



## 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, also fits the industrial grade applications,like AC-DC SMPS requirements for PFC, AC/DC power conversion, 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

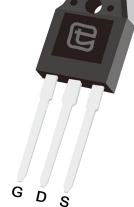
### APPLICATIONS

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

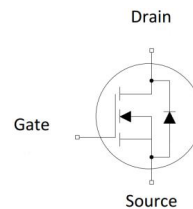
TO-220F



TO-3P



TO-247



### Device Marking and Package Information

Device	Package	Marking
TPA65R100MFD	TO-220F	65R100MFD
TPV65R100MFD	TO-3PN	65R100MFD
TPW65R100MFD	TO-247	65R100MFD

### Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	0.1	$\Omega$
$I_D$	47	A
$Q_{g,typ}$	75	nC
$I_{DM}$	141	A
$t_{rr}$	170	ns
$Q_{rr}$	1.05	$\mu$ C
$I_{rrm}$	12.4	A



Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ , unless otherwise noted				
Parameter	Symbol	Value		Unit
		TO-220F	TO-3PN/TO-247	
Drain-Source Voltage ( $V_{GS} = 0\text{V}$ )	$V_{DSS}$	650		V
Continuous Drain Current	$I_D$	$T_C = 25^\circ\text{C}$	47	A
		$T_C = 100^\circ\text{C}$	28.2	
Pulsed Drain Current (note1)	$I_{DM}$	141		A
Gate-Source Voltage	$V_{GSS}$	$\pm 30$		V
Single Pulse Avalanche Energy (note2)	$E_{AS}$	1160		mJ
Repetitive Avalanche Energy (note2)	$E_{AR}$	1.76		mJ
Avalanche Current	$I_{AR}$	8.7		A
MOSFET dv/dt ruggedness, $V_{DS} = 0 \dots 480\text{V}$	dv/dt	50		V/ns
Power Dissipation	$P_D$	37	391	W
Continuous Body Diode Current	$I_S$	40		A
Pulsed Diode Forward Current (note1)	$I_{SM}$	141		
Reverse diode dv/dt (note3)	dv/dt	50		V/ns
Maximum diode commutation speed (note3)	$di_f/dt$	900		A/us
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55~+150		$^\circ\text{C}$

Thermal Resistance				
Parameter	Symbol	Value		Unit
		TO-220F	TO-3PN/TO-247	
Thermal Resistance, Junction-to-Case	$R_{thJC}$	3.37	0.32	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Ambient	$R_{thJA}$	80	62	



Specifications $T_J = 25^\circ\text{C}$ , unless otherwise noted						
Parameter	Symbol	Test Conditions	Value			Unit
			Min.	Typ.	Max.	
<b>Static</b>						
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 250\mu A$	650	--	--	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 650V, V_{GS} = 0V, T_J = 25^\circ\text{C}$	--	--	5	$\mu A$
Gate-Source Leakage	$I_{GSS}$	$V_{GS} = \pm 30V$	--	--	$\pm 100$	nA
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\mu A$	3	--	5	V
Drain-Source On-Resistance	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 24A$	--	0.088	0.1	$\Omega$
Gate resistance	$R_G$	$f = 1.0\text{MHz}$ open drain	--	0.8	--	$\Omega$
<b>Dynamic</b>						
Input Capacitance	$C_{ISS}$	$V_{GS} = 0V,$ $V_{DS} = 100V,$ $f = 1.0\text{MHz}$	--	3587	--	pF
Output Capacitance	$C_{OSS}$		--	106	--	
Reverse Transfer Capacitance	$C_{RSS}$		--	2.6	--	
Total Gate Charge	$Q_g$	$V_{DD} = 520V, I_D = 47A,$ $V_{GS} = 10V$	--	78	--	nC
Gate-Source Charge	$Q_{gs}$		--	24	--	
Gate-Drain Charge	$Q_{gd}$		--	32	--	
Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 400V, I_D = 47A,$ $R_G = 25\Omega$	--	49	--	ns
Turn-on Rise Time	$t_r$		--	123	--	
Turn-off Delay Time	$t_{d(off)}$		--	105	--	
Turn-off Fall Time	$t_f$		--	49	--	
<b>Drain-Source Body Diode Characteristics</b>						
Body Diode Voltage	$V_{SD}$	$T_J = 25^\circ\text{C}, I_{SD} = 24A, V_{GS} = 0V$	--	1.0	1.5	V
Reverse Recovery Time	$t_{rr}$	$V_R = 400V, I_F = 23A,$ $di_F/dt = 100A/\mu s$	--	170	--	ns
Reverse Recovery Charge	$Q_{rr}$		--	1.05	--	$\mu C$
Peak Reverse Recovery Current	$I_{rrm}$		--	12.4	--	A

**Notes**

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $I_{AS} = 8.7A, V_{DD} = 50V, R_G = 25\Omega$ , 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

