



# 650V Super-junction Power MOSFET

## Description

### 650V Super-junction Power MOSFET

Super-junction power MOSFET is a revolutionary technology for high voltage power MOSFETs, designed according to the SJ principle and pioneered. The Multi-EPI SJ MOSFET provide an extremely fast and robust body diode. Also provide an extremely low switching, communication and conduction losses device with highest robustness make especially resonant switching applications more reliable, more efficient, lighter and cooler, designed by Wuxi Unigroup Microelectronics Company.

## Features

- Ultra-fast body diode
- Very low FOM  $R_{DS(on)} \times Q_g$
- Easy to use/drive
- 100% avalanche tested
- RoHS compliant

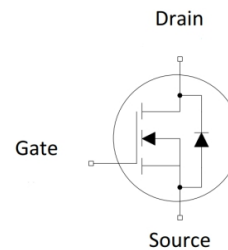
## Applications

- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply (UPS)
- Power Factor Correction (PFC)
- LLC Half-bridge
- Charger

TO-220F



TO-247



## Device Marking and Package Information

Device	Package	Marking
TPA65R300MFD	TO-220F	65R300MFD
TPW65R300MFD	TO-247	65R300MFD

## Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	700	V
$R_{DS(on),max}$	0.30	$\Omega$
$Q_{g,typ}$	29	nC
$I_D$	15	A
$I_{D,pulse}$	45	A
$E_{OSS} @ 400V$	3.23	$\mu J$
Body Diode $di_f/dt$	500	A/ $\mu s$
$t_{rr}$	152	ns
$Q_{rr}$	0.84	$\mu C$
$I_{rrm}$	11	A



Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ , unless otherwise noted				
Parameter		Symbol	Value	Unit
Continuous Drain Current	$T_C = 25^\circ\text{C}$	$I_D$	15	A
	$T_C = 100^\circ\text{C}$		9	
Pulsed Drain Current	(note1)	$I_{D,pulse}$	45	A
Gate-Source Voltage		$V_{GSS}$	$\pm 30$	V
Single Pulse Avalanche Energy	(note2)	$E_{AS}$	290	mJ
Repetitive Avalanche Energy	(note2)	$E_{AR}$	0.44	mJ
Avalanche Current		$I_{AR}$	2.4	A
MOSFET dv/dt Ruggedness, $V_{DS} = 0 \dots 480\text{V}$		dv/dt	50	V/ns
Power Dissipation For TO-220F		$P_D$	32	W
Power Dissipation For TO-247			105	
Continuous Diode Forward Current		$I_S$	15	A
Diode Pulsed Current	(note1)	$I_{S,pulse}$	45	
Reverse Diode dv/dt	(note3)	dv/dt	15	V/ns
Maximum Diode Commutation Speed	(note3)	$di_f/dt$	500	A/ $\mu\text{s}$
Operating Junction and Storage Temperature Range		$T_J, T_{stg}$	-55~+150	$^\circ\text{C}$

Thermal Resistance For TO-220F				
Parameter		Symbol	Value	Unit
Thermal Resistance, Junction-to-Case		$R_{thJC}$	3.9	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient		$R_{thJA}$	80	

Thermal Resistance For TO-247				
Parameter		Symbol	Value	Unit
Thermal Resistance, Junction-to-Case		$R_{thJC}$	1.2	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient		$R_{thJA}$	62	



