Truesemi

September, 2013

SJ-FET

TSP20N65S,TSF20N65S, TSB20N65S
650V N-Channel MOSFET

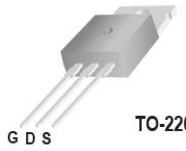
Description

SJ-FET is new generation of high voltage MOSFET family that is utilizing an advanced charge balance mechanism for outstanding low on-resistance and lower gate charge performance.

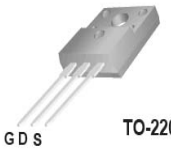
This advanced technology has been tailored to minimize conduction loss, provide superior switching performance, and withstand extreme dv/dt rate and higher avalanche energy. SJ-FET is suitable for various AC/DC power conversion inswitching mode operation for higher efficiency.

Features

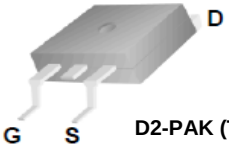
- 650V @TJ = 150 ℃
- Typ. RDS(on) = 0.16 Ω
- Ultra Low Gate Charge (typ. Qg = 63nC)
- 100% avalanche tested
- Rohs Compliant



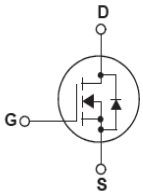
TO-220



TO-220F



D2-PAK (TO-263)



Absolute Maximum Ratings

Symbol	Parameter	TSB20N65S	TSP20N65S	TSF20N65S	Unit
V_{DSS}	Drain-Source Voltage		650		V
I_D	Drain Current -Continuous (TC = 25℃) -Continuous (TC = 100℃)	20* 10*	20 10	20* 10*	A
I_{DM}	Drain Current - Pulsed (Note 1)	60*	60	60*	A
V_{GSS}	Gate-Source voltage		±30		V
E_{AS}	Single Pulsed Avalanche Energy (Note 2)		600		mJ
I_{AR}	Avalanche Current (Note 1)		20		A
E_{AR}	Repetitive Avalanche Energy (Note 1)		20.5		mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)		4.5		V/ns
P_D	Power Dissipation (TC = 25℃) -Derate above 25℃	151 1.5	151 1.67	35 0.3	W W/℃
T_J, T_{STG}	Operating and Storage Temperature Range		-55 to +150		℃
T_L	Maximum Lead Temperature for Soldering Purpose, 1/8" from Case for 5 Seconds		300		℃

* Drain current limited by maximum junction temperature.

Thermal Characteristics

Symbol	Parameter	TSB20N65S	TSP20N65S	TSF20N65S	Unit
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	1.5	0.6	3.6	℃/W
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink Typ.	0.5	--	--	℃/W
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	75	62	62	℃/W

Electrical Characteristics TC = 25℃ unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Off Characteristics						
BVDSS	Drain-Source Breakdown Voltage	VGS = 0V, ID = 250μA, TJ = 25℃	650	--	--	V
		VGS = 0V, ID = 250μA, TJ = 150℃	--	700	--	V
ΔBVDSS / ΔTJ	Breakdown Voltage Temperature Coefficient	ID = 250μA, Referenced to 25℃	--	0.6	--	V/℃
IDSS	Zero Gate Voltage Drain Current	VDS = 650V, VGS = 0V VDS =480V, TC = 125℃	--	--	1 10	μA μA
IGTSF	Gate-Body Leakage Current, Forward	VGS = 30V, VDS = 0V	--	--	100	nA
IGSSR	Gate-Body Leakage Current, Reverse	VGS = -30V, VDS = 0V	--	--	-100	nA
On Characteristics						
VGS(th)	Gate Threshold Voltage	VDS = VGS, ID = 250μA	2.5	--	4.5	V
RDS(on)	Static Drain-Source On-Resistance	VGS = 10V, ID = 10A	--	0.16	0.19	Ω
gFS	Forward Transconductance	VDS = 40V, ID =5A (Note 4)	--	16	--	S
Rg	Gate Resistance	F=1MHz, open drain	--	4.5	--	Ω
Dynamic Characteristics						
Ciss	Input Capacitance	VDS = 25V, VGS = 0V, f = 1.0MHz	--	1440	1870	pF
Coss	Output Capacitance		--	300	--	pF
Crss	Reverse Transfer Capacitance		--	10	--	pF
Switching Characteristics						
td(on)	Turn-On Delay Time	VDD = 400V, ID = 10A RG = 20Ω (Note 4, 5)	--	25	--	ns
tr	Turn-On Rise Time		--	55	--	ns
td(off)	Turn-Off Delay Time		--	70	--	ns
tf	Turn-Off Fall Time		--	40	--	ns
Qg	Total Gate Charge	VDS = 480V, ID = 20A VGS = 10V (Note 4, 5)	--	70	-80	nC
Qgs	Gate-Source Charge		--	7.8	--	nC
Qgd	Gate-Drain Charge		--	9	--	nC
Drain-Source Diode Characteristics and Maximum Ratings						
IS	Maximum Continuous Drain-Source Diode Forward Current		--	--	20	A
ISM	Maximum Pulsed Drain-Source Diode Forward Current		--	--	60	A
VSD	Drain-Source Diode Forward Voltage	VGS = 0V, IS = 10A	--	--	1.5	V
trr	Reverse Recovery Time	VGS = 0V, IS = 10A dIF/dt =100A/μs (Note 4)	--	475	--	ns
Qrr	Reverse Recovery Charge		--	5.8	--	μC
Irrm	Peak Reverse Recovery Current		--	35	--	A