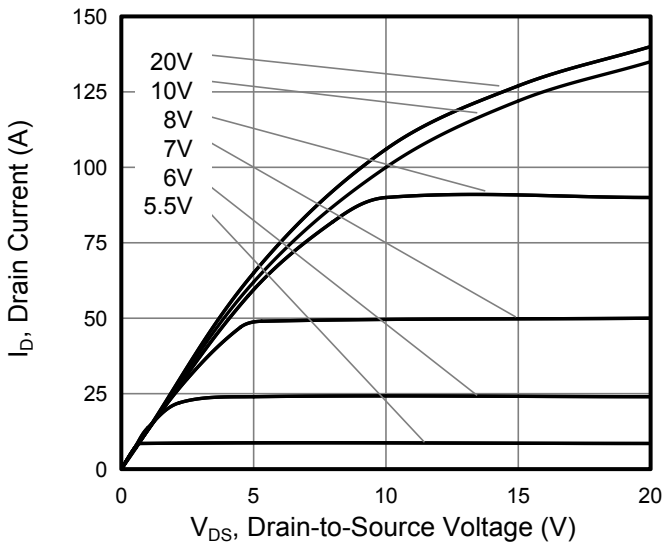


Figure 2. Transfer Characteristics

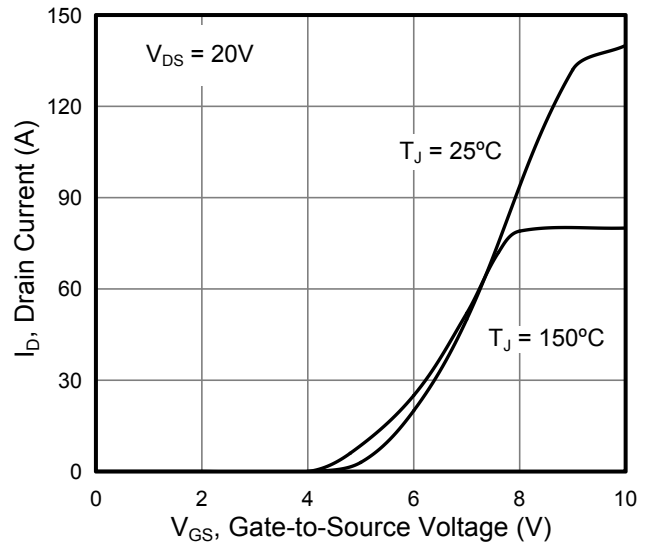


Figure 3. On-Resistance vs. Drain Current

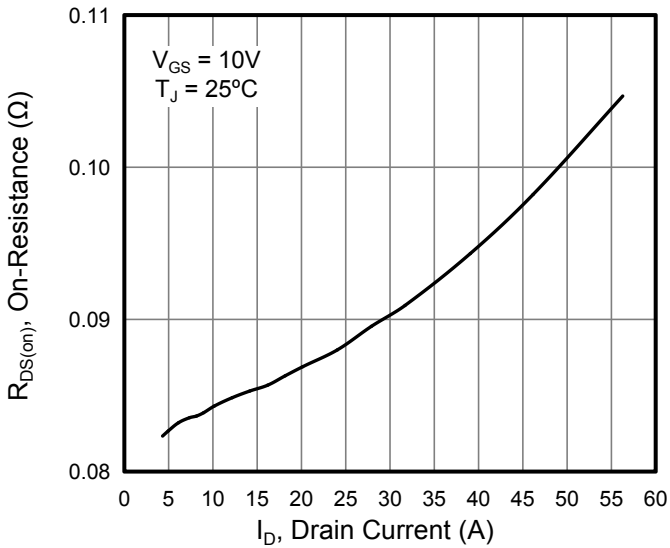


