

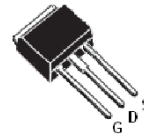
## 650V N-Channel Super Junction power MOSFET

### DESCRIPTION

SJ MOSFET is an advanced technology for high voltage power MOSFETs, designed according to the super junction principle by P&S. The offered devices provide all benefits of a fast switching and low on resistance, making it especially suitable for applications which require more efficient, more compact, LED Lighting, High Performance Adapter etc..

$V_{DS}$	650	V
$R_{DS(ON)}$	850	m $\Omega$
$I_D$	5	A

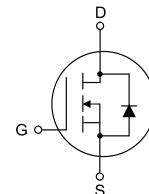
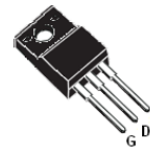
TO-251



TO-252



TO-220F



### Features

- Extremely low losses due to very low  $R_{dson} \cdot Q_g$
- Superior Avalanche Rugged Technology
- Fast switching capability
- 100% Avalanche Tested
- Pb-free lead plating; ROHS compliant

### APPLICATIONS

- Power factor correction (PFC)
- Switched mode power supplies(SMPS)
- Uninterruptible Power Supply (UPS)
- High Performance Adapter
- LED Lighting Power

### ORDERING INFORMATION

Temperature Range	Package	Orderable Device	Package Qty.
-55°C ~ +125°C	TO-251	CWS5N65AT	72 PCS/Tube
	TO-252	CWS5N65ADR	2500 PCS/ R&T
	TO-220F	CWS5N65AF	50 PCS/Tube



**ABSOLUTE MAXIMUM RATINGS**(T<sub>J</sub>=25°C, unless otherwise noted)

Parameter	Symbol	Value	Unit
Drain-Source Voltage (V <sub>GS</sub> =0V)	V <sub>DSS</sub>	650	V
Gate-Source Voltage (V <sub>DS</sub> =0V, static)	V <sub>GS</sub>	±30	V
Continuous Drain Current (T <sub>C</sub> =25 °C)(Note 1)	I <sub>D(DC)</sub>	5	A
Continuous Drain Current (T <sub>C</sub> =100 °C) (Note 1)	I <sub>D(DC)</sub>	3	A
Pulsed Drain Current (Note 2)	I <sub>DM</sub>	15	A
MOSFET dv/dt ruggedness, V <sub>DS</sub> ≤480 V	dv/dt	50	V/nS
Single Pulsed Avalanche Energy (Note 3)	E <sub>AS</sub>	125	mJ
Avalanche Energy, Repetitive (Note 1)	E <sub>AR</sub>	0.3	mJ
Avalanche Current, Repetitive (Note 1)	I <sub>AR</sub>	2	A
Maximum Power Dissipation (T <sub>C</sub> =25 °C)	P <sub>D</sub>	37	W
Operating, Storage Temperature Range	T <sub>J</sub> , T <sub>STG</sub>	-55~150	°C

**THERMAL CHARACTERISTICS**

Parameter	Symbol	Min.	Typ.	Max.	Units
Thermal Resistance, Junction-to-Case	R <sub>thJC</sub>	-	-	3.4	°C/W
Thermal Resistance, Junction-to-Ambient	R <sub>thJA</sub>	-	-	62	°C/W

**ELECTRICAL CHARACTERISTICS**(T<sub>J</sub> = 25°C, unless otherwise noted)

Parameter	Symbol	Test Conditions	Min.	TYP.	Max.	Unit
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> =0V, I <sub>D</sub> =250μA	650	-	-	V
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> =650V, V <sub>GS</sub> =0V	-	-	1	μA
Gate-Source Leakage Current	I <sub>GSS</sub>	V <sub>GS</sub> =±30V, V <sub>DS</sub> =0V	-	-	±100	nA
Gate Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250μA	2.5	3.0	3.5	V
Drain-Source On-state Resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> =10V, I <sub>D</sub> =2.5A	-	0.70	0.85	Ω
Gate Resistance	R <sub>g</sub>	F=1MHZ, open drain	-	11.5	-	Ω



## Dynamic Characteristics

( $T_j = 25^\circ\text{C}$ , unless otherwise noted)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Input capacitance	$C_{iss}$	$V_{DS}=100\text{V}, V_{GS}=0\text{V},$ $f=1\text{MHz}$	-	391	-	pF
Output capacitance	$C_{oss}$		-	18.4	-	
Reverse transfer capacitance	$C_{rss}$		-	1.77	-	
Turn-on delay Time	$t_{d(on)}$	$V_{DD}=480\text{V}, I_D=5\text{A}$ $R_G=10\Omega, V_{GS}=10\text{V}$	-	18	-	ns
Rise time	$t_r$		-	20		
Turn-off delay time	$t_{d(off)}$		-	49		
Fall time	$t_f$		-	22		