NOTES:
1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. L=10.5mH, I_{AS}=10A, VDD=150V, Starting TJ=25 ℃
3. I_{SD}≤20A, di/dt ≤ 200A/us, V_{DD} ≤ BV_{DSS}, Starting TJ = 25 ℃
4. Pulse Test: Pulse width ≤ 300us, Duty Cycle ≤ 2%
5. Essentially Independent of Operating Temperature Typical Characteristics

Typical Performance Characteristics

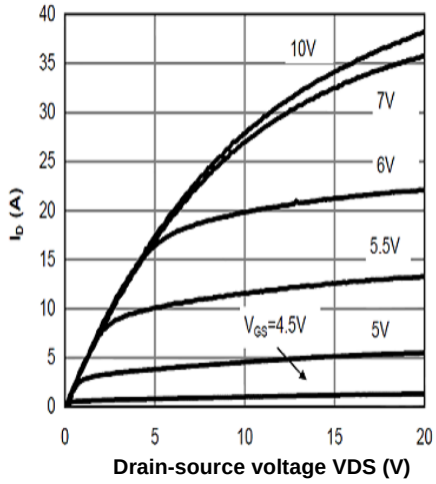


Figure 1: On-Region Characteristics@25° C

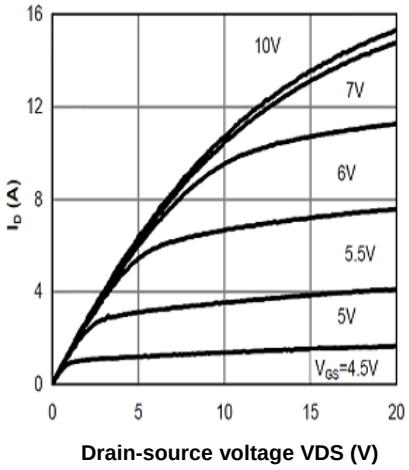


Figure 2: On-Region Characteristics@125° C

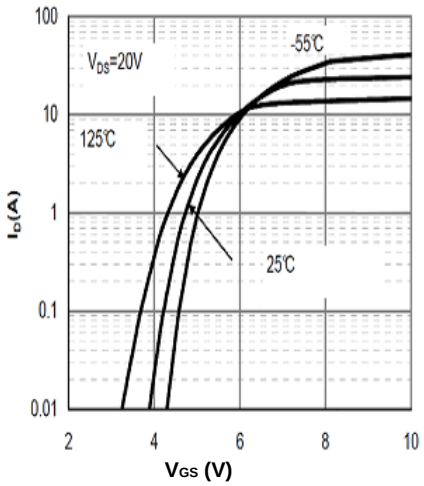


Figure 3: Transfer Charateristics

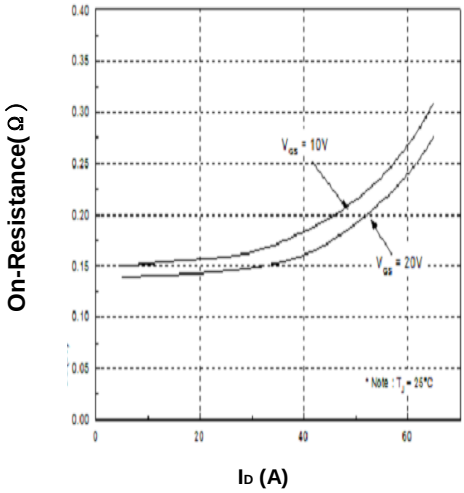


Figure 4: On-Resistance vs. Drain Current (I_D)