Figure 4. Capacitance

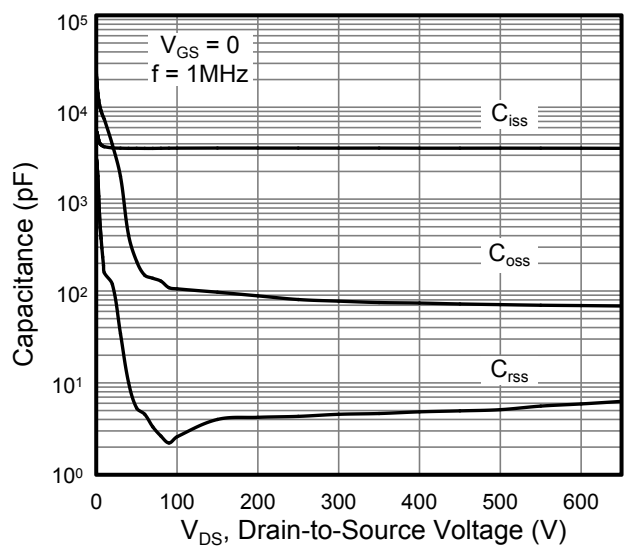


Figure 5. Gate Charge

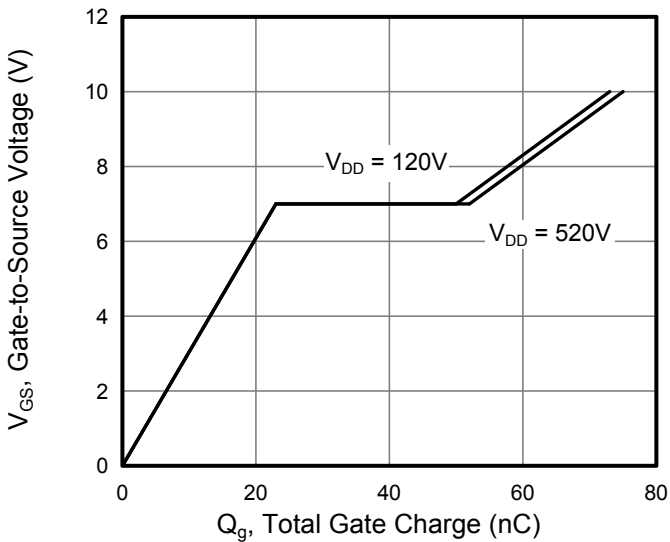
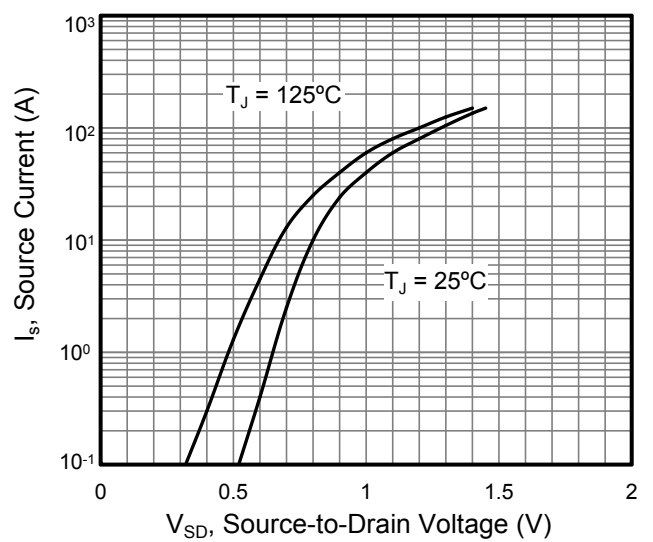


