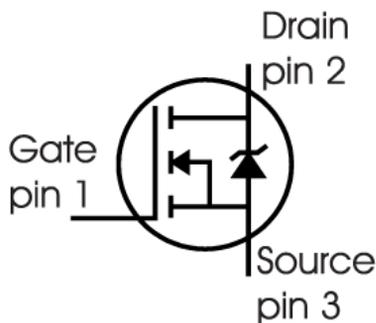


■ **Description** GroupSemiconductor(GS) has series Multi-EPI Super-Junction power MOSFET platforms for voltage up 500V to 1000 volts, both with design service and manufacturing capability, including cell, termination design and simulation.

The GS 600V 45A power MOSFET is a Low voltage N channel Multi-EPI Super-Junction power MOSFET sample with advanced technology to have better characteristics, such as fast switching time, low Ciss and Crss, low on resistance and excellent avalanche characteristics, making it especially suitable for applications which require superior power density and outstanding efficiency.



■ **Features**

- New revolutionary high voltage technology
- Better  $R_{DS(on)}$  in TO-220F
- Ultra Low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Pb-free lead planting
- Intrinsic fast-recovery body diode
- $R_{DS(on)}=0.085\Omega$  @VGS = 10V
- VDS = 600V
- ID (@ VGS=10V) = 20A

**APPLICATIONS**

- Consumer
- EV Charger
- PFC stages for server & telecom
- SMPS
- UPS
- Solar
- Lighting

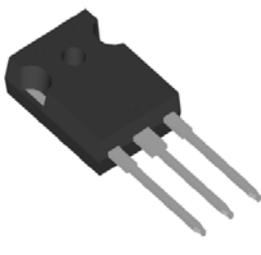
**ORDERING INFORMATION**

Industrial Range: -40° C to +125° C

Order Part No.	Package
GSA45N60EF	TO-220F, Pb-Free
GSW45N60EF	TO-247, Pb-Free
GSB45N60EF	TO-263, Pb-Free
GSP45N60EF	TO-220, Pb-Free
GSJ45N60EF	TO-3P, Pb-Free
GSN45N60EF	DFN 8*8 Pb-Free



TO-220F



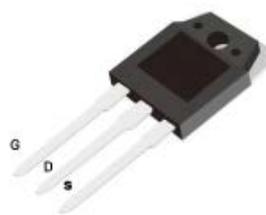
TO-247



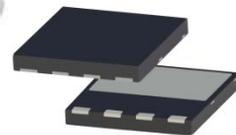
TO-220



TO-263



TO-3P



DFN8\*8

Maximum rating sat  $T_j = 25\text{ }^{\circ}\text{C}$  , unless otherwise specified.

Symbol	Parameter	GSX45N60EF	Unit
$V_{DSS}$	Drain-Source Voltage	600	V
$I_D$	Drain Current -Continuous (TC = 25°C) -Continuous (TC = 100°C)	45* 24*	A
$I_{DM}$	Drain Current - Pulsed (Note 1)	130	A
$V_{GSS}$	Gate-Source voltage	±30	V
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)	1050	mJ
$I_{AR}$	Repetitive Avalanche Current (Note 1)	9.5	A
$E_{AR}$	Repetitive Avalanche Energy (Note 1)	1.6	mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	15	V/ns
dVds/dt	Drain Source voltage slope (Vds=480V)	50	V/ns
$P_D$	Power Dissipation (TC = 25°C)	391	W
$T_J, T_{STG}$	Operating and Storage Temperature Range	-55 to +150	°C
$T_L$	Maximum Lead Temperature for Soldering Purpose, 1/8" from Case for 5 Seconds	300	°C

1) Limited by  $T_{j,max}$ . Maximum duty cycle  $D=0.75$

2) Pulse width  $t_p$  limited by  $T_{j,max}$

3) Identical low side and high side switch with identical  $R_G$ ;  $V_{peak} < V(BR)_{DSS}$  ;  $T_j < T_{j,max}$

**Thermal Characteristics**

Symbol	Parameter	GSX45N60EF	Unit
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	0.32	°C/W
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink Typ.	0.5	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	62	°C/W

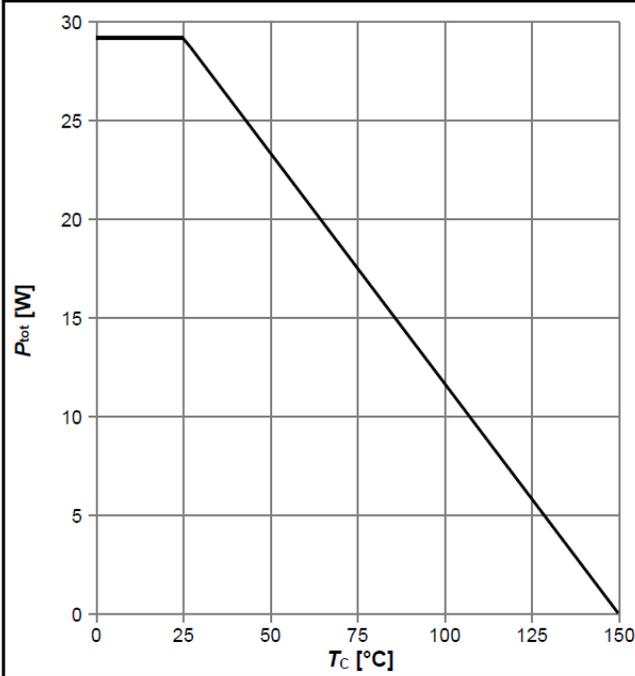
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Off Characteristics</b>						
BV <sub>DSS</sub>	Drain-Source Breakdown Voltage	V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA, T <sub>J</sub> = 25°C	600	--	--	V
		V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA, T <sub>J</sub> = 150°C	--	650	--	V
ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	Breakdown Voltage Temperature Coefficient	I <sub>D</sub> = 250μA, Referenced to 25°C	--	0.6	--	V/°C
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> = 600V, V <sub>GS</sub> = 0V -T <sub>J</sub> = 25°C -T <sub>J</sub> = 150°C	--	-- 10	1 -	μA μA
I <sub>GSSF</sub>	Gate-Body Leakage Current, Forward	V <sub>GS</sub> = 30V, V <sub>DS</sub> = 0V	--	--	100	nA
I <sub>GSSR</sub>	Gate-Body Leakage Current, Reverse	V <sub>GS</sub> = -30V, V <sub>DS</sub> = 0V	--	--	-100	nA
<b>On Characteristics</b>						
V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA	2.5	--	4.5	V
R <sub>DS(on)</sub>	Static Drain-Source On-Resistance	V <sub>GS</sub> = 10V, I <sub>D</sub> = 23A	--	75	85	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 40V, I <sub>D</sub> = 25A	--	30	--	S
<b>Dynamic Characteristics</b>						
C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 25V, V <sub>GS</sub> = 0V, f = 1.0MHz	--	2800	-	pF
C <sub>oss</sub>	Output Capacitance		--	138	-	pF
C <sub>rss</sub>	Reverse Transfer Capacitance		--	5	--	pF
<b>Switching Characteristics</b>						
t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DD</sub> = 480V, I <sub>D</sub> = 23A R <sub>G</sub> = 20Ω (Note 4)	--	19	--	ns
t <sub>r</sub>	Turn-On Rise Time		--	10	--	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		--	87	--	ns
t <sub>f</sub>	Turn-Off Fall Time		--	5	--	ns
Q <sub>g</sub>	Total Gate Charge	V <sub>DS</sub> = 480V, I <sub>D</sub> = 23A V <sub>GS</sub> = 10V (Note 4)	--	190	-	nC
Q <sub>gs</sub>	Gate-Source Charge		--	30	--	nC
Q <sub>gd</sub>	Gate-Drain Charge		--	95	--	nC
<b>Drain-Source Diode Characteristics and Maximum Ratings</b>						
I <sub>S</sub>	Maximum Continuous Drain-Source Diode Forward Current		--	--	45	A
I <sub>SM</sub>	Maximum Pulsed Drain-Source Diode Forward Current		--	--	135	A
V <sub>SD</sub>	Drain-Source Diode Forward Voltage	V <sub>GS</sub> = 0V, I <sub>S</sub> = 23A	--	0.9	1.5	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0V, I <sub>S</sub> = 23A dI <sub>F</sub> /dt = 100A/μs	--	180	--	ns
Q <sub>rr</sub>	Reverse Recovery Charge		--	17	--	μC