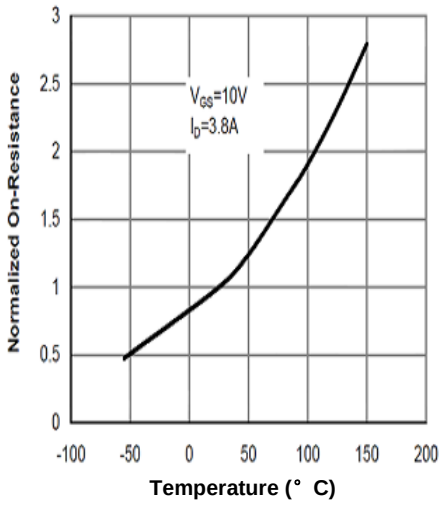


Figure 5: On-Resistance vs. Junction Temperature

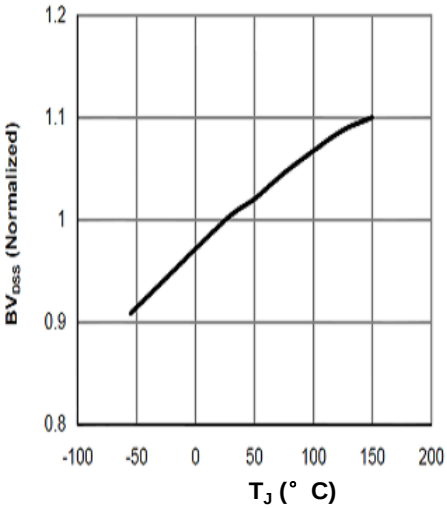


Figure 6: Break Down vs. Junction Temperature

Typical Performance Characteristics

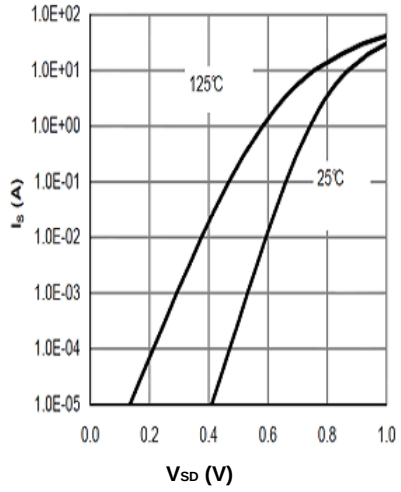


Figure 7: Body-Diode Characteristics

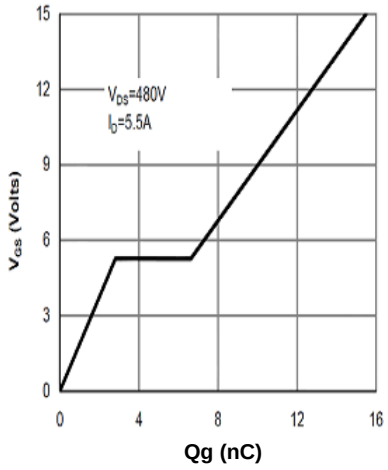


Figure 8: Gate-Charge Characteristics

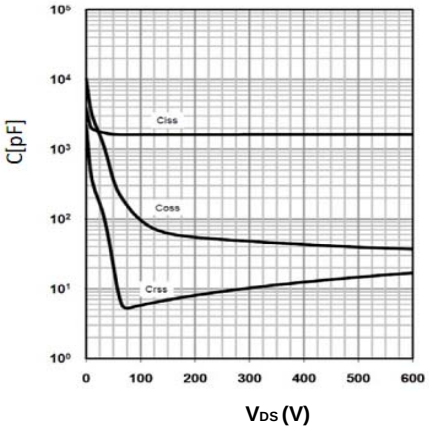