Figure 6. Body Diode Forward Voltage





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

Figure 7. On-Resistance vs. Junction Temperature

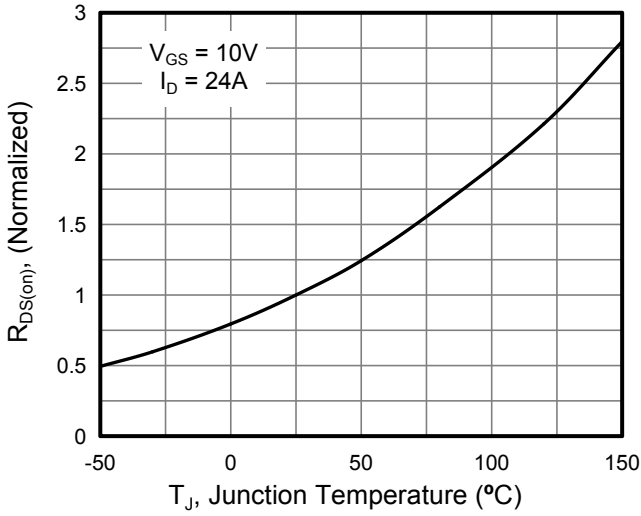


Figure 8. Breakdown voltage vs. Junction Temperature

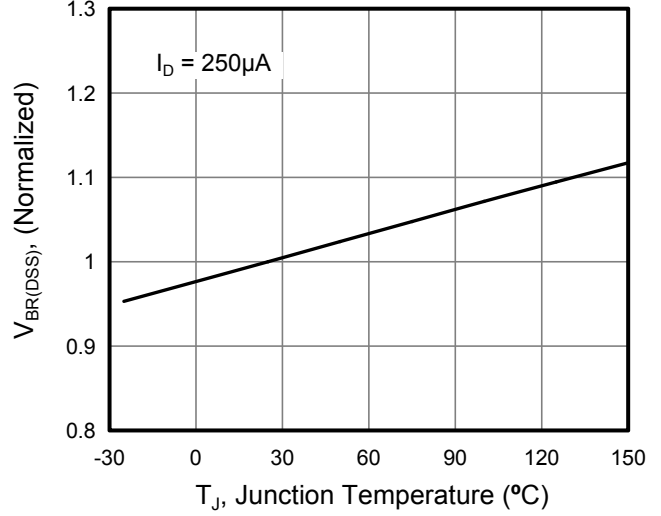


Figure 9. Transient Thermal Impedance for TO-220F