1) Co(er) is a fixed capacitance that gives the same stored energy as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 to 80% V(BR)<sub>DSS</sub>

2) Co(tr) is a fixed capacitance that gives the same charging time as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 to 80% V(BR)<sub>DSS</sub>

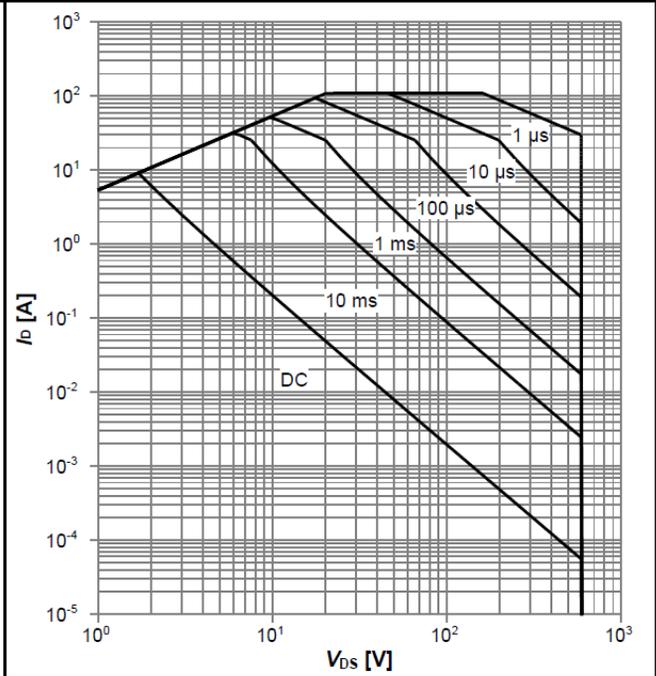
Electrical characteristics diagrams

Diagram 1: Power dissipation



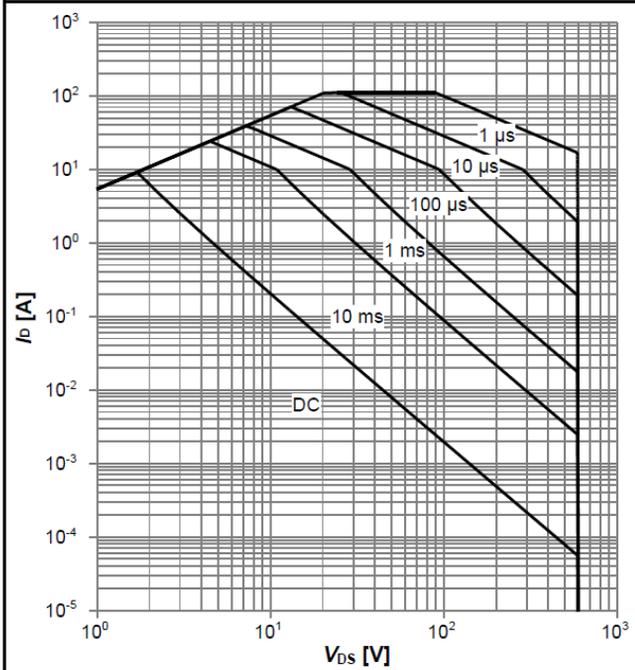
$P_{tot}=f(T_C)$

Diagram 2: Safe operating area



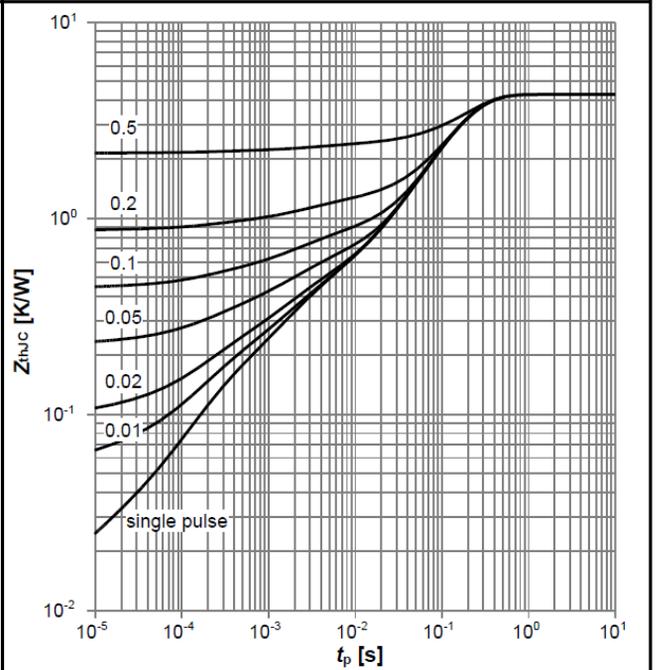
$I_D=f(V_{DS}); T_C=25\text{ }^\circ\text{C}; D=0; \text{parameter: } t_p$