Figure 9: Capacitance Characteristics
C=f(V_{DS}), V_{GS}=0V, f=1MHz

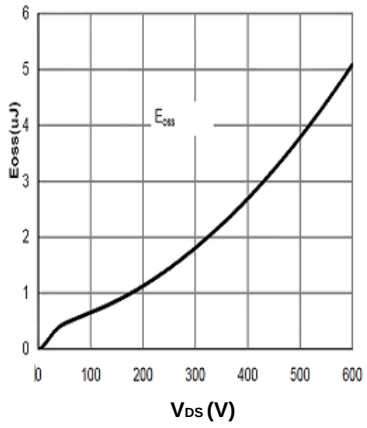


Figure 10: C_{oss} stored Energy

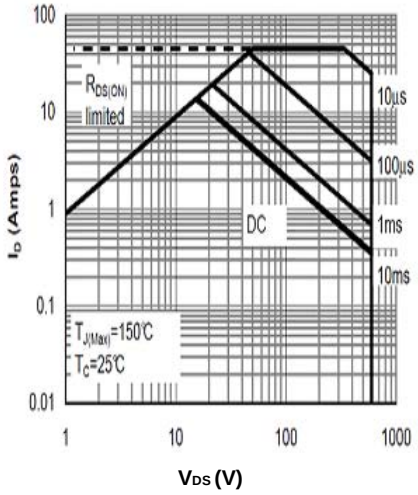


Figure 11: Maximum Forward Biased Safe Operating Area

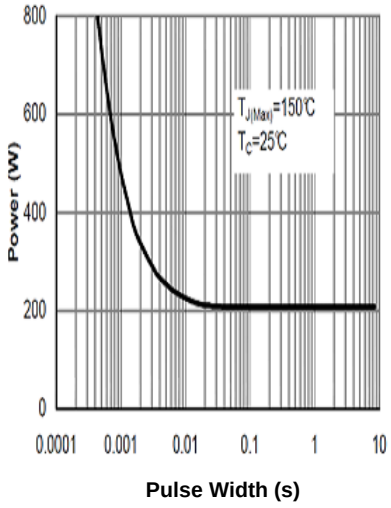


Figure 12: Single Pulse Power Rating Junction to Case

Typical Performance Characteristics

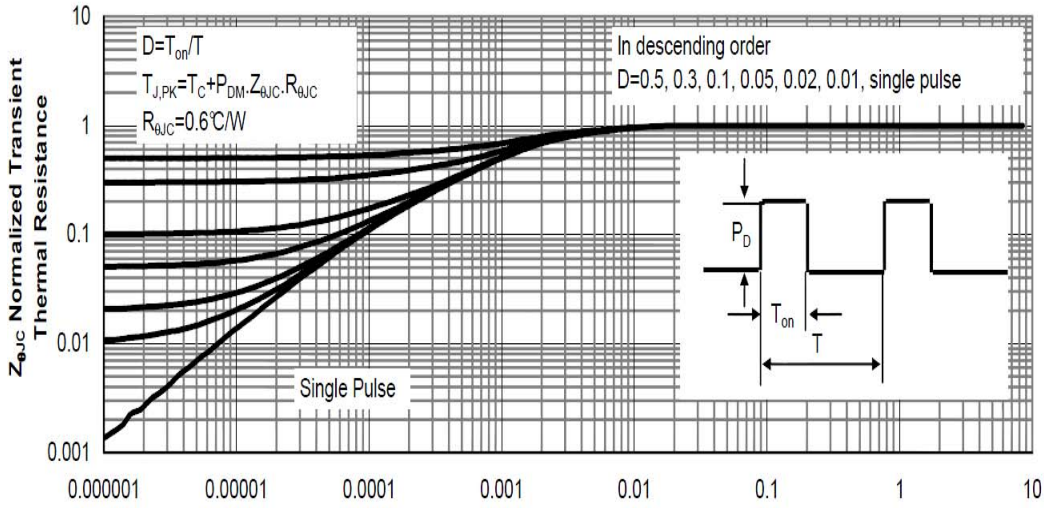