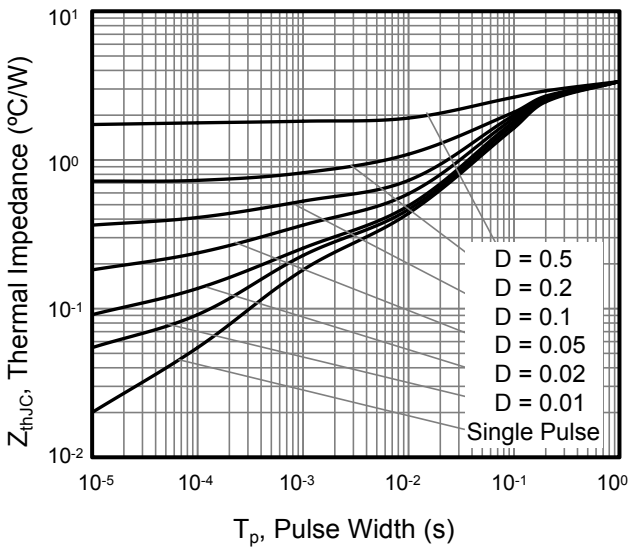


Figure 10. Safe operation area for TO-220F

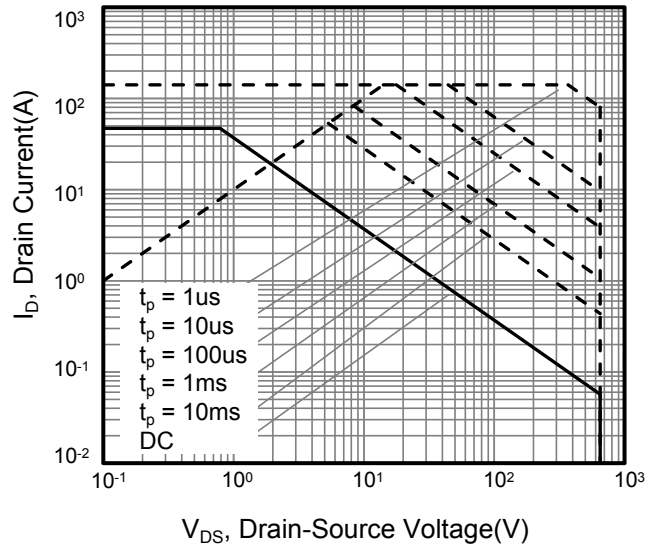


Figure 11. Transient Thermal Impedance for TO-3PN/TO-247

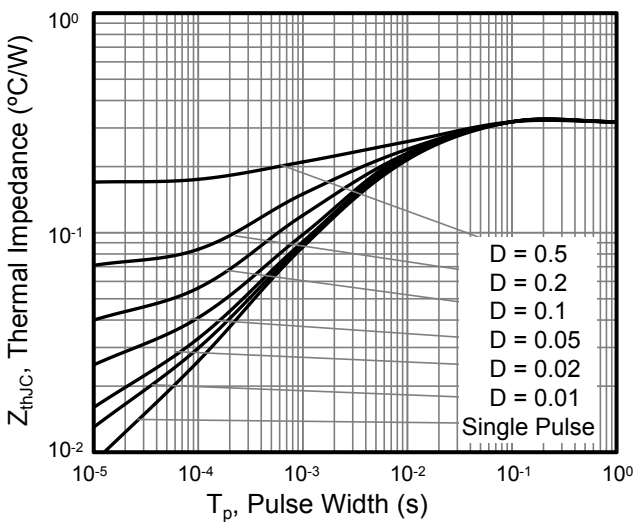


Figure 12. Safe operation area for TO-3PN/TO-247

