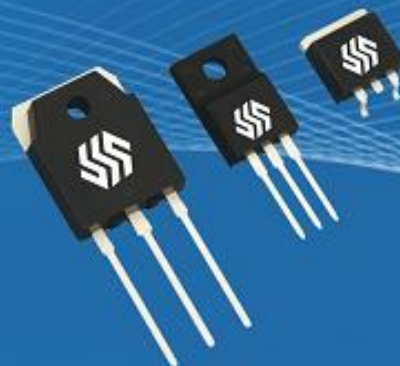




SUPER-SEMI



## SUPER-MOSFET

Super Junction Metal Oxide Semiconductor Field Effect Transistor

650V Super Junction Power MOSFET Gen- II  
SS\*65R650S2

Rev. 0.9  
Oct. 2018

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# SSF65R650S2/SSP65R650S2/SST65R650S2 650V N-Channel Super-Junction MOSFET Gen-II

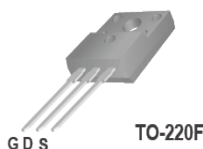
## Description

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 in switching mode operation for higher efficiency.

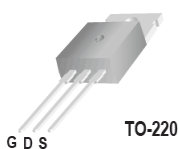
## Features

- Multi-Epi process SJ-FET
- 700V @T<sub>J</sub> = 150 °C
- Typ. RDS(on) = 0.55Ω
- Ultra Low Gate Charge (typ. Q<sub>g</sub> = 13.6nC)
- 100% avalanche tested

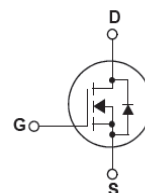
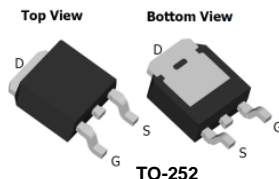
SSF65R650S2



SSP65R650S2



SST65R650S2



## Absolute Maximum Ratings

Symbol	Parameter	SSP_T65R650S2	SSF65R650S2	Unit
V <sub>DSS</sub>	Drain-Source Voltage	650		V
I <sub>D</sub>	Drain Current -Continuous (TC = 25°C) -Continuous (TC = 100°C)	7.8* 4.9*		A
I <sub>DM</sub>	Drain Current - Pulsed (Note 1)	31.2		A
V <sub>GSS</sub>	Gate-Source voltage	±30		V
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)	106		mJ
I <sub>AS</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> max)	2.7		A
dv/dt	Peak Diode Recovery dv/dt (Note 3)	15		V/ns
dVds/dt	Drain Source voltage slope (V <sub>ds</sub> =480V)	50		V/ns
P <sub>D</sub>	Power Dissipation (TC = 25°C)	80	30	W
T <sub>J</sub> , T <sub>STG</sub>	Operating and Storage Temperature Range	-55 to +150		°C
T <sub>L</sub>	Maximum Lead Temperature for Soldering Purpose, 1/16" from Case for 10 Seconds	260		°C

\* Drain current limited by maximum junction temperature. Maximum duty cycle D=0.75.

## Thermal Characteristics

Symbol	Parameter	SSP_T65R650S2	SSF65R650S2	Unit
R <sub>θJC</sub>	Thermal Resistance, Junction-to-Case	1.55	4.2	°C/W
R <sub>θCS</sub>	Thermal Resistance, Case-to-Sink Typ.	0.5	-	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction-to-Ambient	62	80	°C/W