## Gate charge characteristics

( $T_j = 25^\circ\text{C}$ , unless otherwise noted)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Gate to Source Charge	$Q_{gs}$	$V_{DD}=480\text{V}, I_D=5\text{A}$ $V_{GS}=0$ to $10\text{V}$	-	2.1	-	nC
Gate to Drain Charge	$Q_{gd}$		-	2.6	-	
Gate Charge Total	$Q_g$		-	9.2	-	
Gate Plateau Voltage	$V_{plateau}$		-	4.4	-	V

## Reverse diode characteristics

( $T_j = 25^\circ\text{C}$ , unless otherwise noted)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Body Diode Forward Voltage	$V_{SD}$	$V_{GS}=0\text{V}, I_{SD}=5\text{A}$	-	0.9	-	V
Reverse Recovery Time	$t_{rr}$	$V_R=480\text{V}, I_F=5\text{A}$ $di_F/dt=100\text{A}/\mu\text{s}$	-	192	-	nS
Reverse Recovery Charge	$Q_{rr}$		-	1.7	-	$\mu\text{C}$
Peak Reverse Recovery Current	$I_{rrm}$		-	14.2	-	A

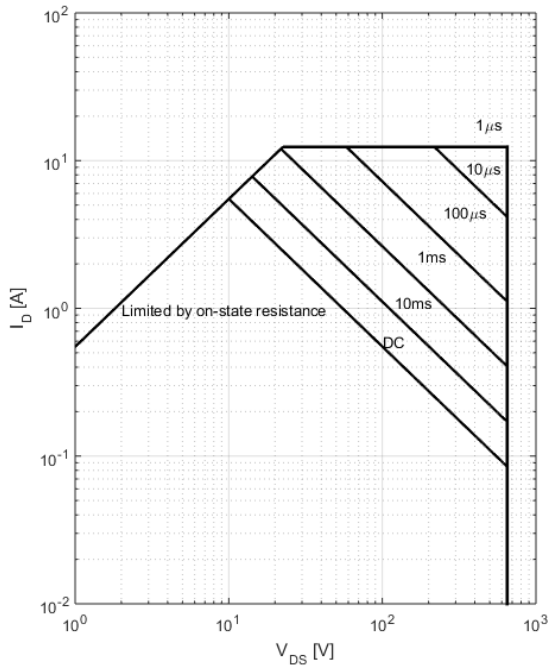
### Notes:

1. Limited by maximum junction temperature;
2. Pulse width limited by maximum junction temperature;
3.  $I_{AS} = 2.0\text{ A}$ ,  $V_{DD} = 50\text{ V}$ ,  $R_G = 25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$ .