Electrical Characteristics $T_J = 25^{\circ}\text{C}$ , unless otherwise noted						
Parameter	Symbol	Test Conditions	Value			Unit
			Min.	Typ.	Max.	
<b>Static Characteristics</b>						
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 250\mu A$	650	--	--	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 650V, V_{GS} = 0V, T_J = 25^{\circ}\text{C}$	--	--	1.75	$\mu A$
		$V_{DS} = 650V, V_{GS} = 0V, T_J = 150^{\circ}\text{C}$	--	--	1750	
Gate-Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 30V$	--	--	$\pm 100$	nA
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\mu A$	3	--	5	V
Drain-Source On-State-Resistance	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 7.5A$	--	0.26	0.30	$\Omega$
Gate Resistance	$R_G$	$f = 1.0\text{MHz}$ open drain	--	12.5	--	$\Omega$
<b>Dynamic Characteristics</b>						
Input Capacitance	$C_{iss}$	$V_{GS} = 0V,$ $V_{DS} = 100V,$ $f = 1.0\text{MHz}$	--	1205	--	$\mu F$
Output Capacitance	$C_{oss}$		--	45	--	
Reverse Transfer Capacitance	$C_{rss}$		--	3	--	
Total Gate Charge	$Q_g$	$V_{DD} = 520V, I_D = 15A,$ $V_{GS} = 10V$	--	29	--	nC
Gate-Source Charge	$Q_{gs}$		--	8	--	
Gate-Drain Charge	$Q_{gd}$		--	11	--	
Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 400V, I_D = 15A,$ $R_G = 25\Omega$	--	24	--	ns
Turn-on Rise Time	$t_r$		--	31	--	
Turn-off Delay Time	$t_{d(off)}$		--	121	--	
Turn-off Fall Time	$t_f$		--	40	--	
<b>Drain-Source Body Diode Characteristics</b>						
Body Diode Forward Voltage	$V_{SD}$	$T_J = 25^{\circ}\text{C}, I_{SD} = 7.5A, V_{GS} = 0V$	--	1.0	1.5	V
Reverse Recovery Time	$t_{rr}$	$V_R = 400V, I_F = I_S,$ $di_F/dt = 100A/\mu s$	--	152	--	ns
Reverse Recovery Charge	$Q_{rr}$		--	0.84	--	$\mu C$
Peak Reverse Recovery Current	$I_{rrm}$		--	11	--	A

**Notes**

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $I_{AS} = 2.4A, V_{DD} = 50V, R_G = 25\Omega,$  Starting  $T_J = 25^{\circ}\text{C}$
3. Identical low side and high side switch with identical  $R_G$