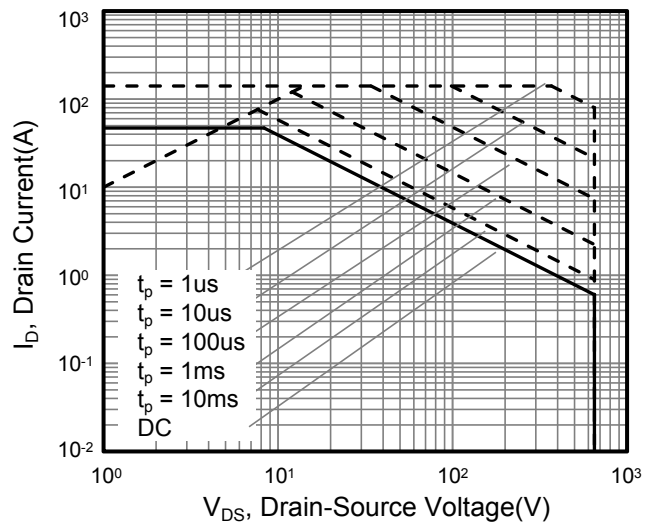




Figure A: Gate Charge Test Circuit and Waveform

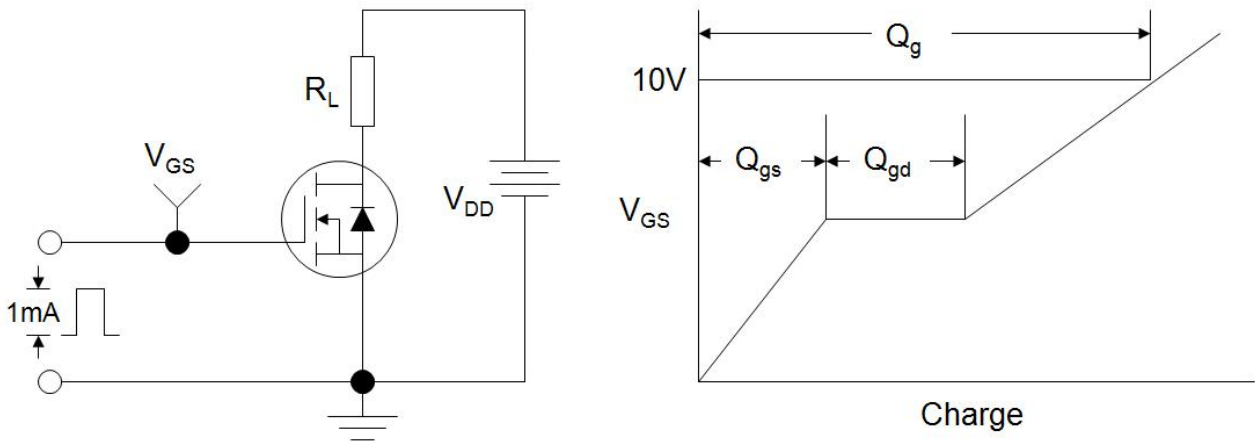


Figure B: Resistive Switching Test Circuit and Waveform

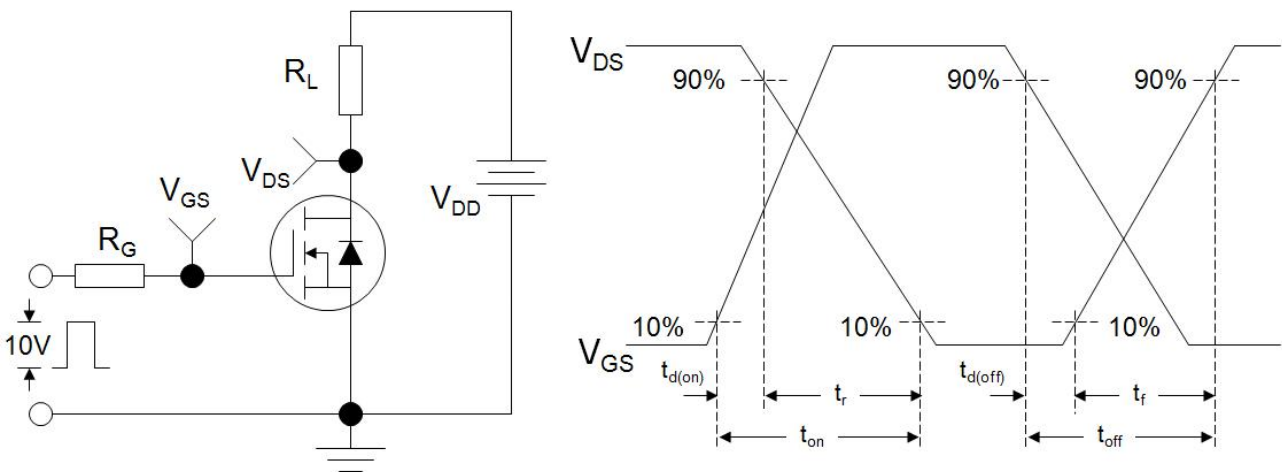
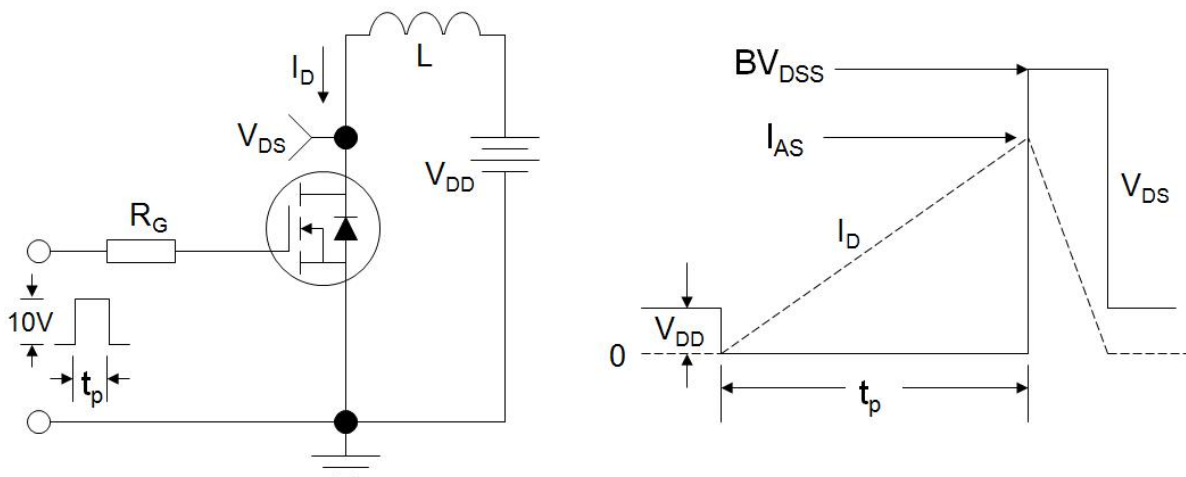
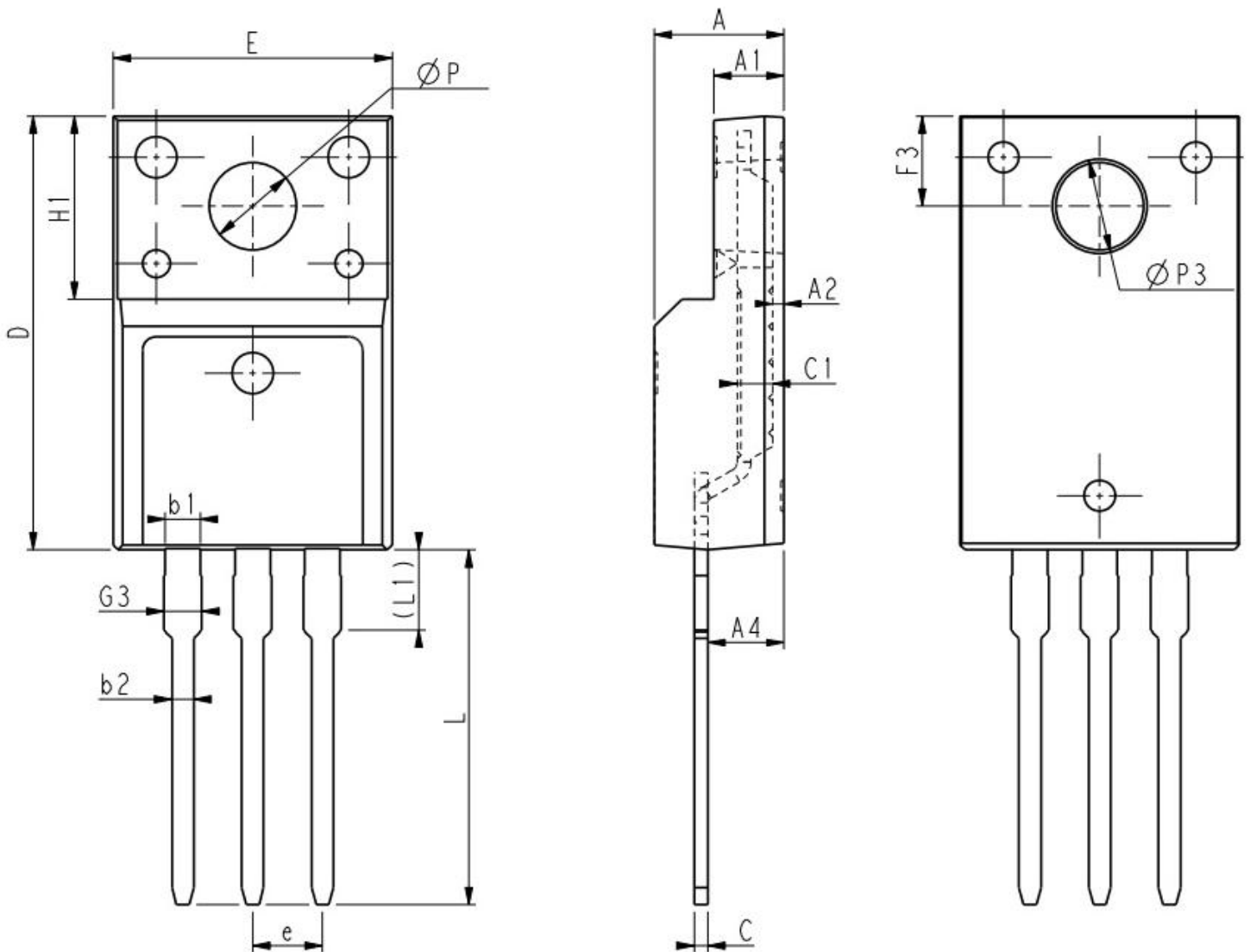