# Electrical Characteristics TC = 25°C unless otherwise noted

SSF65R650S2/SSP65R650S2/SST65R650S2 650V N-Channel Super-Junction MOSFET Gen-II

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	650	-	-	V
		V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA, T <sub>J</sub> = 150°C	-	700	-	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> = 650V, V <sub>GS</sub> = 0V -T <sub>C</sub> = 125°C	-	-	1 100	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	2.0	3.0	4.0	V
R <sub>DS(on)</sub>	Static Drain-Source On-Resistance	V <sub>GS</sub> = 10V, I <sub>D</sub> = 3.5A (TO-220, TO-220F)	-	0.55	0.65	Ω
		V <sub>GS</sub> = 10V, I <sub>D</sub> = 3.5A (TO-252)	-	0.56	0.67	Ω
<b>Dynamic Characteristics</b>						
C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 100V, V <sub>GS</sub> = 0V, f = 1.0MHz	-	480	-	pF
C <sub>oss</sub>	Output Capacitance		-	22	-	pF
C <sub>rss</sub>	Reverse Transfer Capacitance		-	1.1	-	pF
Q <sub>g</sub>	Total Gate Charge	V <sub>DS</sub> = 400V, I <sub>D</sub> = 7.8A, V <sub>GS</sub> = 10V (Note 4)	-	13.6	-	nC
Q <sub>gs</sub>	Gate-Source Charge		-	3.2	-	nC
Q <sub>gd</sub>	Gate-Drain Charge		-	5.6	-	nC
R <sub>g</sub>	Gate resistance	f=1 MHz, open drain	-	9.6	-	Ω
<b>Switching Characteristics</b>						
t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DS</sub> = 400V, I <sub>D</sub> = 3.9A R <sub>G</sub> = 10Ω, V <sub>GS</sub> = 10V (Note 4)	-	11	-	ns
t <sub>r</sub>	Turn-On Rise Time		-	21	-	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		-	40	-	ns
t <sub>f</sub>	Turn-Off Fall Time		-	31	-	ns
<b>Drain-Source Diode Characteristics and Maximum Ratings</b>						
I <sub>S</sub>	Maximum Continuous Drain-Source Diode Forward Current		-	-	7.8	A
I <sub>SM</sub>	Maximum Pulsed Drain-Source Diode Forward Current		-	-	31.2	A
V <sub>SD</sub>	Drain-Source Diode Forward Voltage	V <sub>GS</sub> = 0V, I <sub>S</sub> = 7.8A	-	0.9	1.4	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 400V, I <sub>S</sub> = 3.9A, dI <sub>F</sub> /dt = 100A/μs	-	205	-	ns
Q <sub>rr</sub>	Reverse Recovery Charge		-	1.4	-	μC
I <sub>rrm</sub>	Peak Reverse Recovery Current		-	12	-	A

## NOTES:

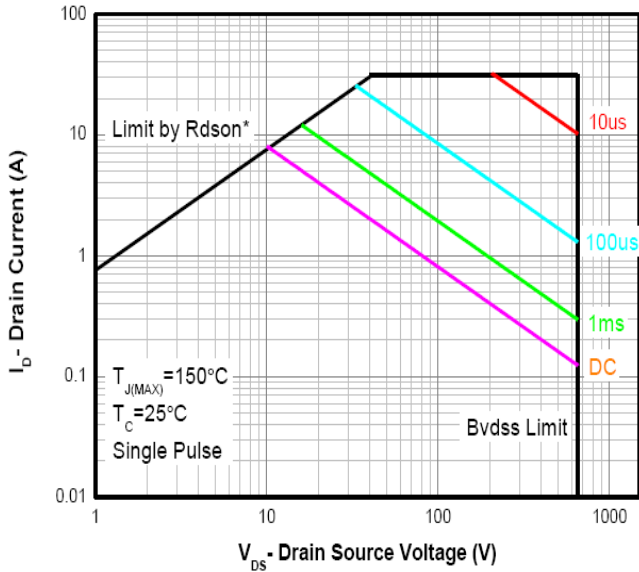
1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. I<sub>D</sub>=I<sub>AS</sub>, V<sub>DD</sub>=50V, Starting T<sub>J</sub>=25 °C
3. I<sub>SD</sub>≤I<sub>D</sub>, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ BV<sub>DSS</sub>, Starting T<sub>J</sub> = 25 °C
4. Essentially Independent of Operating Temperature Typical Characteristics