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

Figure 1. Output Characteristics

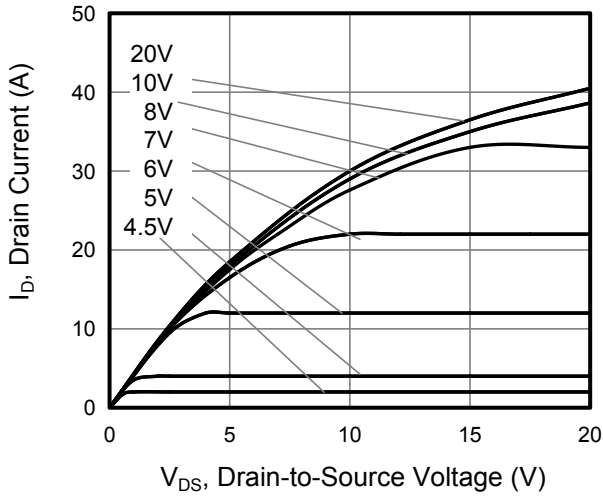


Figure 2. Transfer Characteristics

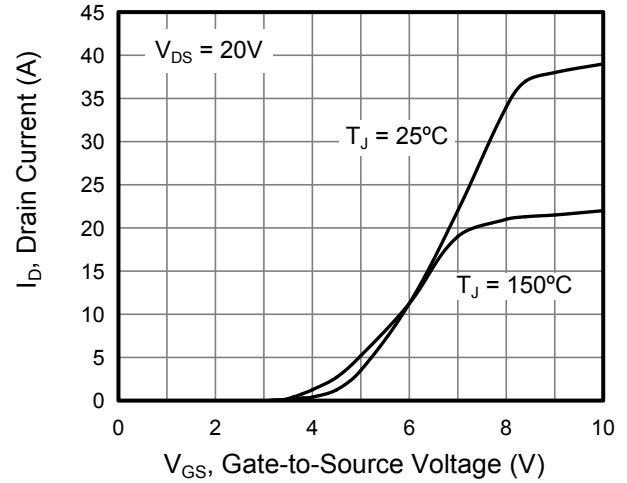


Figure 3. On-Resistance vs. Drain Current

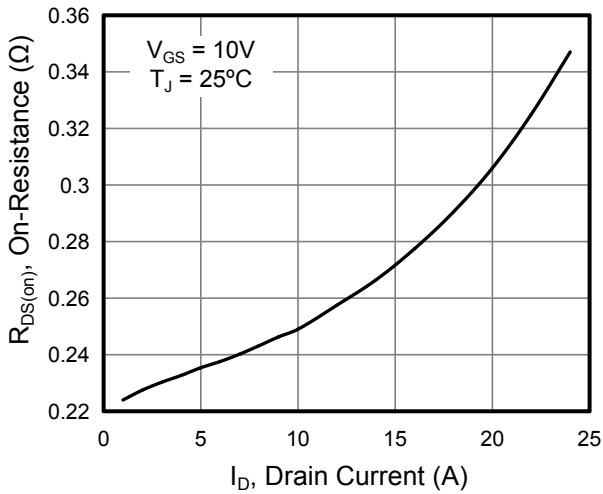


Figure 4. Capacitance

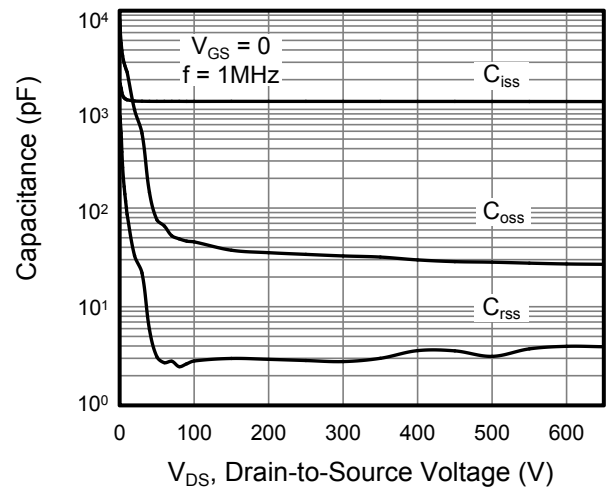


Figure 5. Gate Charge

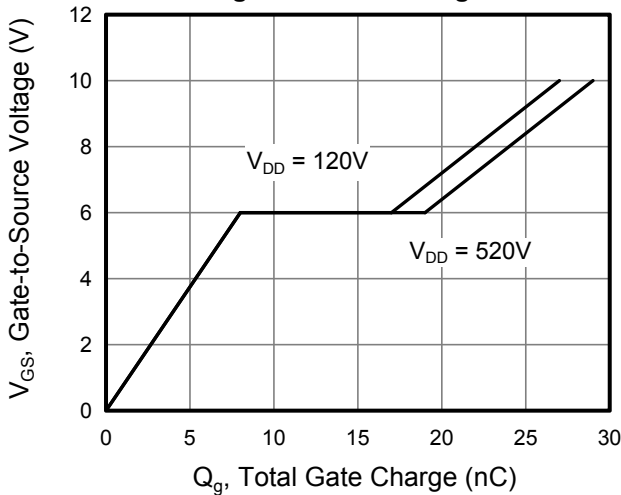
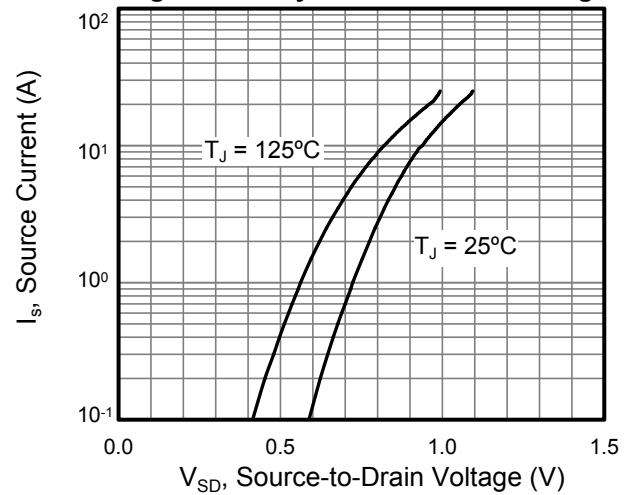


