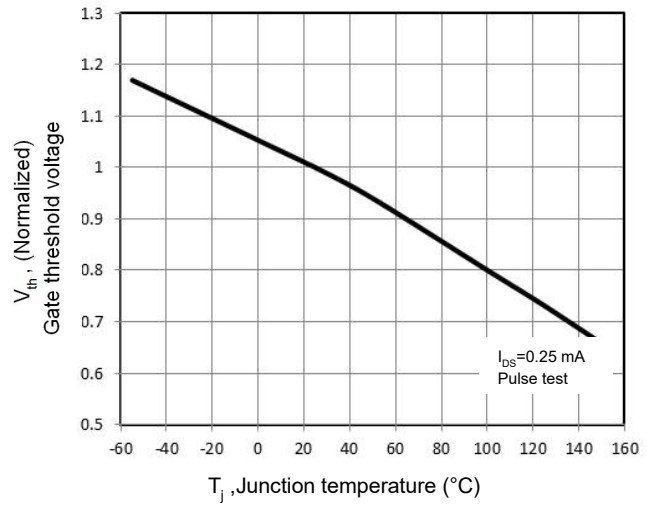


Figure 5. Breakdown Voltage vs. Temperature

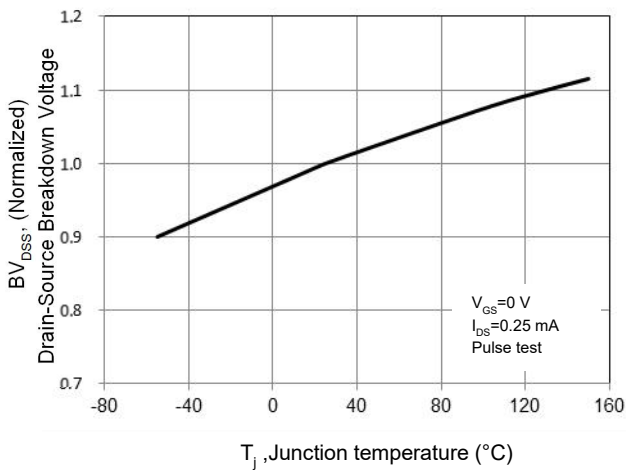
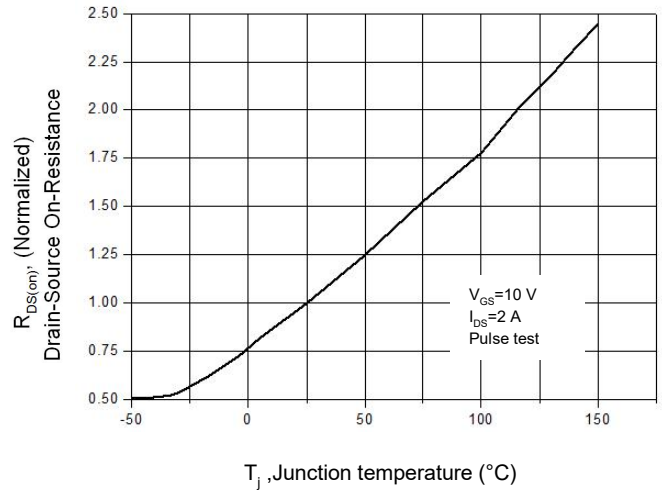


Figure 6. On-Resistance vs. Temperature





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Figure 7. Capacitance Characteristics