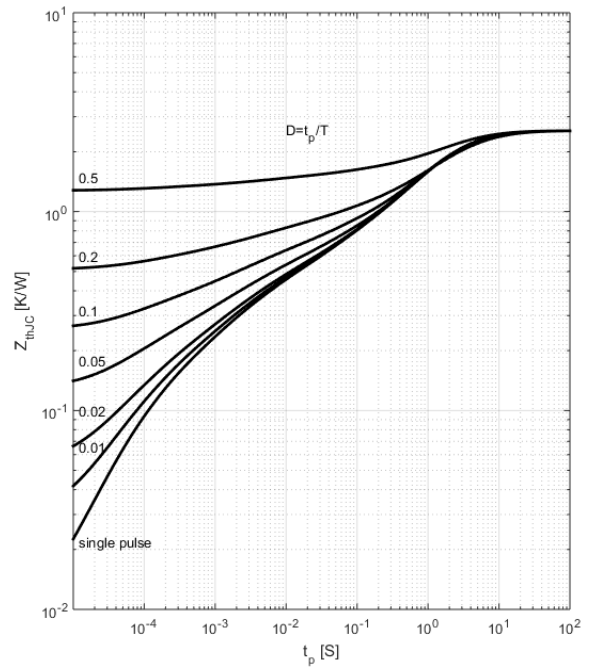
## ELECTRICAL CHARACTERISTICS DIAGRAMS

**Figure 1. Safe operating area**



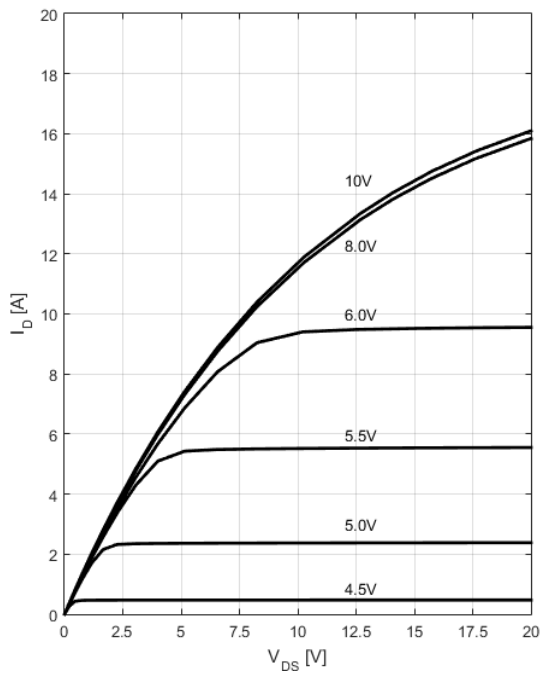
$I_D = f(V_{DS}); T_c = 25^\circ\text{C};$  parameter  $t_p$

**Figure 2. Transient thermal impedance**



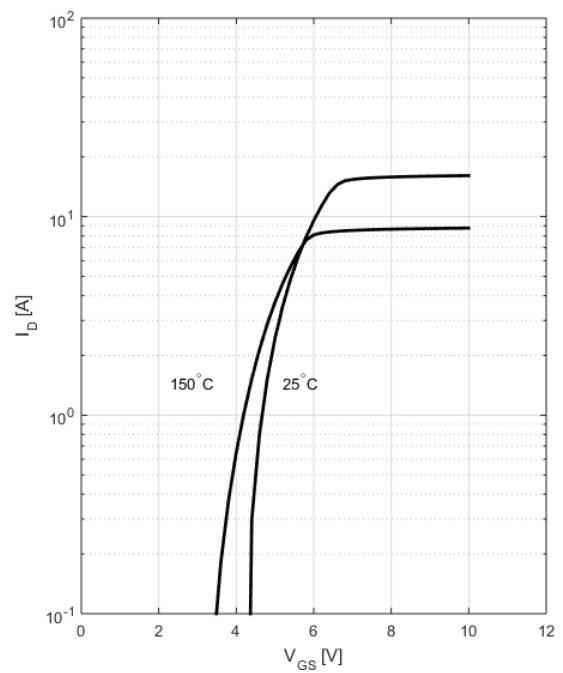
$Z_{(thJC)} = f(t_p);$  parameter:  $D = t_p / T$