Figure 12: Normalized Maximum Transient Thermal Impedance

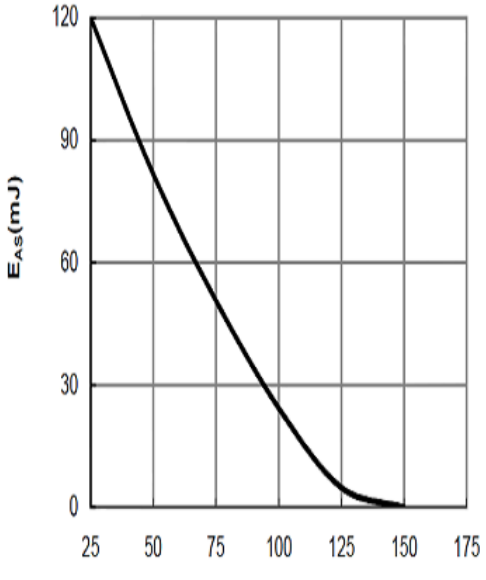


Figure 13: Avalanche energy

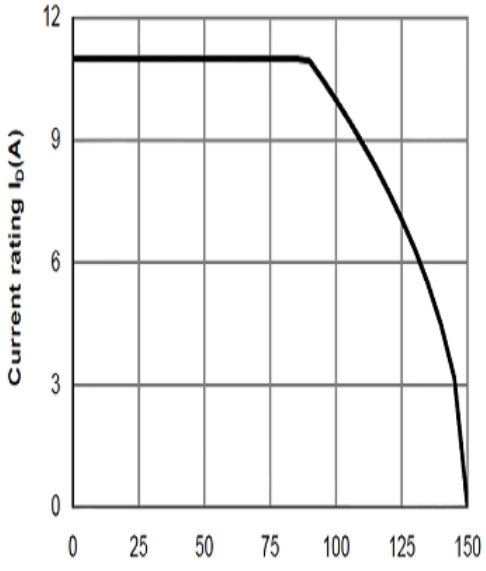


Figure 14: Current De-rating

Typical Performance Characteristics

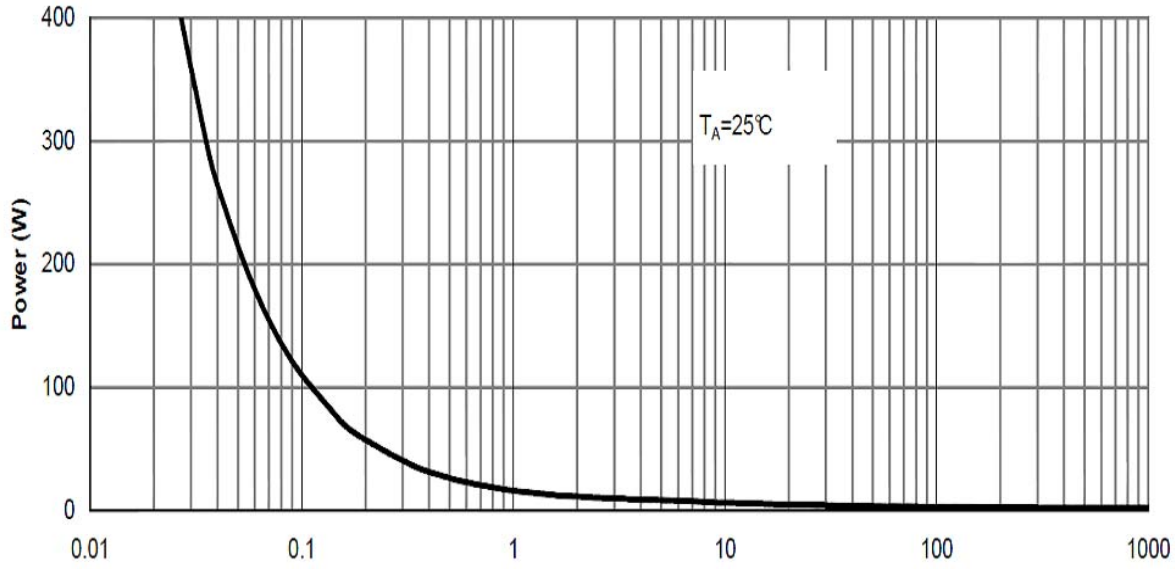


Figure 15: Single Pulse Power Rating Junction-Ambient

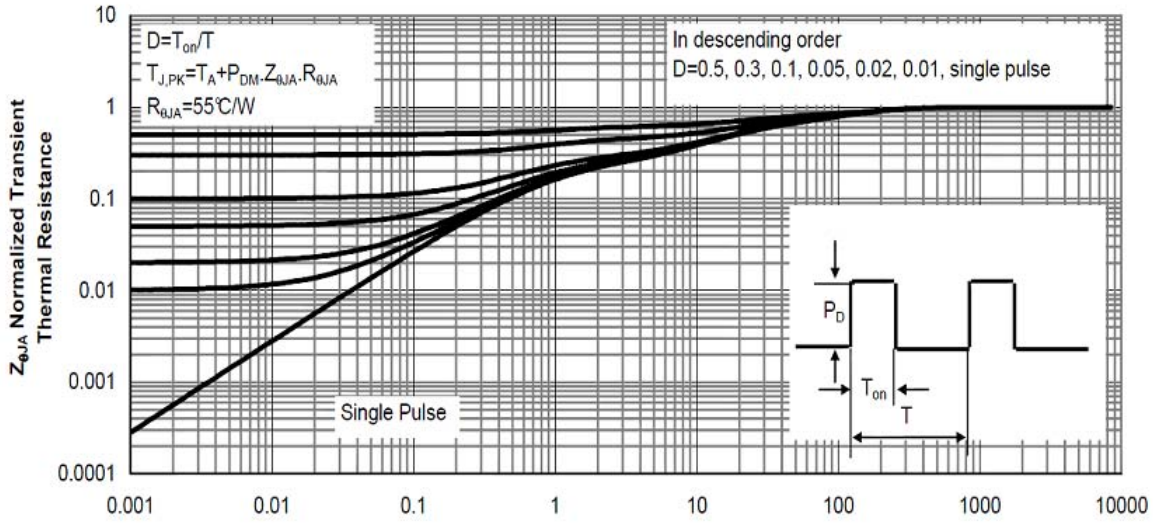
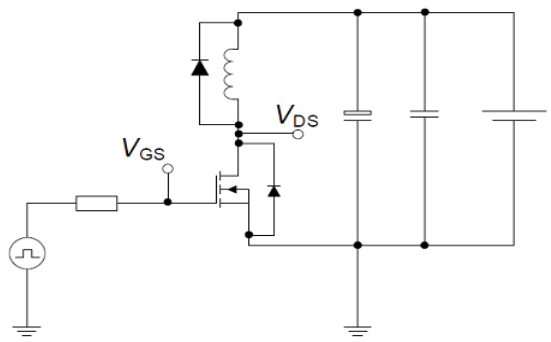