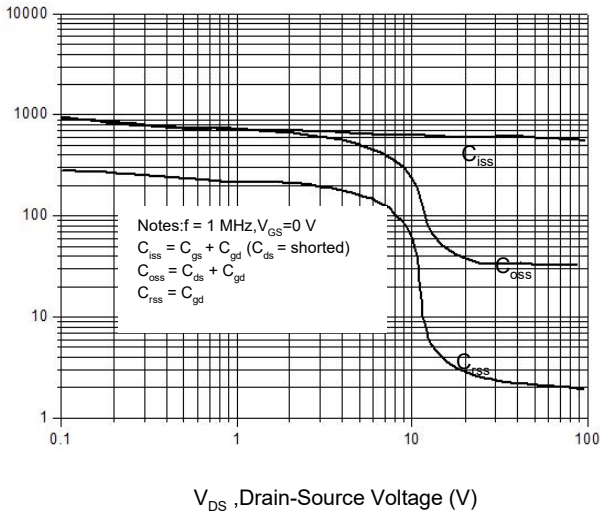


Figure 8. Gate Charge Characteristic

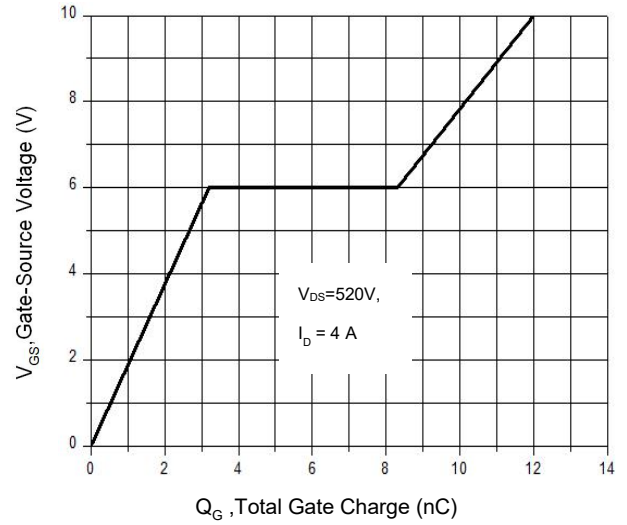


Figure 9. Maximum Safe Operating Area TO-220F

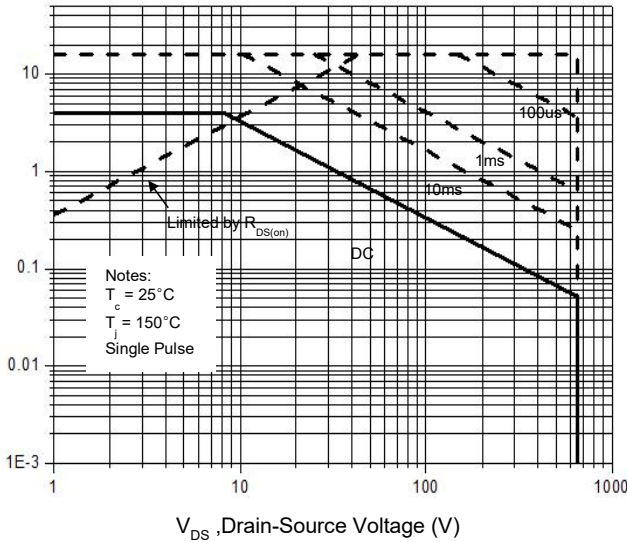


Figure 10. Maximum Safe Operating Area TO-220/ TO-252

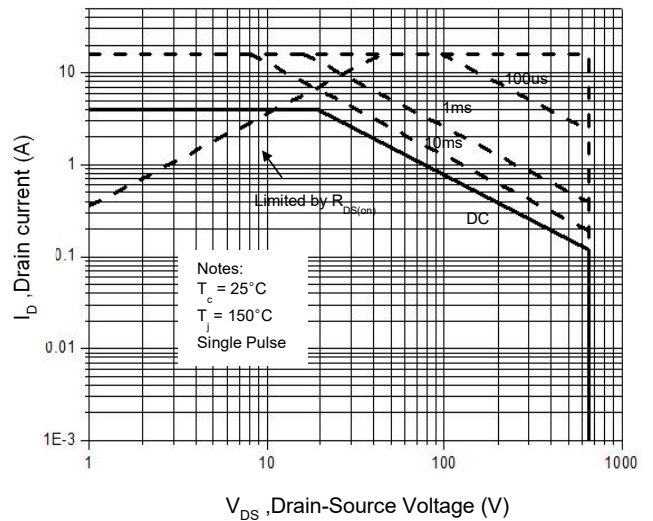