Figure 6. Body Diode Forward Voltage





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

Figure 7. On-Resistance vs. Junction Temperature

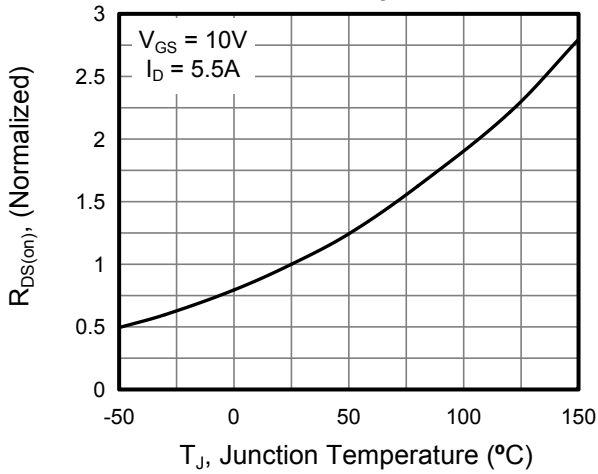


Figure 8. Breakdown voltage vs. Junction Temperature

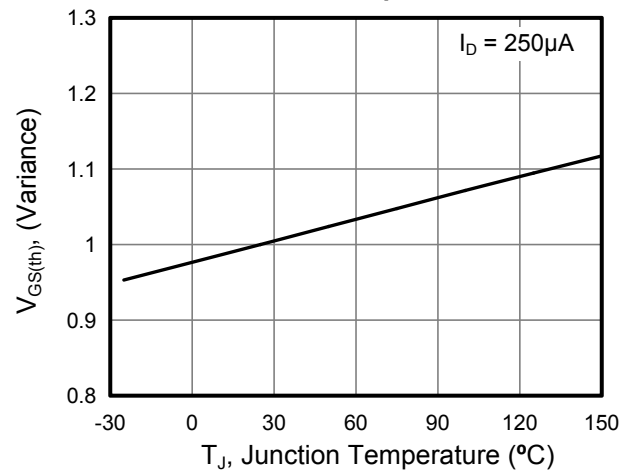


Figure 9. Transient Thermal Impedance For TO-220F

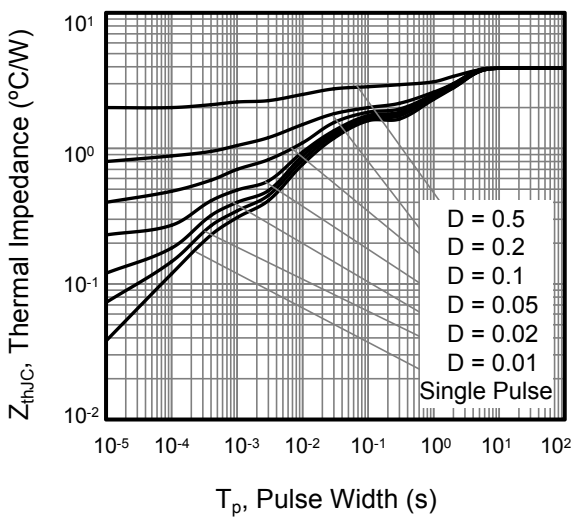


Figure 10. Transient Thermal Impedance For TO-247

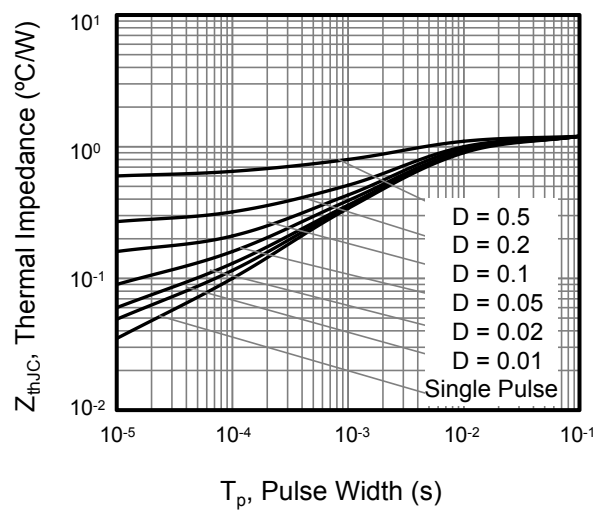


Figure 11. Safe Operation Area For TO-220F

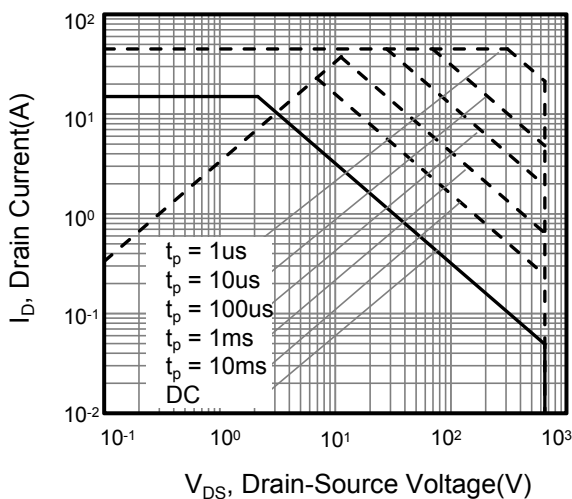
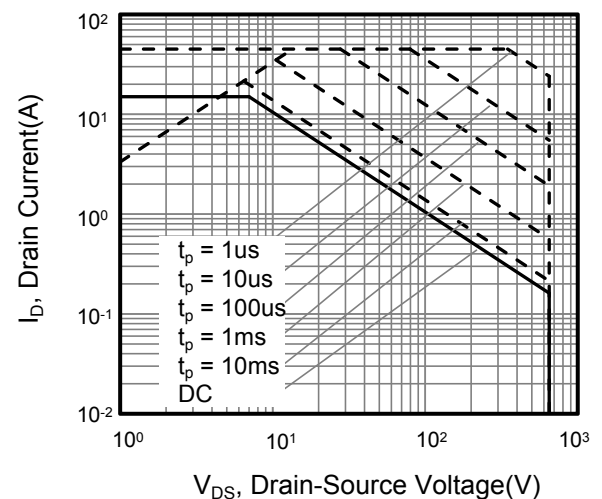