Figure 16: Normalized Maximum Transient Thermal Impedance

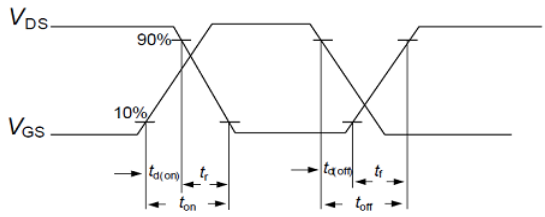
Test circuits

Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load

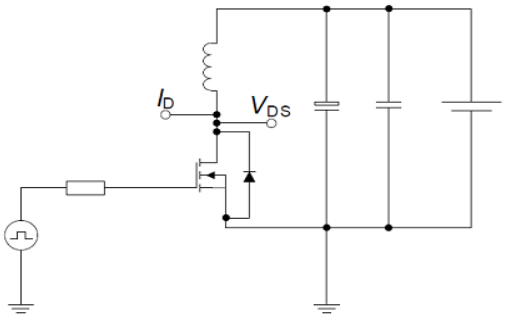


Switching time waveform

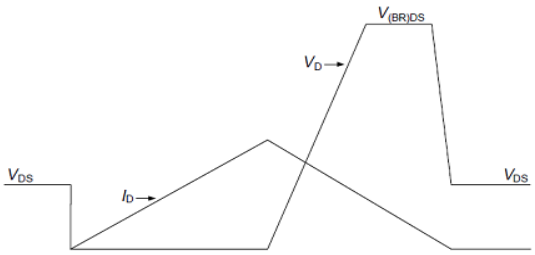


Unclamped inductive load test circuit and waveform

Unclamped inductive load test circuit

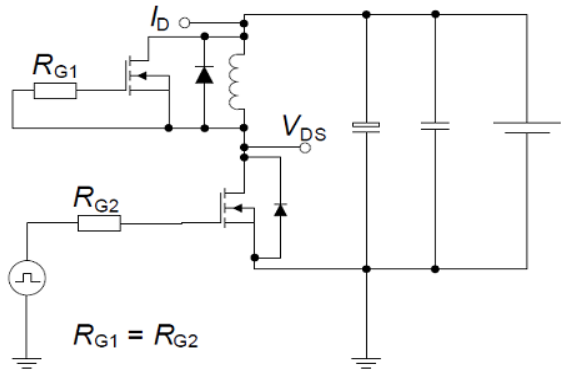


Unclamped inductive waveform

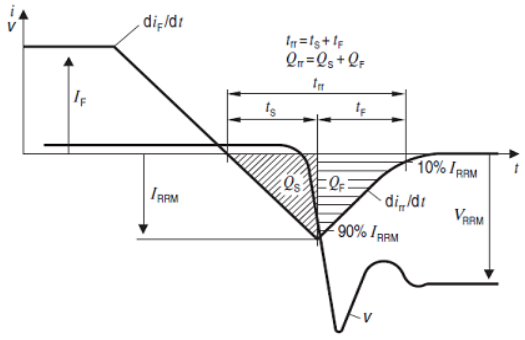


Test circuit and waveform for diode characteristics

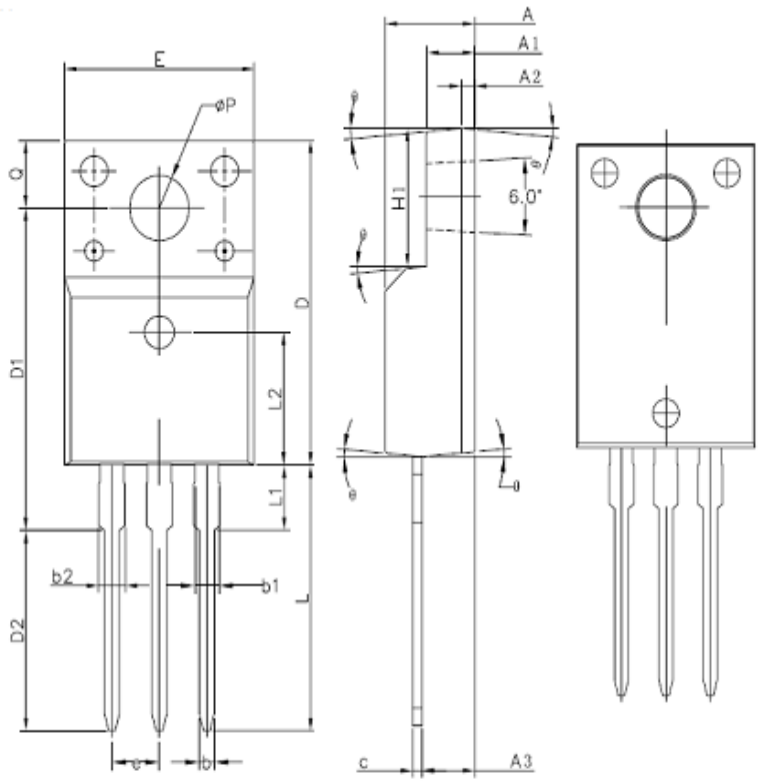