Figure 11. Power Dissipation vs. Temperature TO-220F

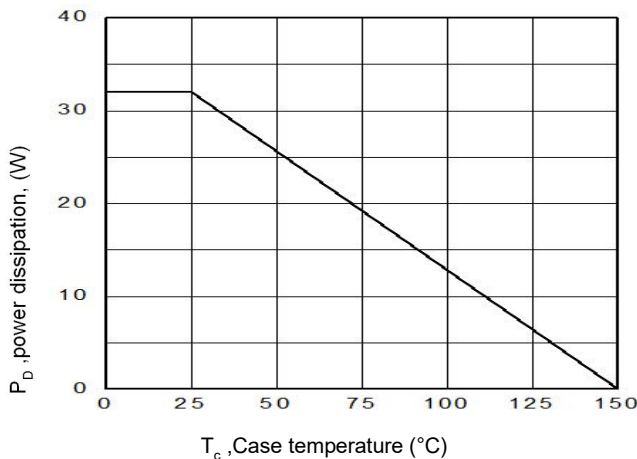
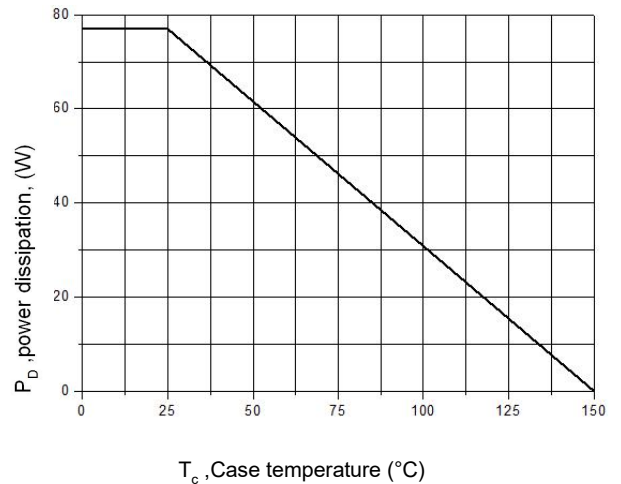


Figure 12. Power Dissipation vs. Temperature TO-220/ TO-252





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650V N-Channel Enhancement Mode MOSFET