**Figure 3. Typ. output characteristics**



$I_D = f(V_{DS}); T_j = 25^\circ\text{C};$  parameter:  $V_{GS}$

**Figure 4. Typ. transfer characteristics**



$I_D = f(V_{GS}); V_{DS} = 20\text{V}$

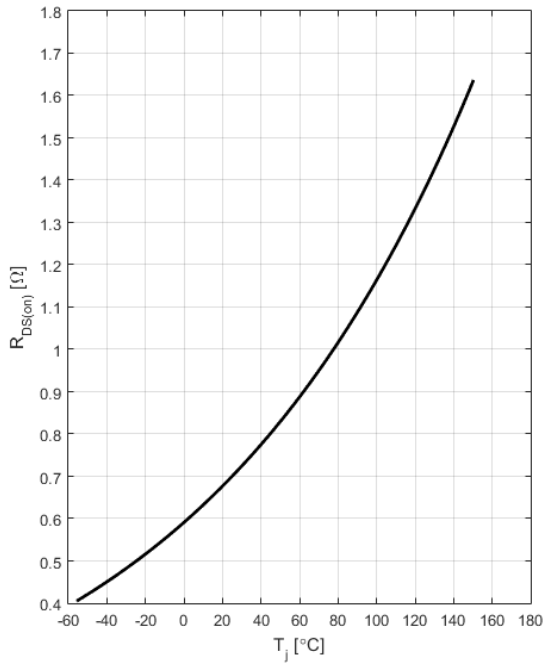


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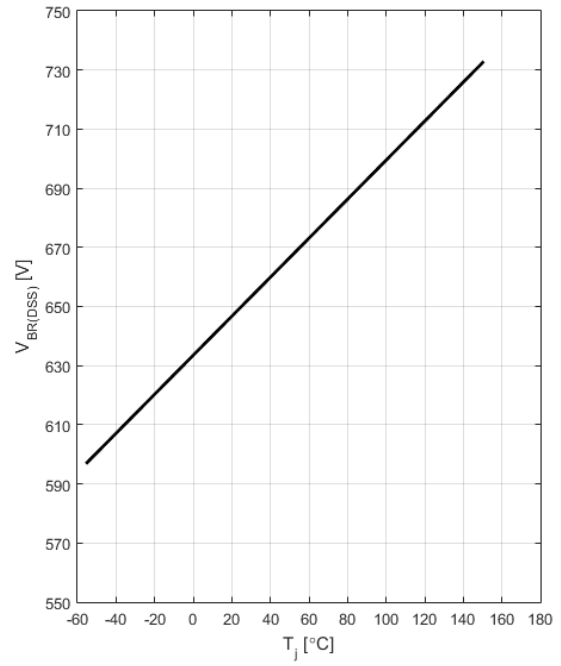
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**Figure 5. Drain-source on-state resistance**



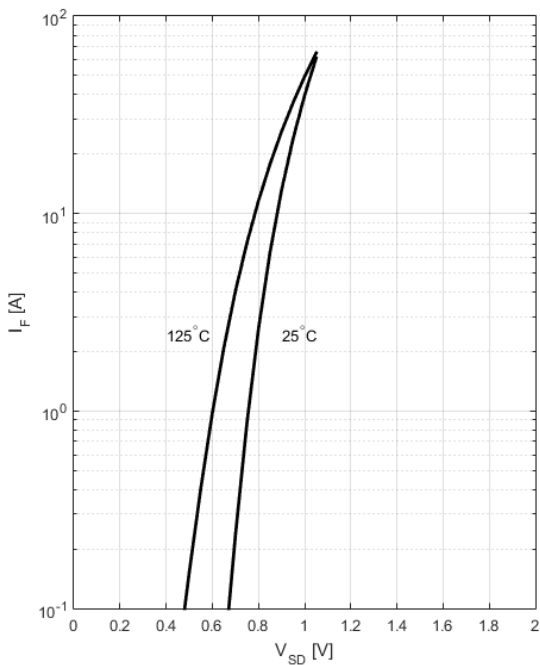
**$R_{DS(ON)}=f(T_j)$ ;  $I_D=2.5A$ ;  $V_{GS}=10V$**