Figure 12. Safe Operation Area For TO-247





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

Figure 13. Typ. Coss Stored Energy

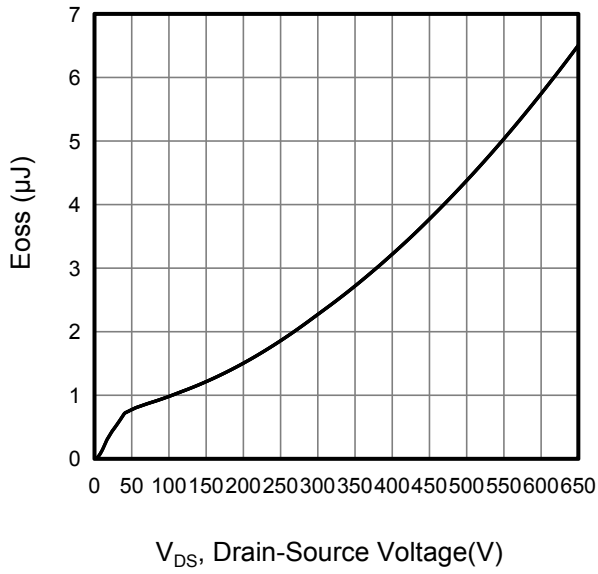




Figure A: Gate Charge Test Circuit and Waveform