Diagram 3: Safe operating area



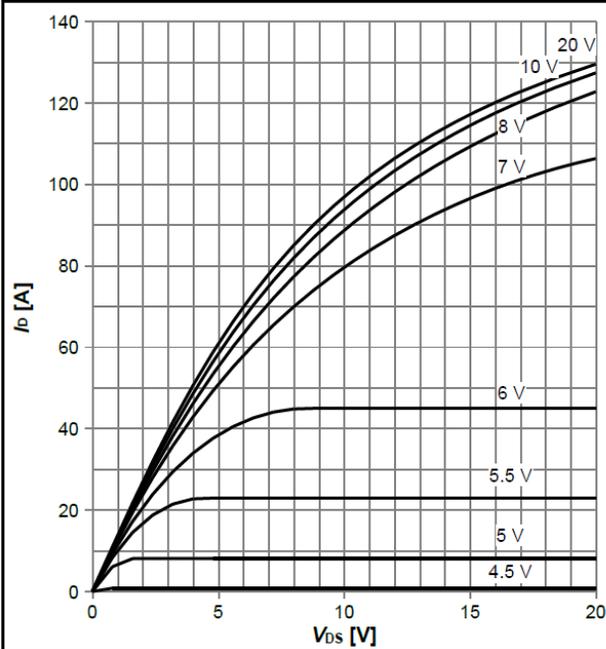
$I_D=f(V_{DS}); T_C=80\text{ }^\circ\text{C}; D=0; \text{parameter: } t_p$

Diagram 4: Max. transient thermal impedance



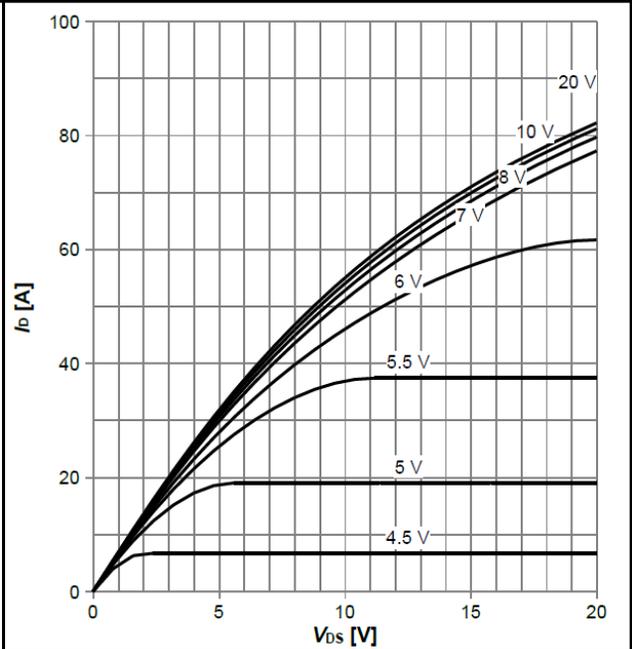
$Z_{thJC}=f(t_p); \text{parameter: } D=t_p/T$

**Diagram 5: Typ. output characteristics**



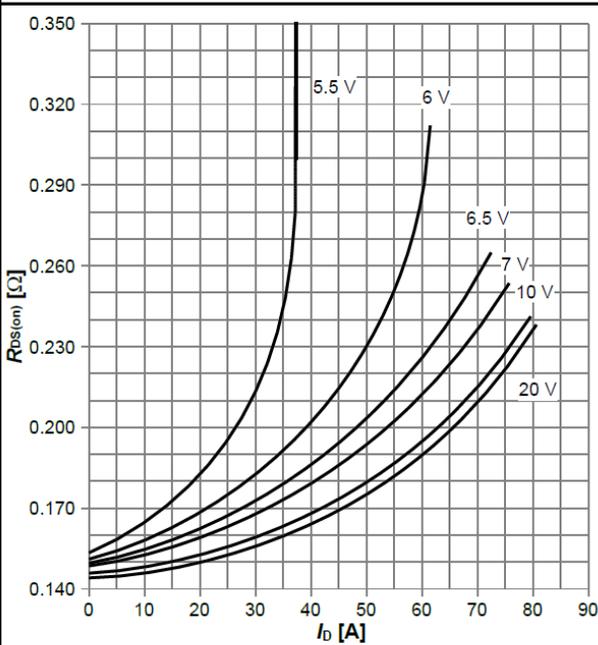
$I_D=f(V_{DS}); T_j=25\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

**Diagram 6: Typ. output characteristics**



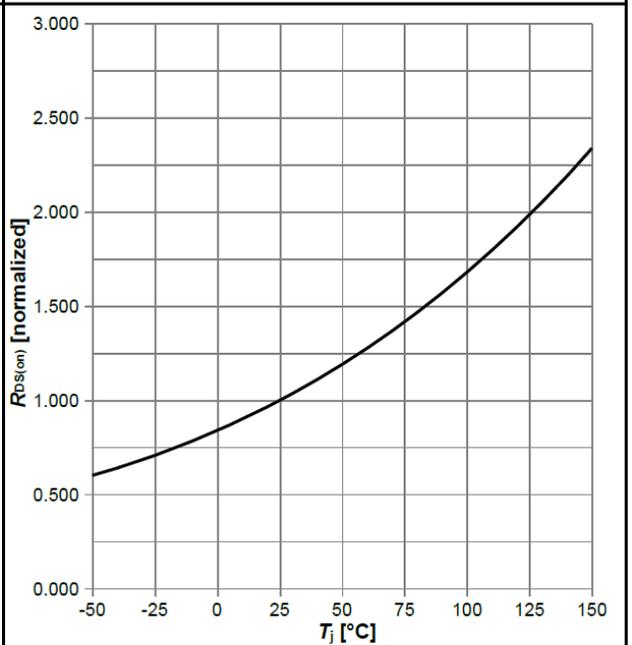
$I_D=f(V_{DS}); T_j=125\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

**Diagram 7: Typ. drain-source on-state resistance**



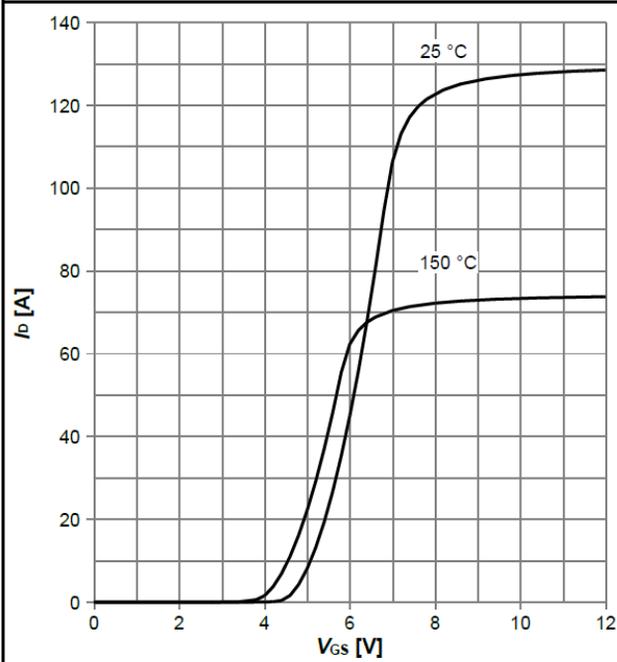
$R_{DS(on)}=f(I_D); T_j=125\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