**Figure6. Drain-source breakdown voltage**



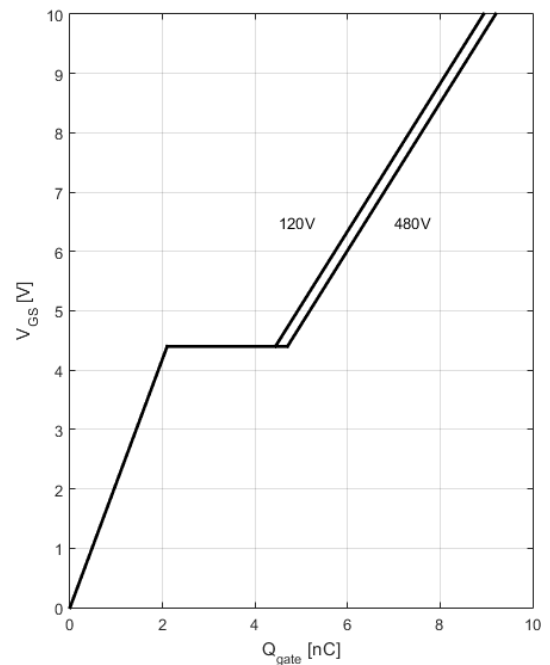
**$V_{BR(DSS)}=f(T_j)$ ;  $I_D=10mA$**

**Figure7. Forward characteristics of reverse diode**



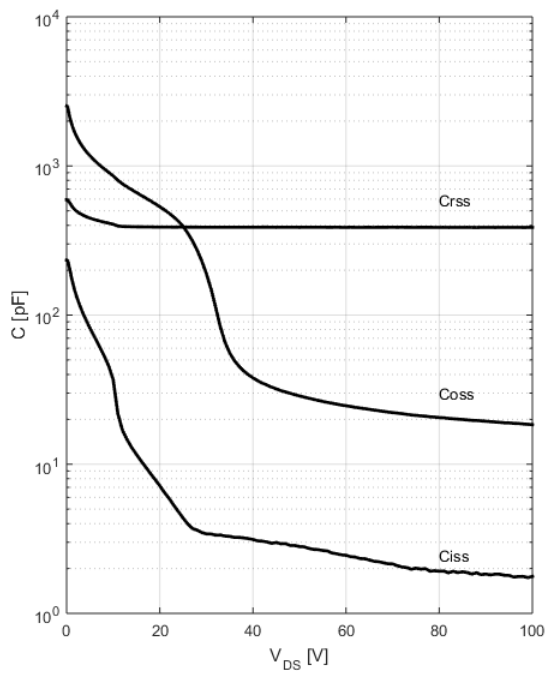
**$I_F=f(V_{SD})$ ; parameter:  $T_j$**

**Figure 8. Typ. gate charge**



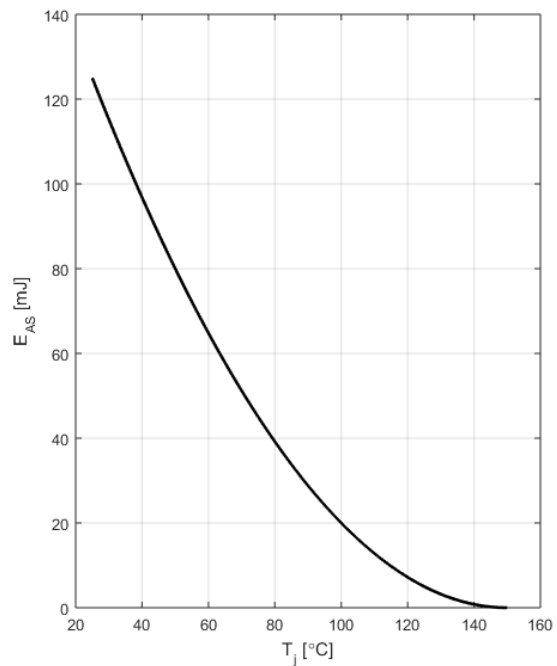
**$V_{GS}=f(Q_{gate})$ ,  $I_D=5A$  pulsed**

**Figure 9: Typ. capacitances**



**$C=f(V_{DS}); V_{GS}=0; f=1\text{MHz}$**

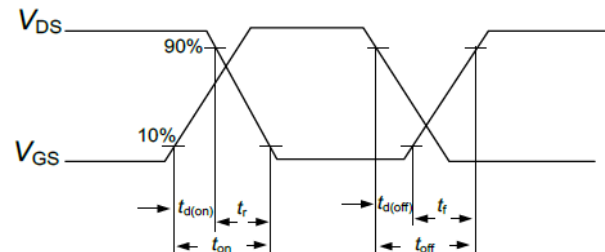
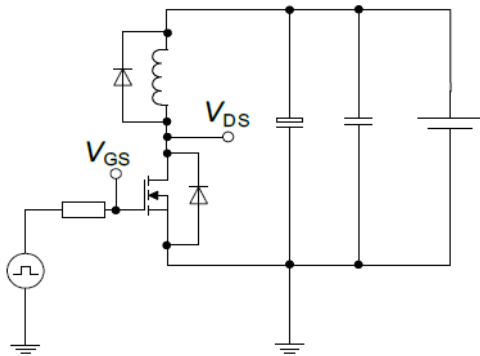
**Figure 10: Avalanche energy**



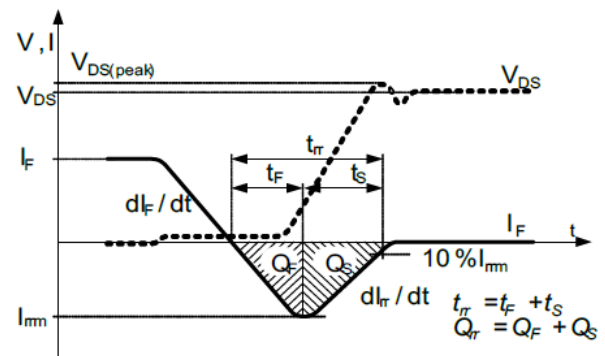
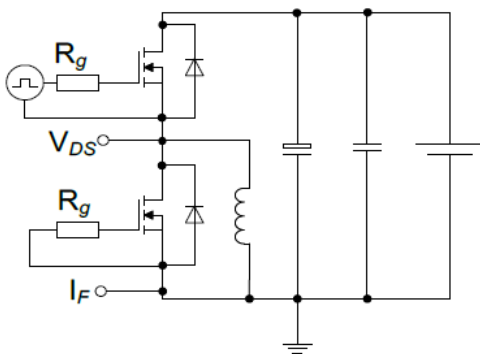
**$E_{AS}=f(T_j); I_D=2\text{A}; V_{DD}=50\text{V}$**