Figure 13. Continuous Drain Current vs. Temperature

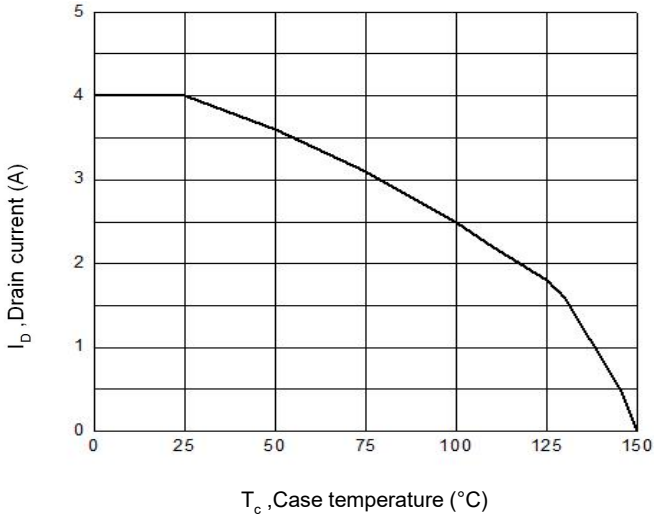


Figure 14. Body Diode Transfer Characteristics

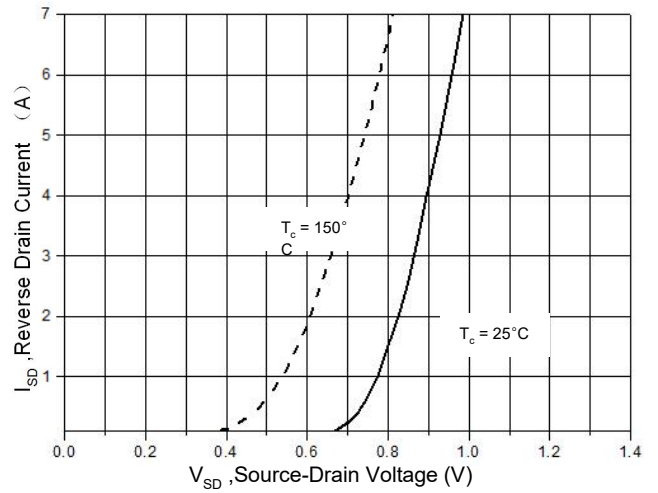


Figure 15 Transient Thermal Impedance, Junction to Case, TO-220F

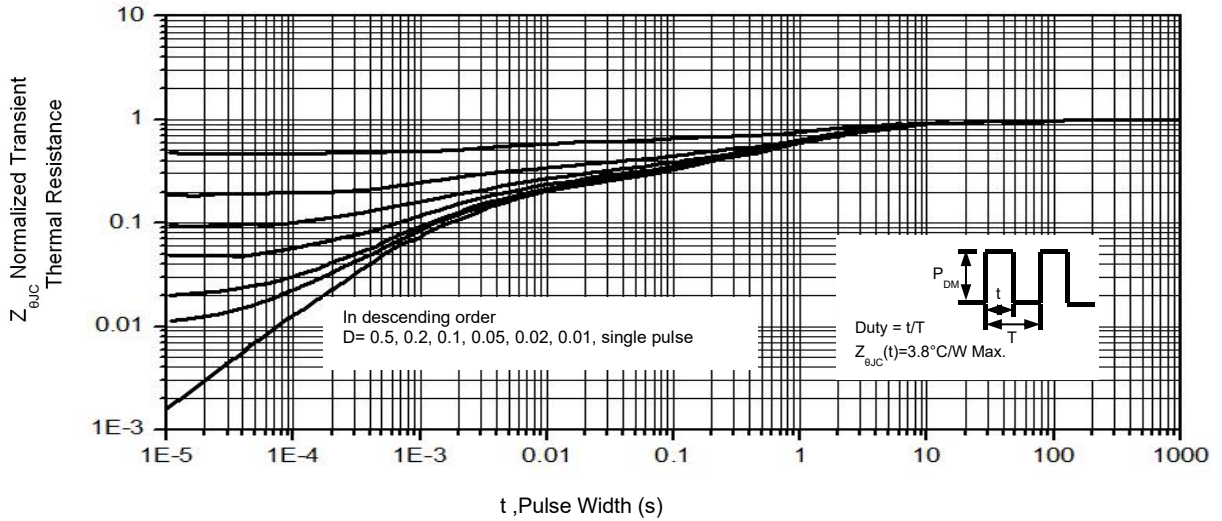
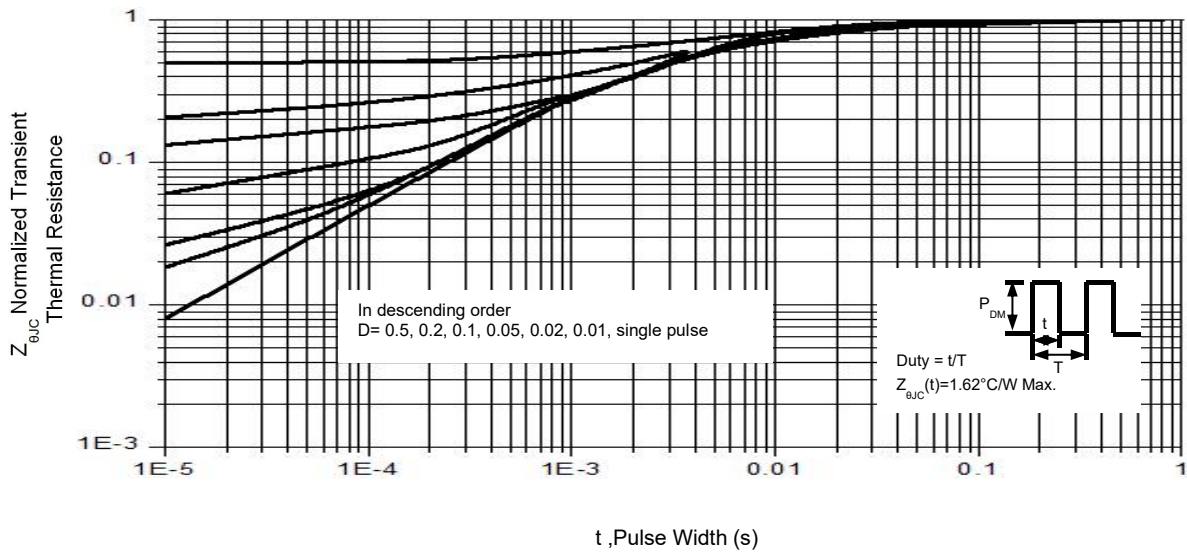