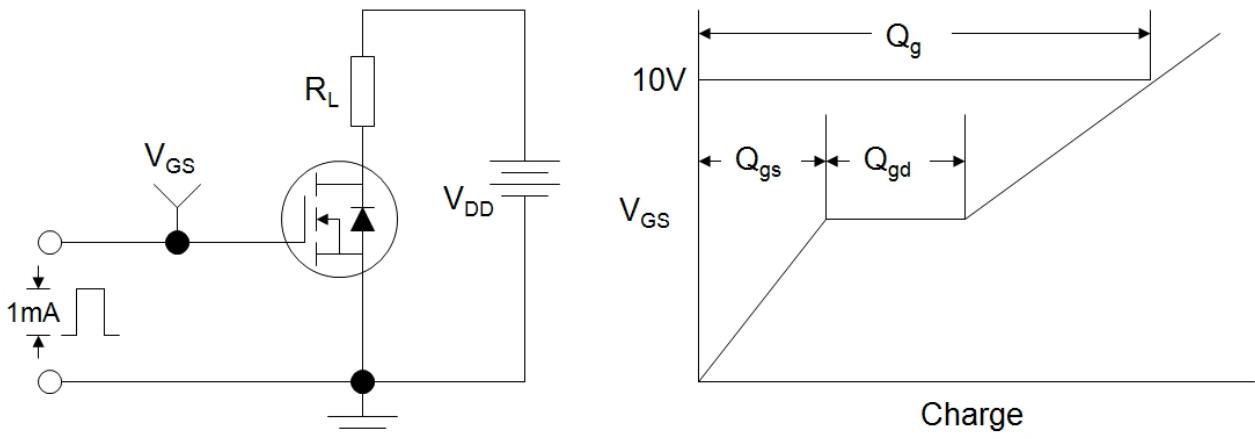


Figure B: Resistive Switching Test Circuit and Waveform

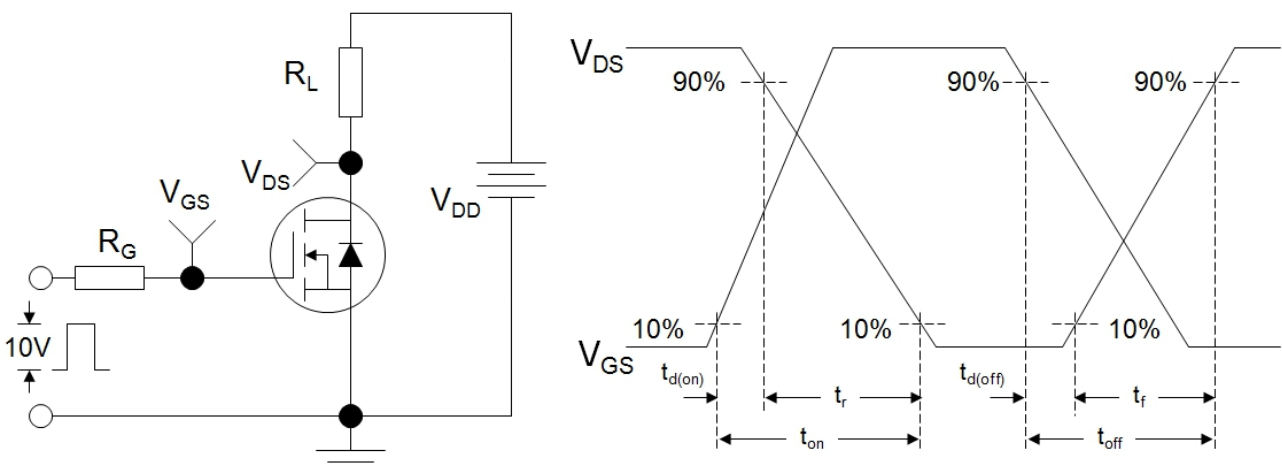
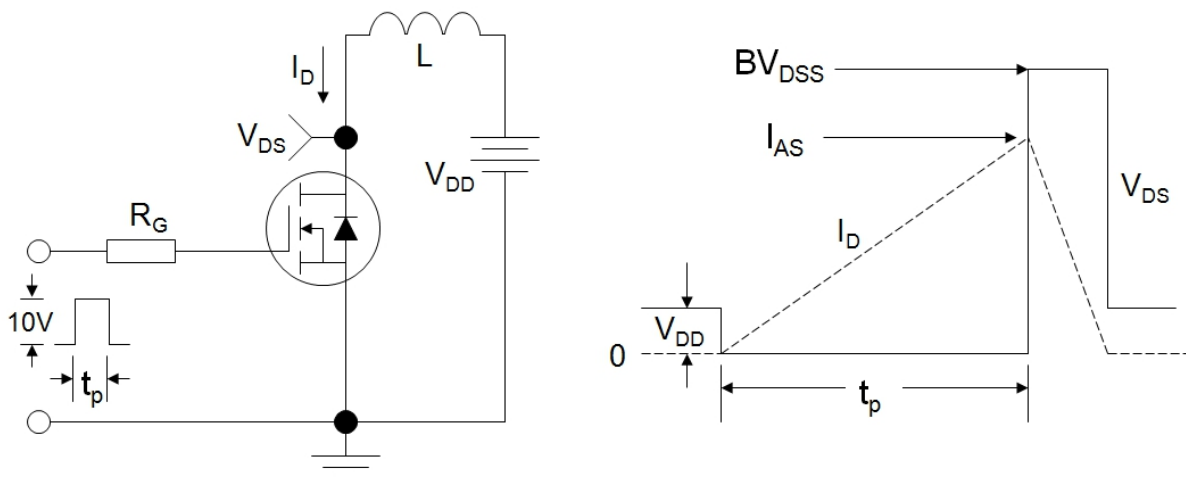
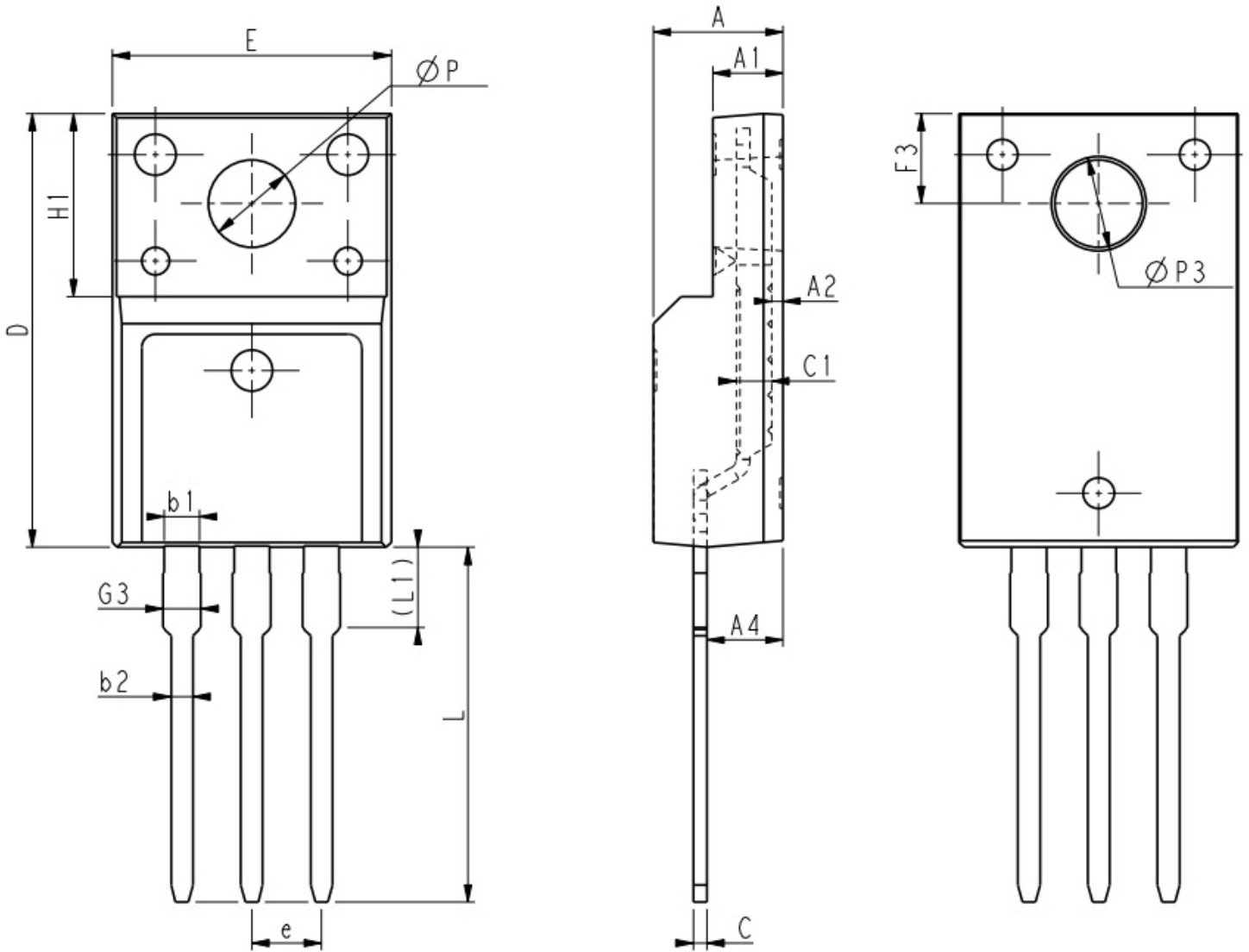