## Test Circuits

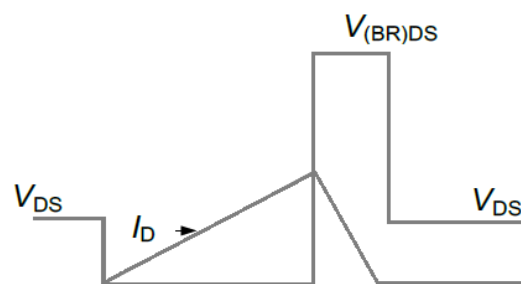
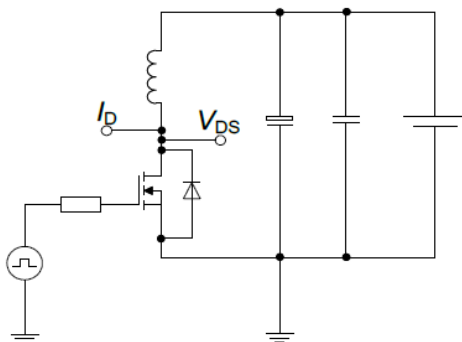
### Switch time test circuit



### Reverse diode characteristics test circuit and waveform

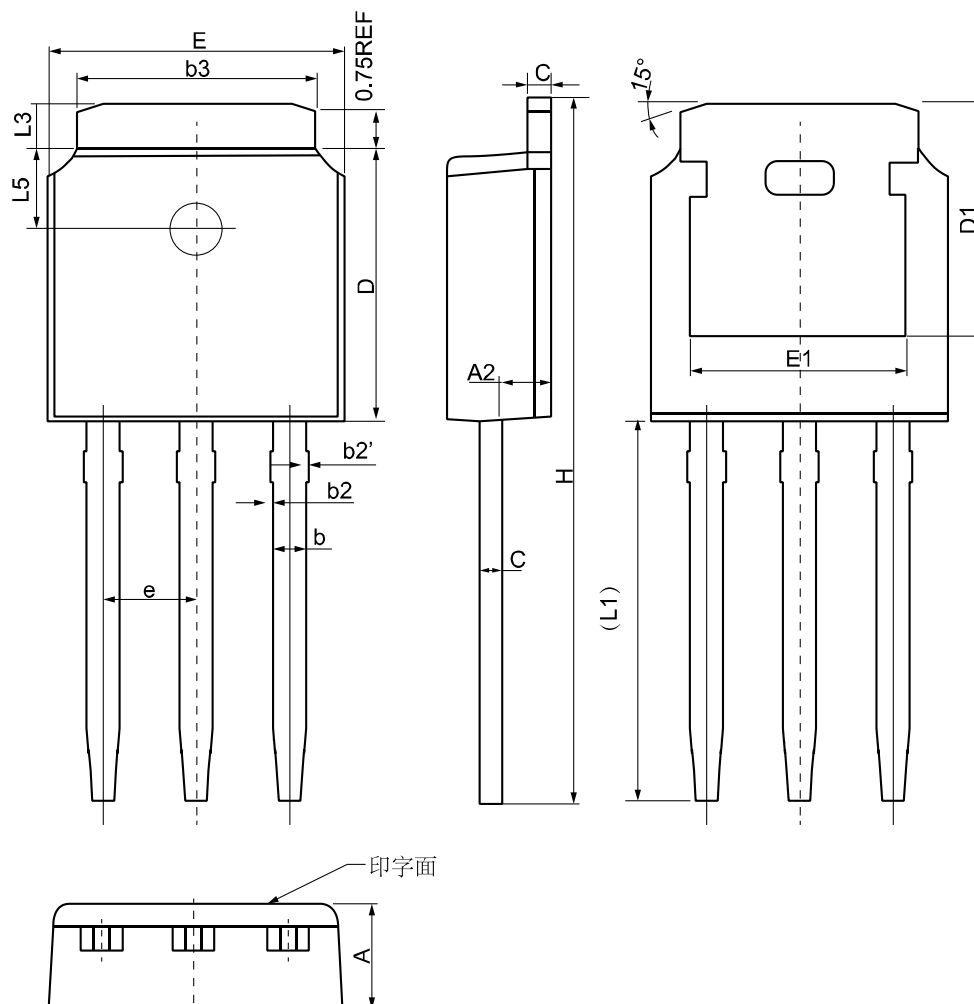


### Unclamped inductive switching test circuit & waveform



## PHYSICAL DIMENSIONS

TO-251



Symbol	Dimension (mm)			Symbol	Dimension (mm)		
	Min	Nom	Max		Min	Nom	Max
A	2.20	2.30	2.40	D1	5.30(REF)		
A2	0.97	1.07	1.17	E	6.40	6.60	6.80
b	0.68	0.78	0.90	E1	4.63	-	-
b2	0.00	0.04	0.10	e	2.286(BSC)		
b2'	0.00	0.04	0.10	H	16.22	16.52	16.82
b3	5.20	5.33	5.50	L1	9.15	9.40	9.65
c	0.43	0.53	0.63	L3	0.88	1.02	1.28
D	5.98	6.10	6.22	L5	1.65	1.80	1.95