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





### TO-220F

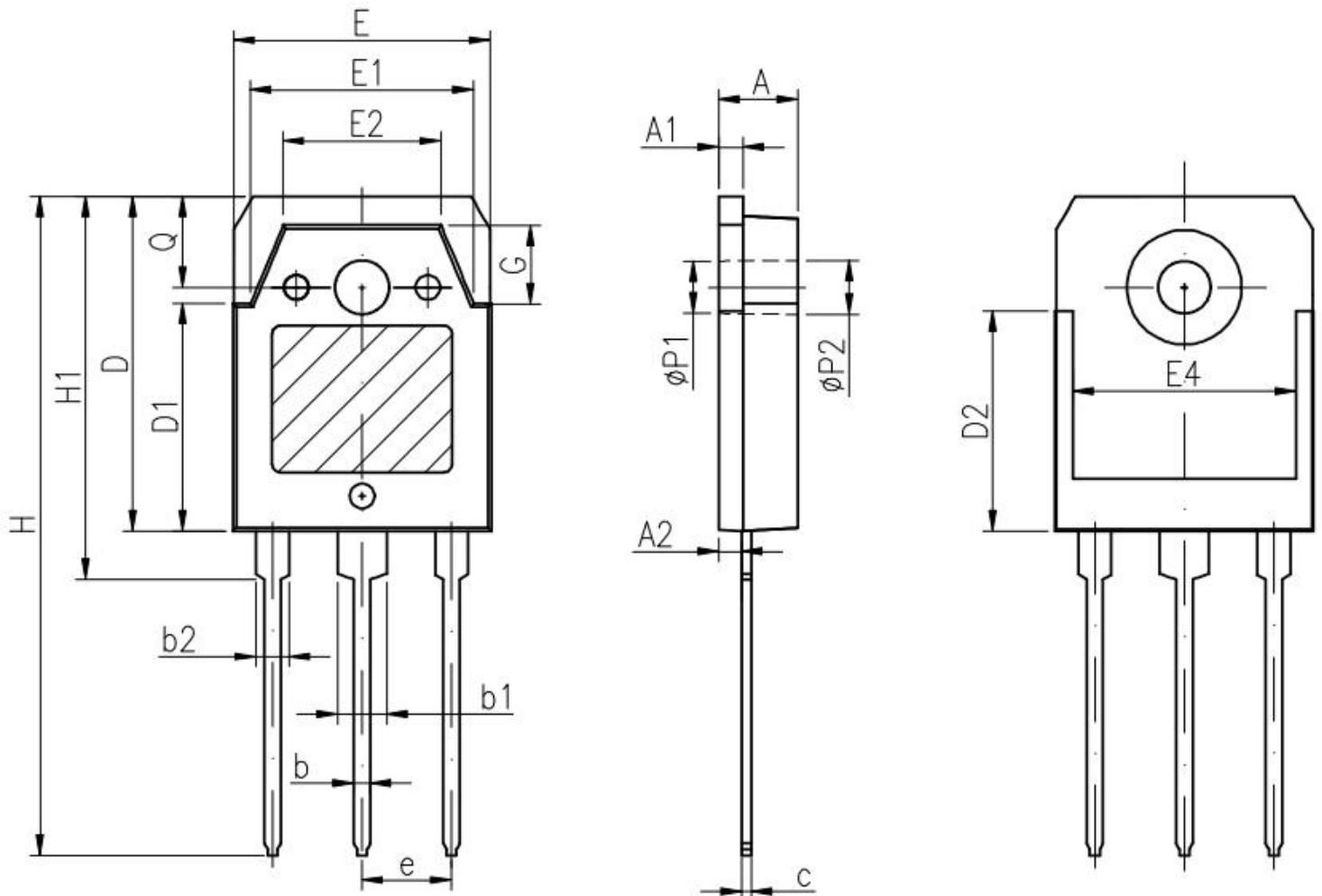


Unit:mm			
Symbol	Min.	Nom	Max.
E	9.96	10.16	10.36
A	4.50	4.70	4.90
A1	2.34	2.54	2.74
A2	0.30	0.45	0.60
A4	2.56	2.76	2.96
c	0.40	0.50	0.65
c1	1.20	1.30	1.35
D	15.57	15.87	16.17
H1	6.70REF		