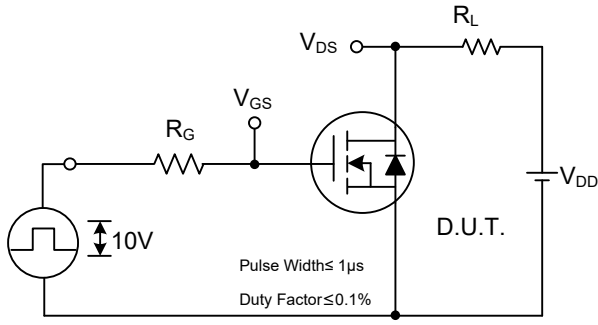
Figure 16. Transient Thermal Impedance, Junction to Case, TO-220/ TO-252



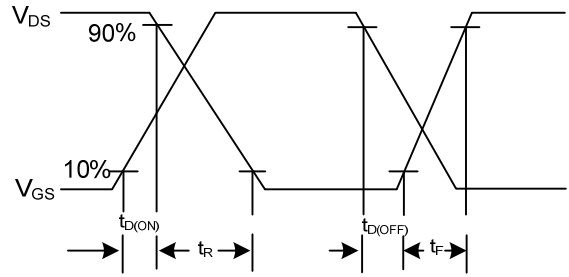


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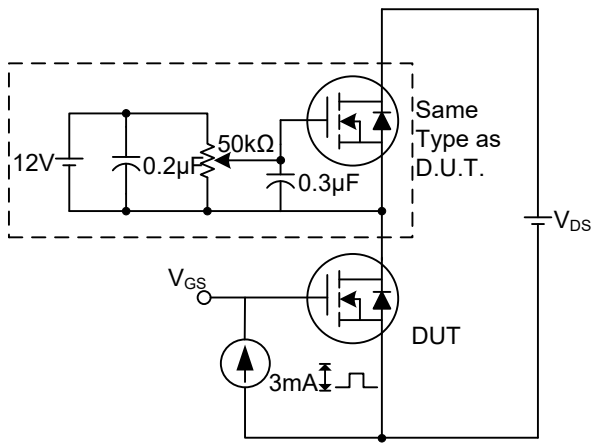
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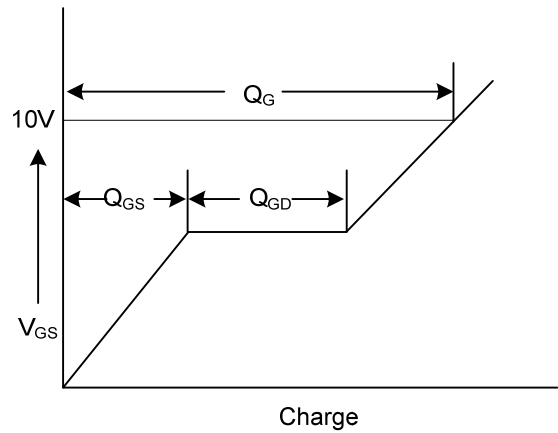
Switching Test Circuit