**Diagram 8: Drain-source on-state resistance**



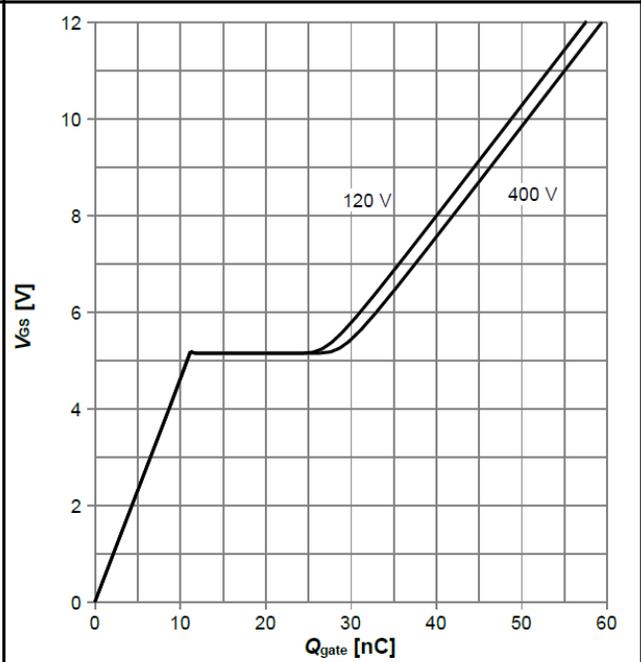
$R_{DS(on)}=f(T_j); I_D=11.8\text{ A}; V_{GS}=10\text{ V}$

**Diagram 9: Typ. transfer characteristics**



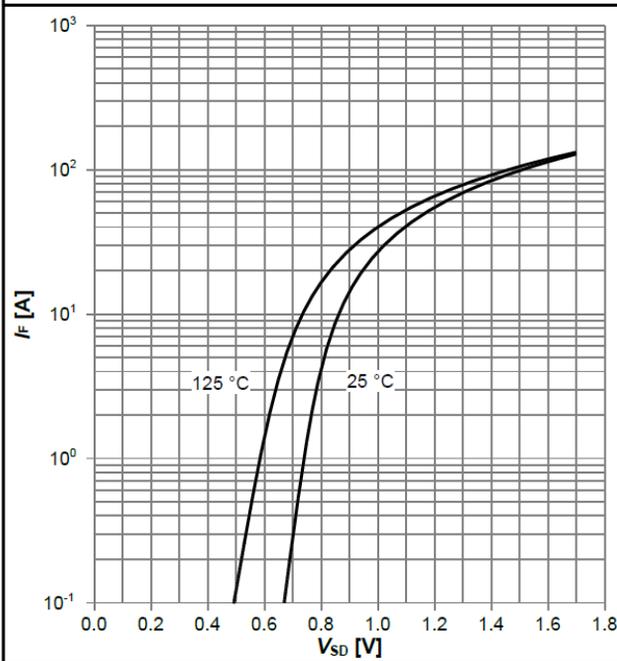
$I_D=f(V_{GS})$ ;  $V_{DS}=20V$ ; parameter:  $T_j$

**Diagram 10: Typ. gate charge**



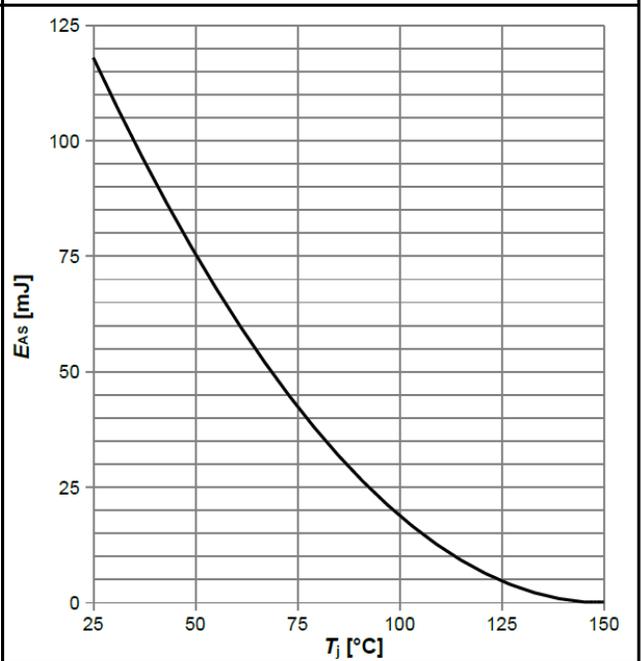
$V_{GS}=f(Q_{gate})$ ;  $I_D=11.8$  A pulsed; parameter:  $V_{DD}$

**Diagram 11: Forward characteristics of reverse diode**



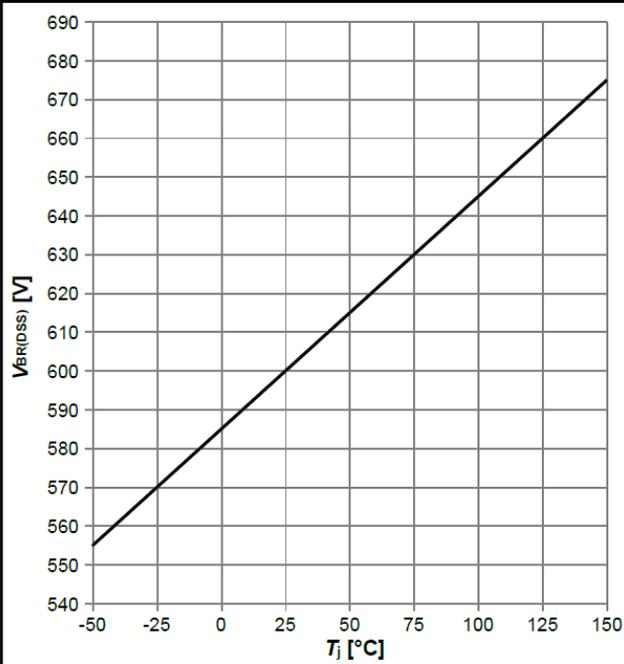
$I_F=f(V_{SD})$ ; parameter:  $T_j$

**Diagram 12: Avalanche energy**



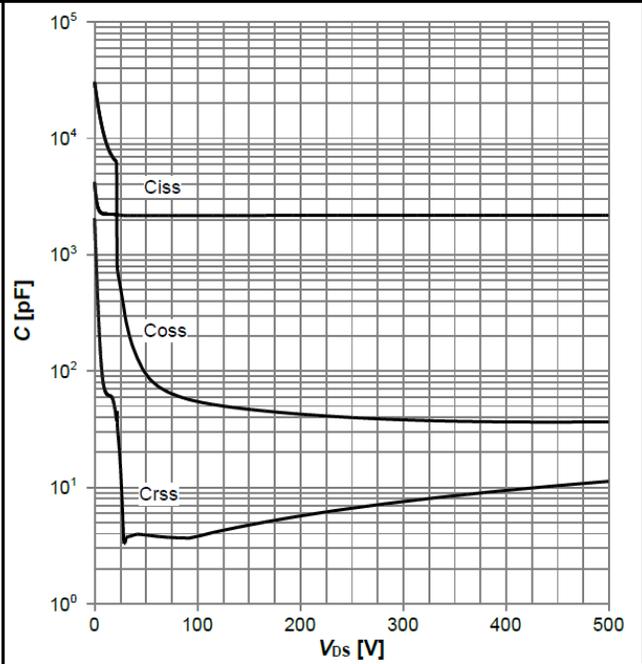
$E_{AS}=f(T_j)$ ;  $I_D=5.5$  A;  $V_{DD}=50$  V