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





**TO-220F (封装厂 H)**



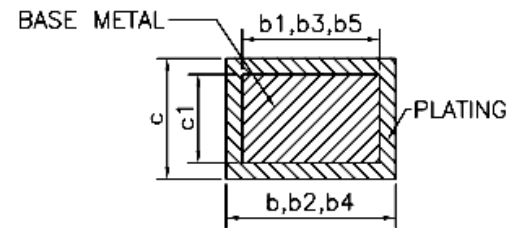
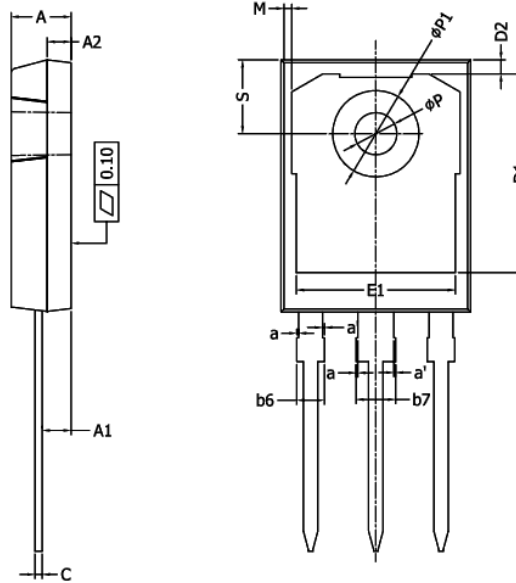
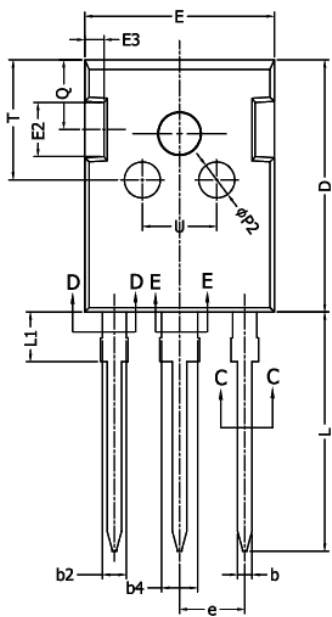
Unit:mm			
Symbol	Min.	Nom	Max.
E	9.96	10.16	10.36
A	4.50	4.70	4.90
A1	2.34	2.54	2.74
A2	0.30	0.45	0.60
A4	2.56	2.76	2.96
c	0.40	0.50	0.65
c1	1.20	1.30	1.35
D	15.57	15.87	16.17
H1	6.70REF		