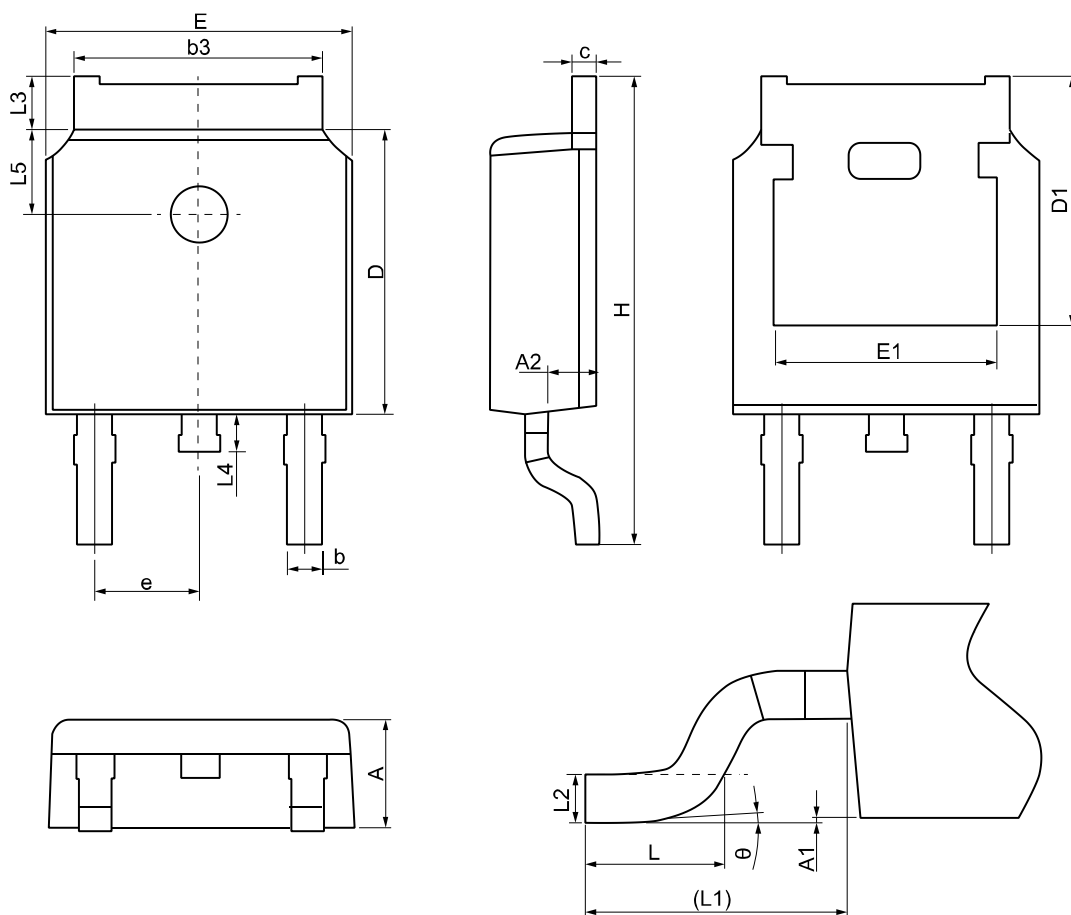
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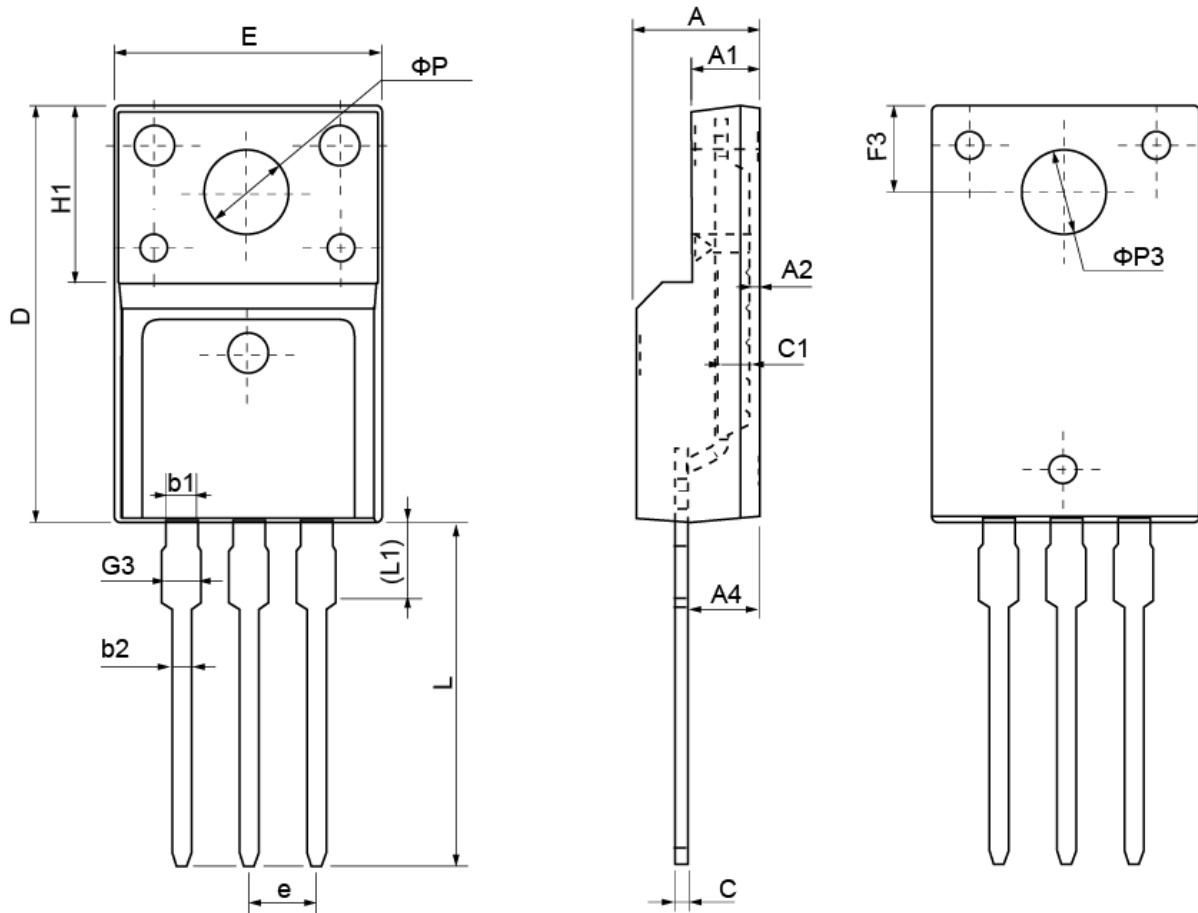
## TO-252