Diagram 13: Drain-source breakdown voltage



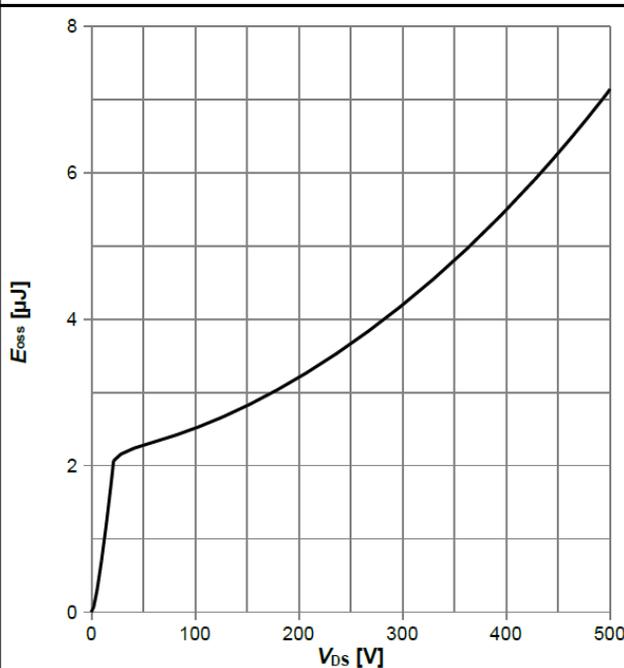
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