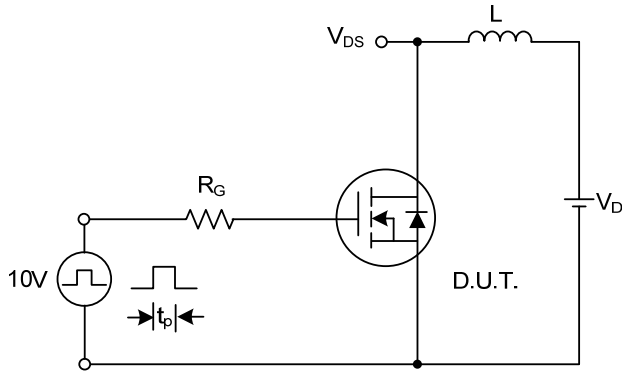
Switching Waveforms



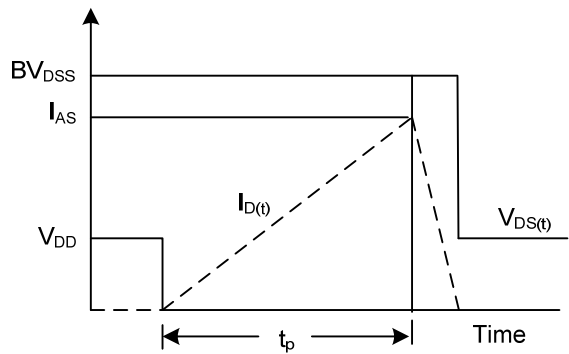
Gate Charge Test Circuit



Gate Charge Waveform



Unclamped Inductive Switching Test Circuit



Unclamped Inductive Switching Waveforms

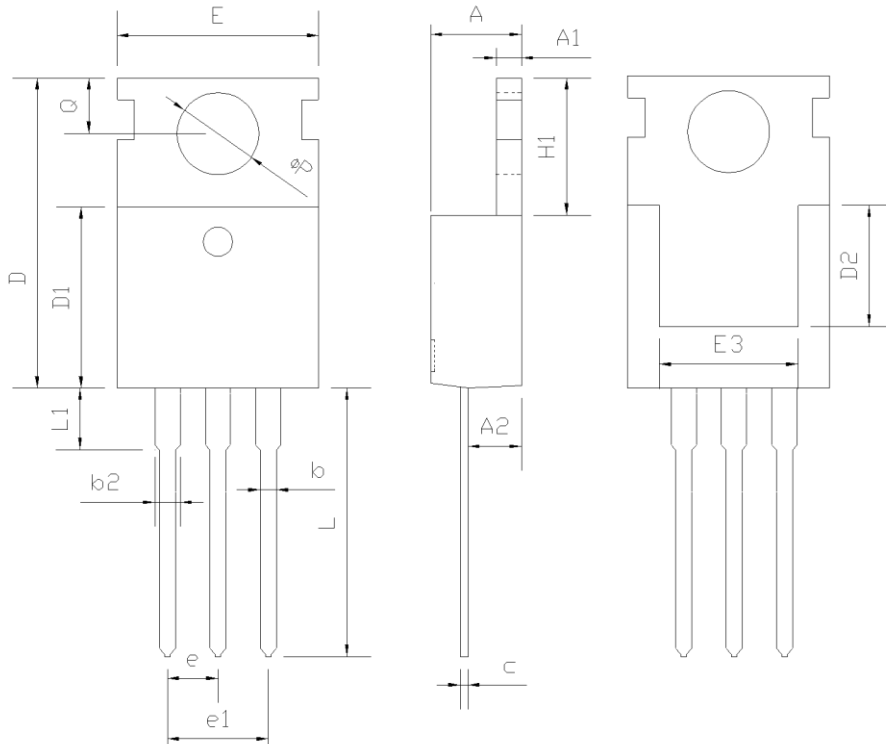
The curve above is for reference only.



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650V N-Channel Enhancement Mode MOSFET

Mechanical Dimensions for TO-220



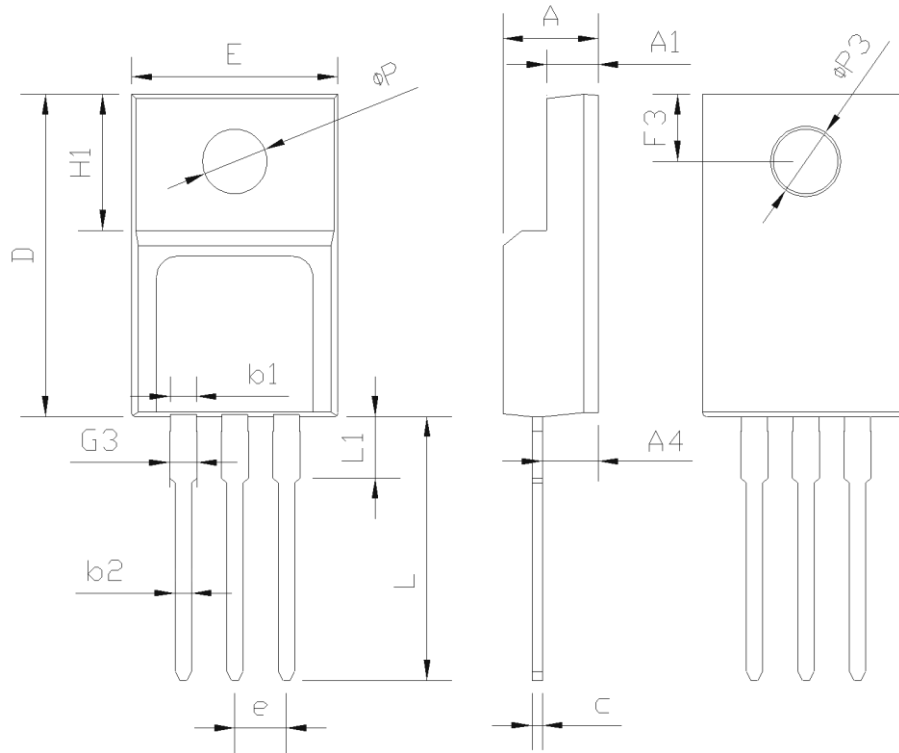
SYMBOL	mm		
	MIN	NOM	MAX
A	4.37	4.57	4.70
A1	1.25	1.30	1.40
A2	2.20	2.40	2.60
b	0.70	0.80	0.95
b2	1.17	1.27	1.47
c	0.45	0.50	0.60
D	15.10	15.60	16.10
D1	8.80	9.10	9.40
D2	5.50	-	-
E	9.70	10.00	10.30
E3	7.00	-	-
e	2.54 BSC		
e1	5.08 BSC		
H1	6.25	6.50	6.85
L	12.75	13.50	13.80
L1	-	3.10	3.40
ΦP	3.40	3.60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