Test circuit for diode characteristics



Diode recovery waveform

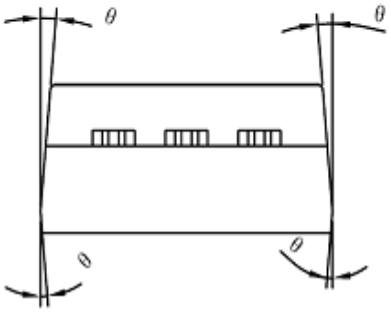


PKG TO-220F

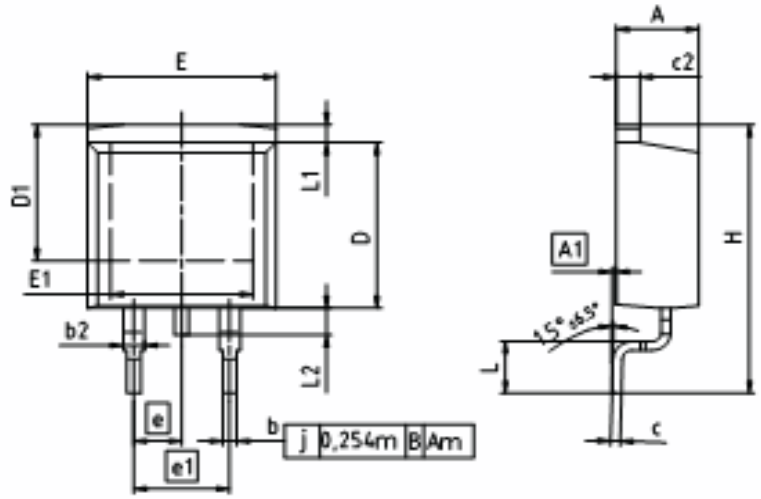


COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

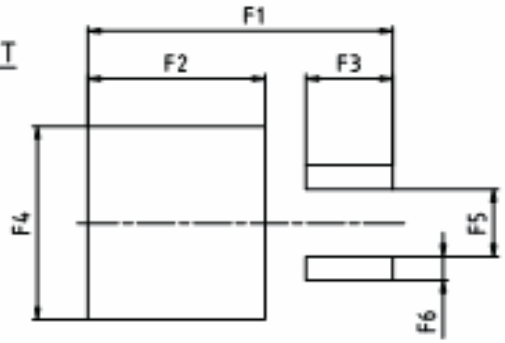
SYMBOL	MIN	NOM	MAX
A	4.50	4.70	4.90
A1	2.34	2.54	2.74
A2		0.70 REF	
A3	2.56	2.76	2.96
b	0.70	–	0.90
b1	1.18	–	1.38
b2	–	–	1.47
c	0.45	0.50	0.60
D	15.67	15.87	16.07
D1	15.55	15.75	15.95
D2	9.60	9.80	10.0
E	9.96	10.16	10.36
e		2.54BSC	
H1	6.48	6.68	6.88
L	12.68	12.98	
L1	–	–	3.50
L2		6.50REF	
ØP	3.08	3.18	3.28
Q	3.20	–	3.40
θ	3°	5°	7°