Diagram 14: Typ. capacitances



$C=f(V_{DS}); V_{GS}=0 \text{ V}; f=250 \text{ kHz}$

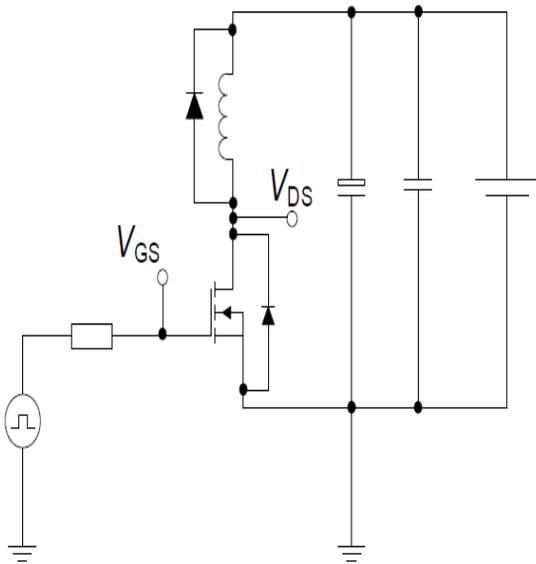
Diagram 15: Typ. Coss stored energy



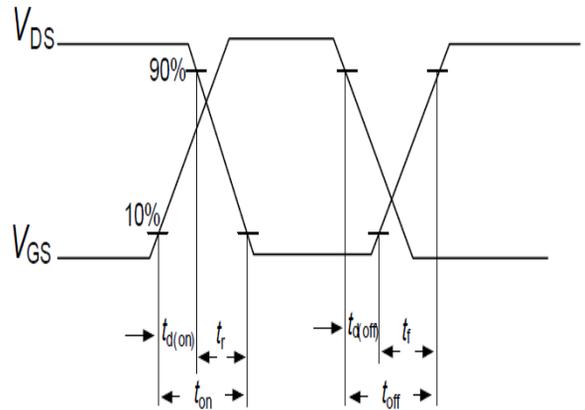
$E_{oss}=f(V_{DS})$

Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load

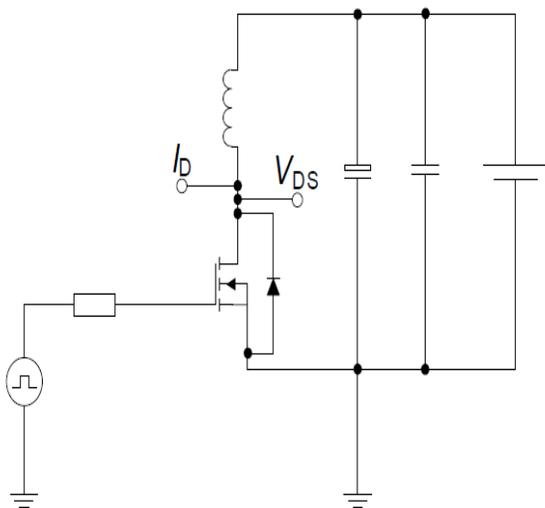


Switching time waveform

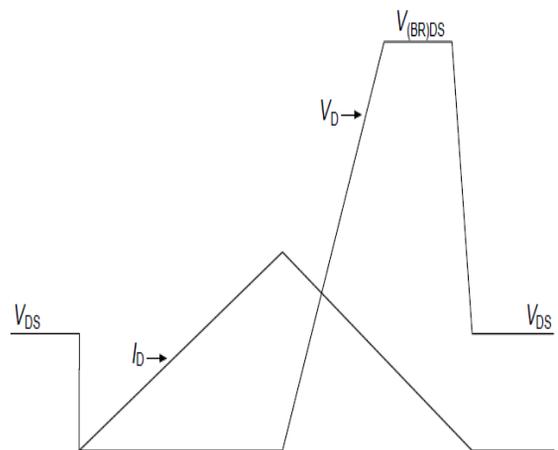


Unclamped inductive load test circuit and waveform

Unclamped inductive load test circuit

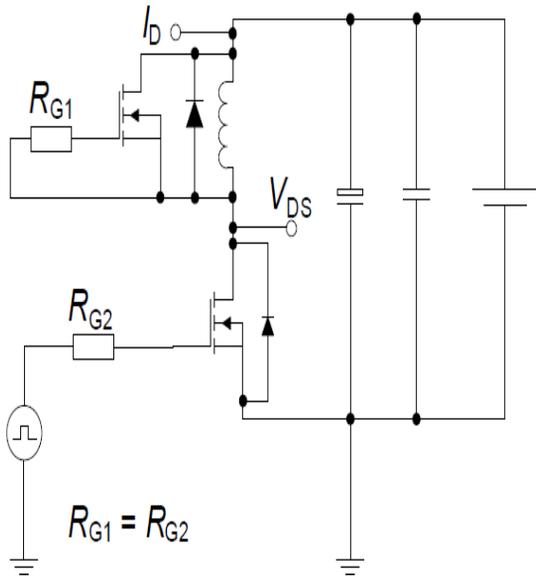


Unclamped inductive waveform

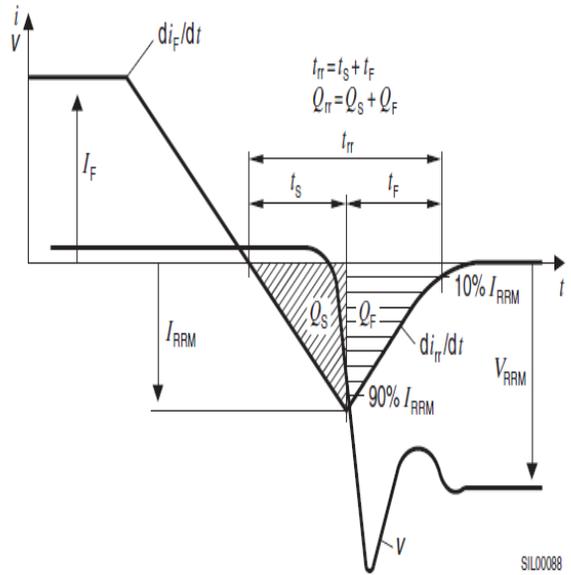


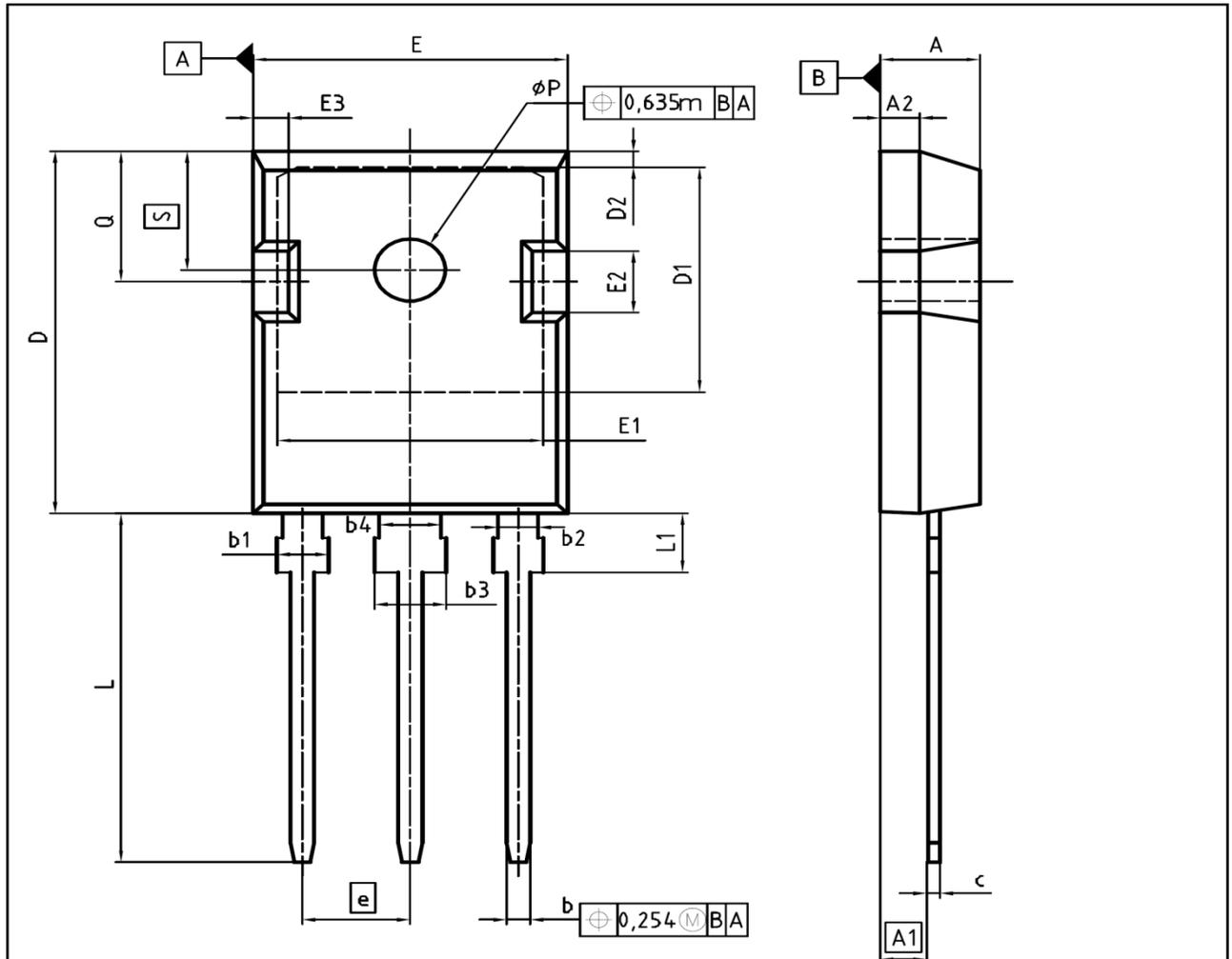
Test circuit and waveform for diode characteristics

Test circuit for diode characteristics



Diode recovery waveform





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		0.214	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	0.176
phi P	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