MDD4N65F/MDD4N65P/MDD4N65D

650V N-Channel Enhancement Mode MOSFET

Mechanical Dimensions for TO-220F



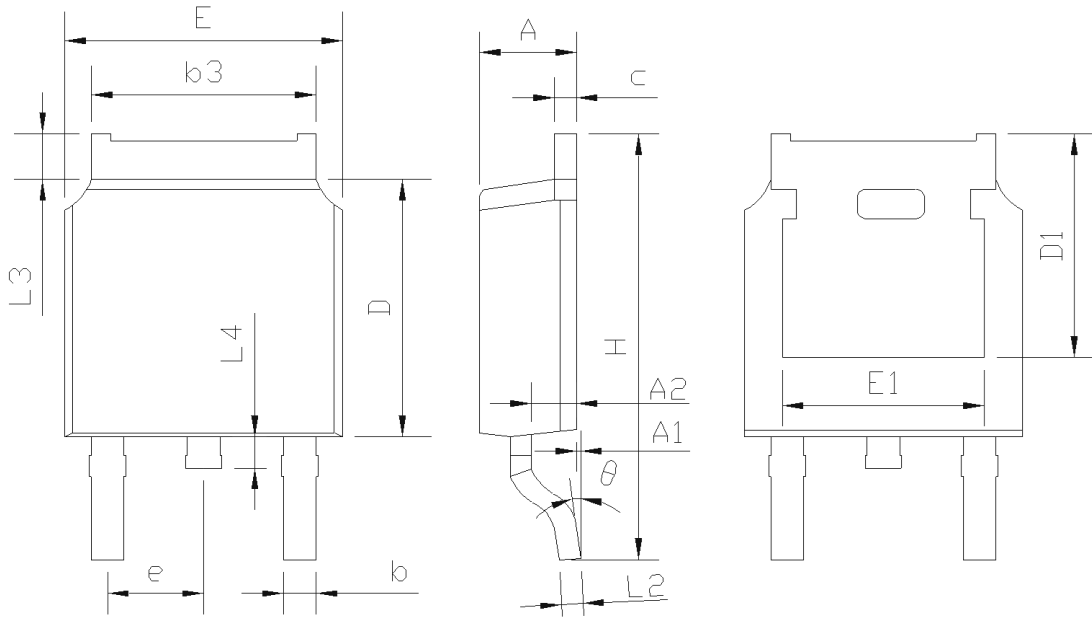
SYMBOL	mm		
	MIN	NOM	MAX
E	9.96	10.16	10.36
A	4.50	4.70	4.90
A1	2.34	2.54	2.74
A4	2.56	2.76	2.96
c	0.40	0.50	0.65
D	15.57	15.87	16.17
H1	6.70REF		
e	2.54BSC		
L	12.68	12.98	13.28
L1	2.88	3.03	3.18
ΦP	3.03	3.18	3.38
ΦP3	3.15	3.45	3.65
F3	3.15	3.30	3.45
G3	1.25	1.35	1.55
b1	1.18	1.28	1.43
b2	0.70	0.80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



MDD4N65F/MDD4N65P/MDD4N65D

650V N-Channel Enhancement Mode MOSFET

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