Unit:mm			
Symbol	Min.	Nom	Max.
e	2.54BSC		
L	12.68	12.98	13.28
L1	2.93	3.03	3.13
$\Phi P$	3.03	3.18	3.38
$\Phi P3$	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





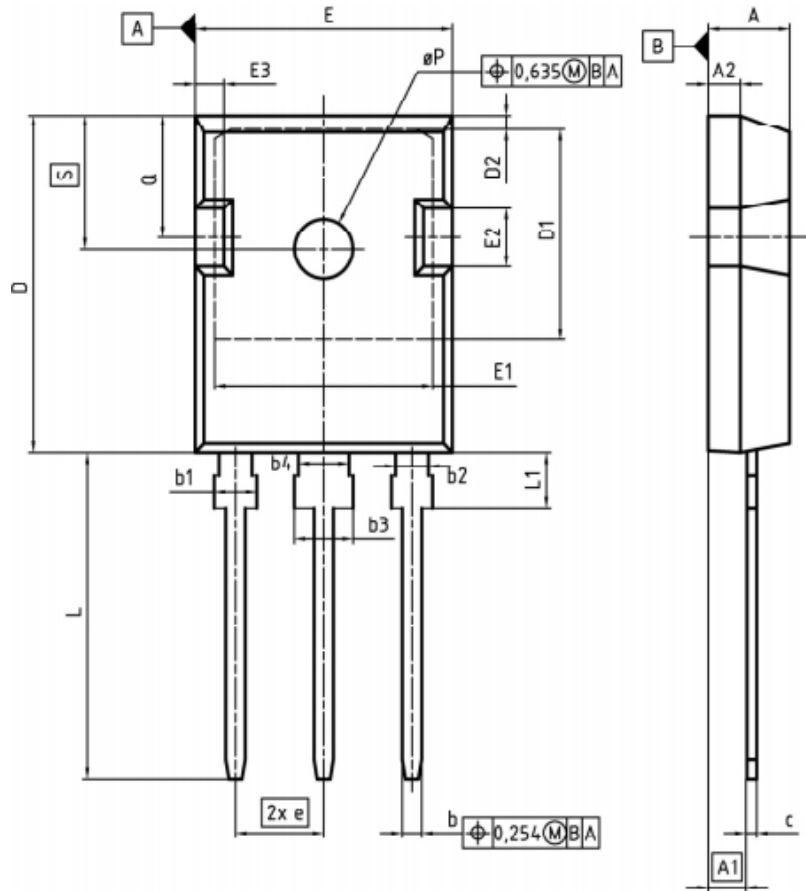
### TO-247 (封装厂 I)



SYMBOL	MIN	NOM	MAX
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
a	0	---	0.15
a'	0	---	0.15
b	1.16	---	1.26
b1	1.15	1.2	1.22
b2	1.96	---	2.06
b3	1.95	2.00	2.02
b4	2.96	---	3.06
b5	2.96	3.00	3.02
b6	---	---	2.25
b7	---	---	3.25
c	0.59	---	0.66
c1	0.58	0.60	0.62
D	20.90	21.00	21.10
D1	16.25	16.55	16.85
D2	1.05	1.17	1.35
E	15.70	15.80	15.90
E1	13.10	13.30	13.50
E2	4.40	4.50	4.60
E3	2.40	2.50	2.60
e	5.436 BSC		
L	19.80	19.92	20.10
L1	---	---	4.30
M	0.35	---	0.95
P	3.40	3.50	3.60
P1	7.00	---	7.40
P2	2.40	2.50	2.60
Q	5.60	---	6.00
S	6.05	6.15	6.25
T	9.80	---	10.20
U	6.00	---	6.40



TO-247 (封装厂 E)



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	0.176
øP	3.50	3.70	0.138	0.146
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248



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