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-3PN



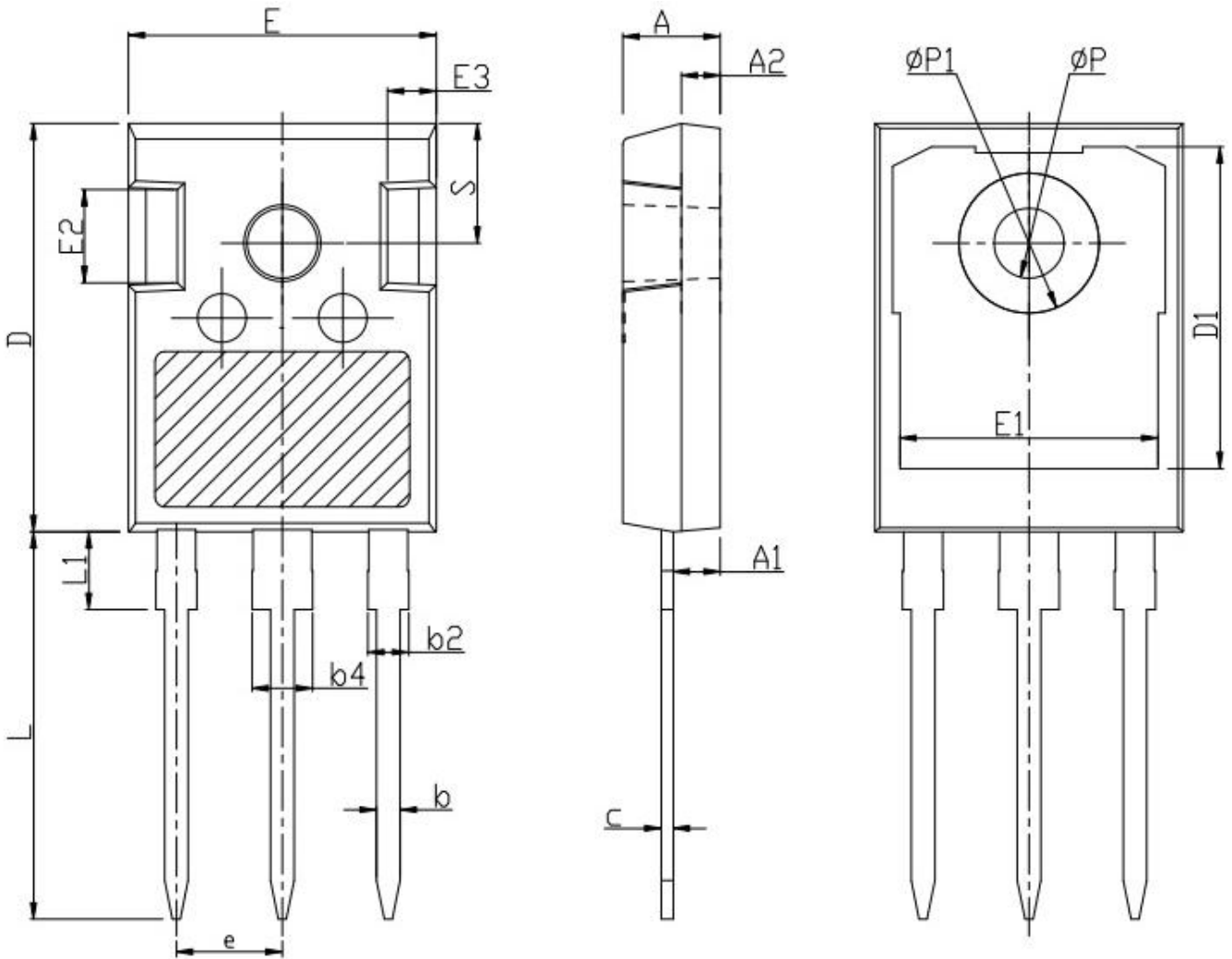
Unit:mm			
Symbol	Min.	Nom	Max.
A	4.60	4.80	5.00
A1	1.40	1.50	1.65
A2	1.18	1.38	1.58
b	0.80	1.00	1.20
b1	2.80	3.00	3.20
b2	1.80	2.00	2.20
c	0.50	0.60	0.75
D	19.60	19.90	20.20
D1	13.55	13.90	14.25
D2	12.90 REF		

Unit:mm			
Symbol	Min.	Nom	Max.
E	15.35	15.60	15.85
E1	13.40	13.60	13.80
E2	9.40	9.60	9.80
E4	12.60	-	-
e	5.45 TYP		
G	4.55	4.80	5.05
H	40.10	40.50	40.90
H1	23.15	23.40	23.65
φP1	3.20 REF		
φP2	3.50REF		
Q	5.00 REF		





### TO-247



Unit:mm			
Symbol	Min.	Nom	Max.
A	4.80	5.00	5.20
A1	2.21	2.41	2.61
A2	1.85	2.00	2.15
b	1.11	1.21	1.36
b2	1.91	2.01	2.21
b4	2.91	3.01	3.21
c	0.51	0.61	0.75
D	20.70	21.00	21.30
D1	16.25	16.55	16.85

Unit:mm			
Symbol	Min.	Nom.	Max.
E	15.50	15.80	16.10
E1	13.00	13.30	13.60
E2	4.80	5.00	5.20
E3	2.30	2.50	2.70
e	5.44BSC		
L	19.62	19.92	20.22
L1	-	-	4.30
phi P	3.40	3.60	3.80
phi P1	-	-	7.30
S	6.15BSC		



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