DOCUMENT NO.  
Z8B00003327

SCALE

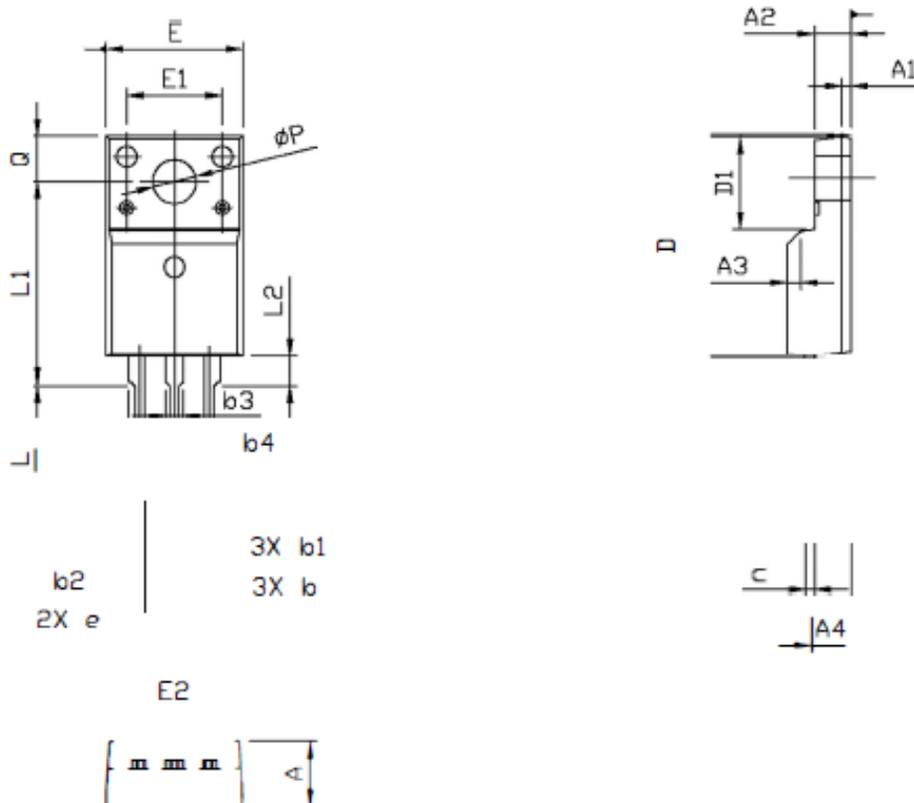
7.5mm

EUROPEAN PROJECTION

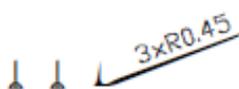
ISSUE DATE  
01-10-2009

REVISION  
04

TO220F PACKAGE OUTLINE



RECOMMENDATION OF HOLE PATTERN



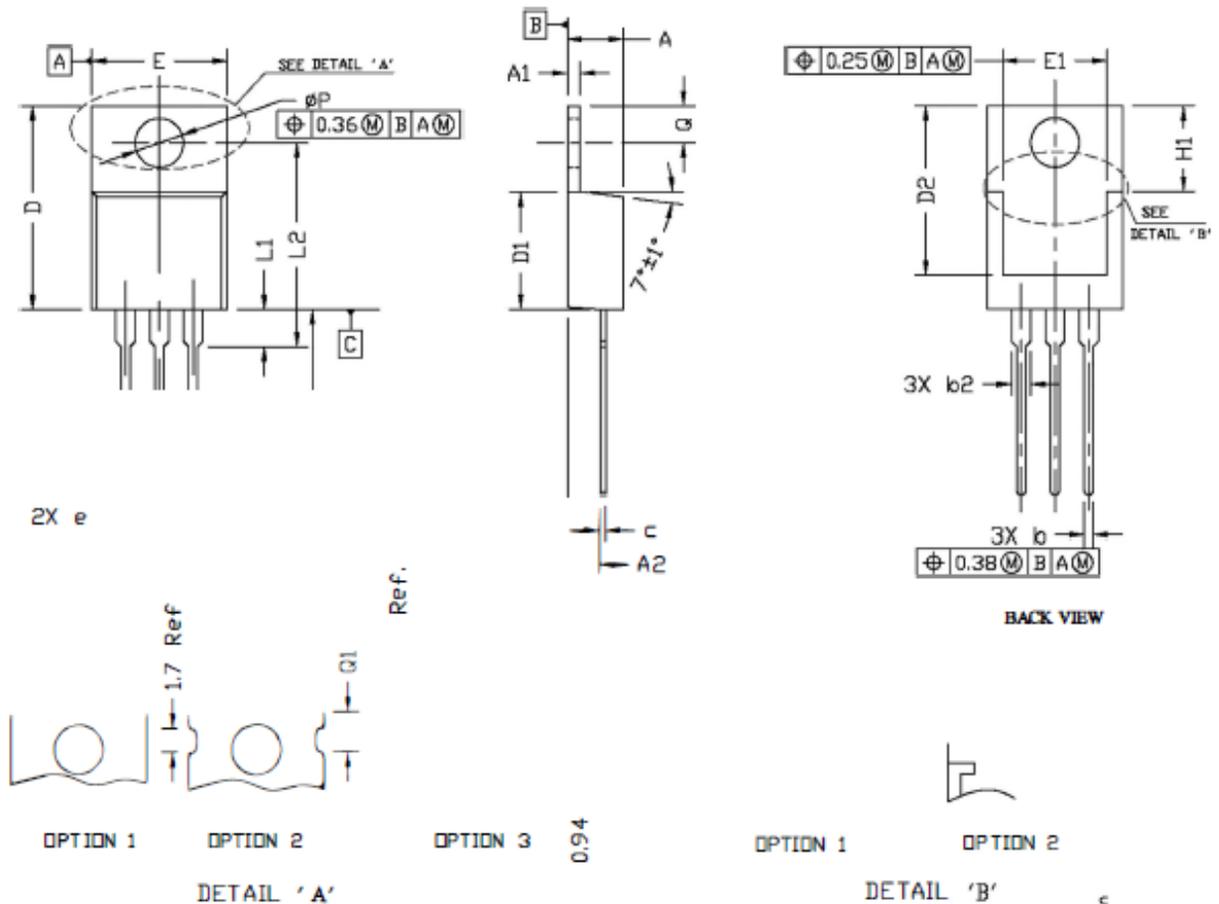
UNIT: mm

SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	4.50	4.70	4.90	0.177	0.185	0.193
A1		0.70			0.028	
A2	2.34	2.54	2.74	0.092	0.100	0.108
A3		1X45°			1X45°	
A4	2.66	2.76	2.86	0.105	0.106	0.113
b	0.59	0.69	0.79	0.023	0.027	0.031
b1	0.25	0.35	0.45	0.010	0.014	0.018
b2	1.14	1.24	1.29	0.045	0.049	0.051
b3	1.28	1.38	1.43	0.050	0.054	0.056
b4		1.40 MIN			0.055 MIN	
c	0.59	0.64	0.74	0.023	0.025	0.029
D	15.67	15.87	16.07	0.617	0.625	0.633
D1	6.48	6.68	6.88	0.255	0.263	0.271
e		2.54 BSC			0.100 BSC	
E	9.96	10.16	10.36	0.392	0.400	0.408
E1		7.00			0.276	
E2	9.26	9.46	9.66	0.365	0.372	0.380
L	10.76	10.96	11.16	0.424	0.431	0.439
L1	14.39	14.59	14.79	0.567	0.574	0.582
L2	1.70	2.03	2.20	0.067	0.080	0.087
phi	3.20	3.30	3.40	0.126	0.130	0.134
phi P	3.08	3.18	3.28	0.121	0.125	0.129

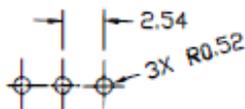
NOTE

1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS. MOLD FLASH SHOULD BE LESS THAN 6 MIL.
2. TOLERANCE 0.100 MILLIMETERS UNLESS OTHERWISE SPECIFIED.
3. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.