Symbol	Dimension (mm)			Symbol	Dimension (mm)		
	Min	Nom	Max		Min	Nom	Max
A	2.20	2.30	2.40	e	2.286(BSC)		
A1	0.00	-	0.20	H	9.40	10.10	10.50
A2	0.97	1.07	1.17	L	1.38	1.50	1.75
b	0.68	0.78	0.90	L1	2.90(REF)		
b3	5.20	5.33	5.50	L2	0.51(BSC)		
c	0.43	0.53	0.63	L3	0.88	-	1.28
D	5.98	6.10	6.22	L4	0.50	-	1.00
D1	5.30(REF)			L5	1.65	1.80	1.95
E	6.40	6.60	6.80	θ	0°	-	8°
E1	4.63	-	-	-	-	-	-



## TO-220F



Symbol	Dimension (mm)			Symbol	Dimension (mm)		
	Min	Nom	Max		Min	Nom	Max
E	9.96	10.16	10.36	e	2.54(BSC)		
A	4.50	4.70	4.90	L	12.68	12.98	13.28
A1	2.34	2.54	2.74	L1	2.93	3.03	3.13
A2	0.30	0.45	0.60	$\Phi P$	3.03	3.18	3.38
A4	2.56	2.76	2.96	$\Phi P3$	3.15	3.45	3.65
c	0.40	0.50	0.65	F3	3.15	3.30	3.45
c1	1.20	1.30	1.35	G3	1.25	1.35	1.55
D	15.57	15.87	16.17	b1	1.18	1.28	1.43
H1	6.70(REF)			b2	0.70	0.80	0.95

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