PKG TO-263



FOOTPRINT



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	0.00	0.25	0.000	0.010
b	0.65	0.85	0.026	0.033
b2	0.95	1.15	0.037	0.045
c	0.33	0.65	0.013	0.026
c2	1.17	1.40	0.046	0.055
D	8.51	9.45	0.335	0.372
D1	7.10	7.90	0.280	0.311
E	9.80	10.31	0.386	0.406
E1	6.80	8.60	0.268	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	2		2	
H	14.61	15.88	0.575	0.625
L	2.29	3.00	0.090	0.118
L1	0.70	1.60	0.028	0.063
L2	1.00	1.78	0.039	0.070
F1	16.05	16.26	0.632	0.640
F2	9.30	9.50	0.366	0.374
F3	4.80	4.70	0.177	0.185
F4	10.70	10.90	0.421	0.429
F5	3.65	3.85	0.144	0.152
F6	1.25	1.45	0.049	0.057

DOCUMENT NO.
28800003324

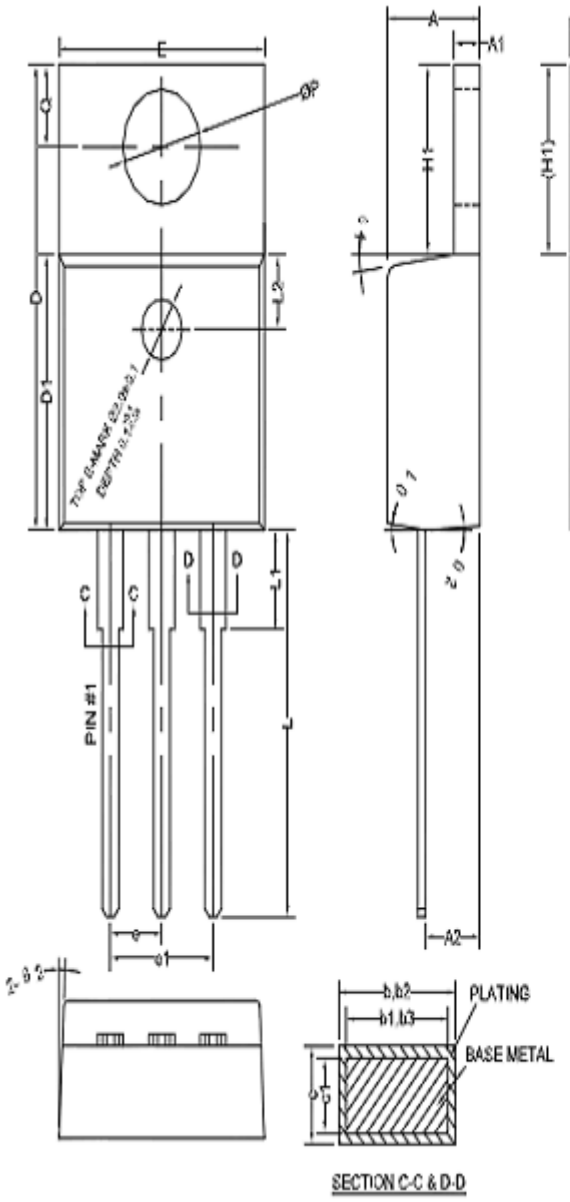
SCALE 0 5 5 7.5mm

EUROPEAN PROJECTION

ISSUE DATE
30-08-2007

REVISION
01

PKG TO-220



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

	SYMBOL	MIN	NOM	MAX
	A	4.40	4.57	4.70
	A1	1.22	-	1.32
	A2	2.59	2.38	2.78
	b	0.77	-	0.90
	b1	0.78	0.81	0.83
	b2	1.23	-	1.35
	b3	1.22	1.27	1.32
	c	0.34	-	0.47
	c1	0.33	0.38	0.43
	D	15.15	15.45	15.75
	D1	9.05	9.15	9.25
⚠	D2	11.40	-	12.88
	E	9.96	10.16	10.36
⚠	E1	8.66	-	8.89
⚠	e	2.44	2.54	2.64
⚠	e1	4.96	5.06	5.1
	H1	8.10	8.30	8.50
⚠	L	12.70	-	13.12
	L1	-	-	3.90
	L2	2.50REF		
	ØP	3.80	3.84	3.88
	Q	2.60	-	2.90
	θ1	5°	7°	9°
	θ2	1°	3°	5°

NOTES:
1. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-220 AB DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
⚠ 2.'D2' AND 'E1' ARE VARIABLES DEPENDING ON DIE PAD SIZES.