TO220 PACKAGE OUTLINE



RECOMMENDATION OF HOLE PATTERN



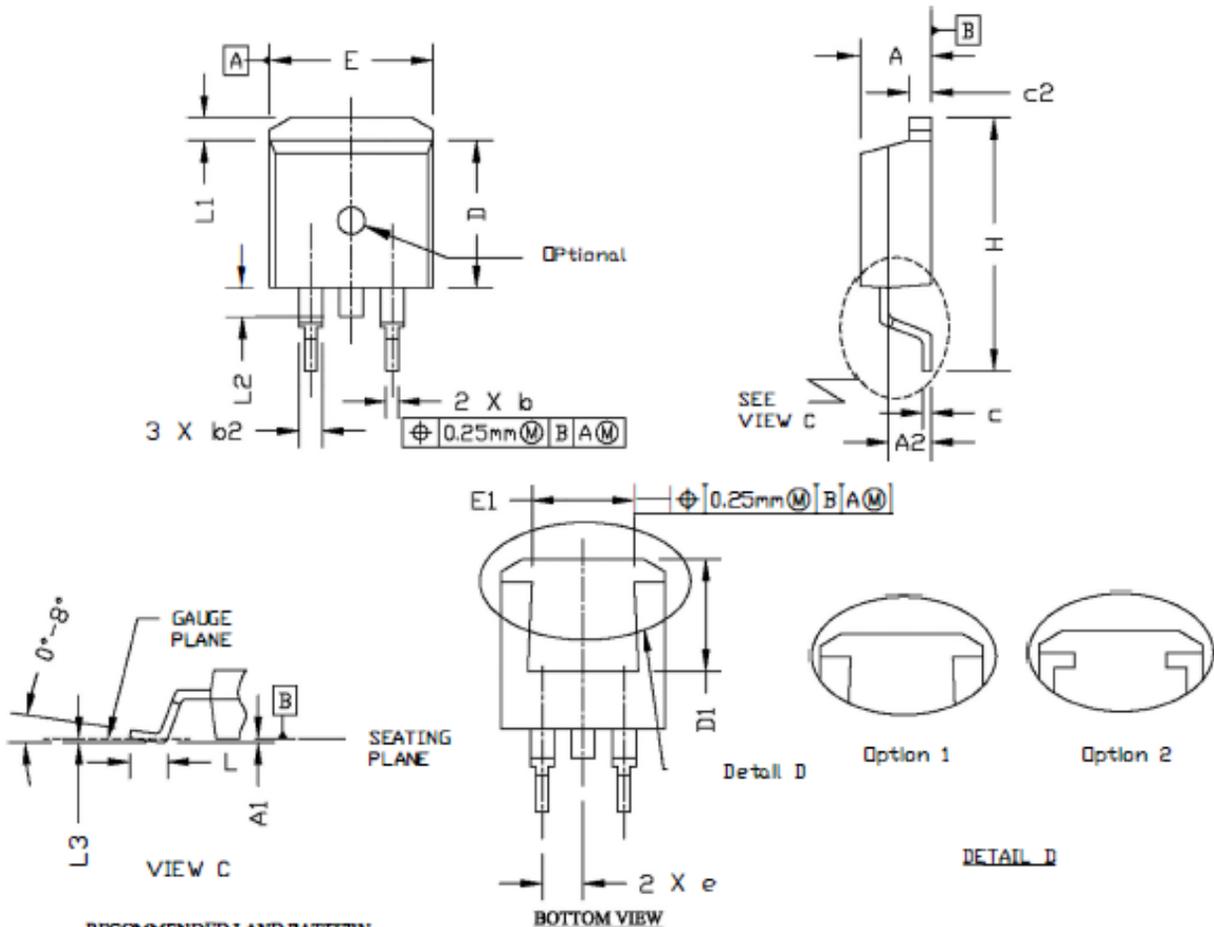
UNIT: mm

NOTE

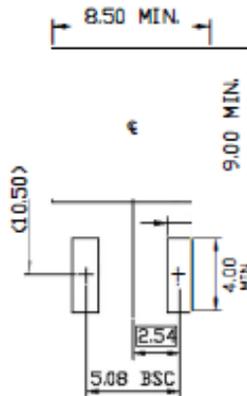
1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS. MOLD FLASH SHOULD BE LESS THAN 6 MIL.
2. TOLERANCE 0.100 MILLIMETERS UNLESS OTHERWISE SPECIFIED.
3. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.

SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	4.30	4.45	4.72	0.169	0.175	0.186
A1	1.15	1.27	1.40	0.045	0.050	0.055
A2	2.20	2.67	2.90	0.087	0.105	0.114
b	0.69	0.81	0.95	0.027	0.032	0.037
b2	1.17	1.37	1.45	0.046	0.050	0.058
c	0.36	0.38	0.60	0.014	0.015	0.024
D	14.50	15.44	15.80	0.571	0.608	0.622
D1	8.59	9.14	9.65	0.338	0.360	0.380
D2	11.43	11.73	12.48	0.450	0.462	0.491
e	2.54 BSC			0.100 BSC		
E	9.66	10.03	10.54	0.380	0.395	0.415
E1	6.22			0.245		
H1	6.10	6.30	6.50	0.240	0.248	0.256
L	12.27	12.82	14.27	0.483	0.505	0.562
L1	2.47		3.90	0.097		0.154
L2			16.70			0.657
Q	2.59	2.74	2.89	0.102	0.108	0.114
$\phi P$	3.50	3.84	3.89	0.138	0.151	0.153
Q1	2.70		2.90	0.106		0.114

TO263(D2PAK) PACKAGE OUTLINE



RECOMMENDED LAND PATTERN



UNIT: mm

SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	4.064	4.45	4.826	0.160	0.175	0.190
A1	0.00		0.254	0.000		0.010
A2	2.20	2.67	2.90	0.087	0.105	0.114
b	0.508	0.81	0.991	0.020	0.032	0.039
b2	1.143	1.27	1.778	0.045	0.050	0.070
c	0.381	0.50	0.737	0.015	0.020	0.029
c2	1.143	1.27	1.651	0.045	0.050	0.065
D	8.382	9.14	9.652	0.330	0.360	0.380
D1	6.858	8.00	8.37	0.270	0.315	0.330
e	2.54 BSC			0.100 BSC.		
E	9.652	10.03	10.668	0.380	0.395	0.420
E1	6.223	8.00	8.37	0.245	0.315	0.330
H	14.605	15.24	15.875	0.575	0.600	0.625
L	1.778	2.54	2.794	0.070	0.100	0.110
L1	1.02	1.27	1.676	0.040	0.050	0.066
L2	1.27	1.52	1.778	0.50	0.60	0.070
L3	0.25 BSC			0.010 BSC.		

NOTE:

- PACKAGE BODY SIDES EXCLUDE MOLD FLASH AND GATE BURRS. MOLD FLASH SHOULD BE LESS THAN 6 MILS.
- TOLERANCE 0.10 MILLIMETERS UNLESS OTHERWISE SPECIFIED.
- DIMENSION L IS MEASURED IN GAUGE LINE.
- CONTROLLING DIMENSION IS MILLIMETER.
- CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.
- REFER TO JEDEC TO-263 AB.