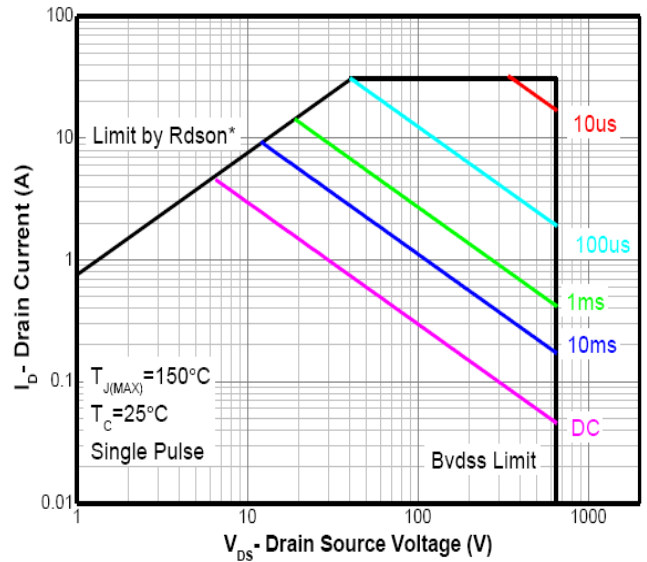
# Typical Performance Characteristics

SSF65R650S2/SSP65R650S2/SST65R650S2 650V N-Channel Super-Junction MOSFET Gen-II

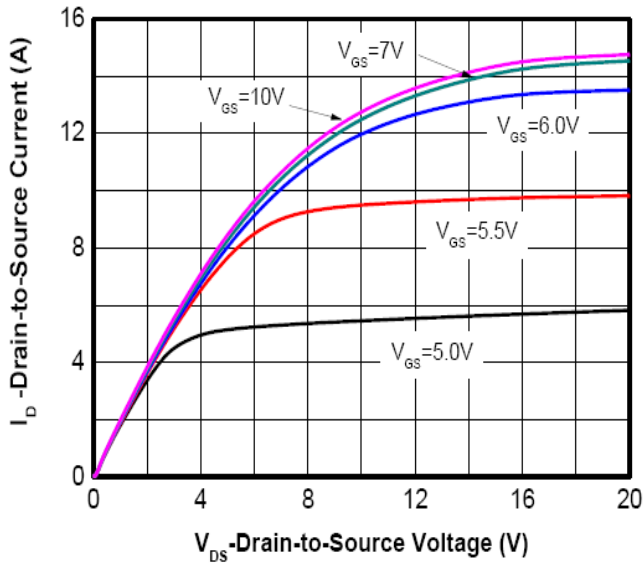
Safe operating area TC=25 °C  
TO-220, TO-252



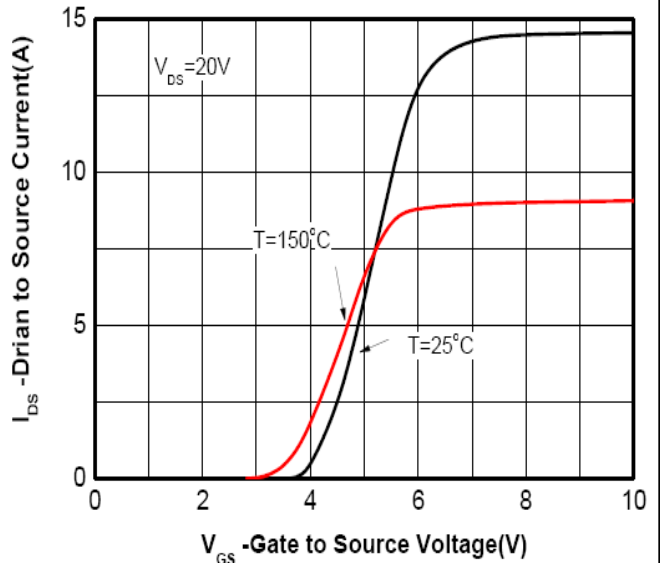
Safe operating area TC=25 °C  
TO-220FullIPAK



Typ. output characteristics  $T_J=25^\circ C$



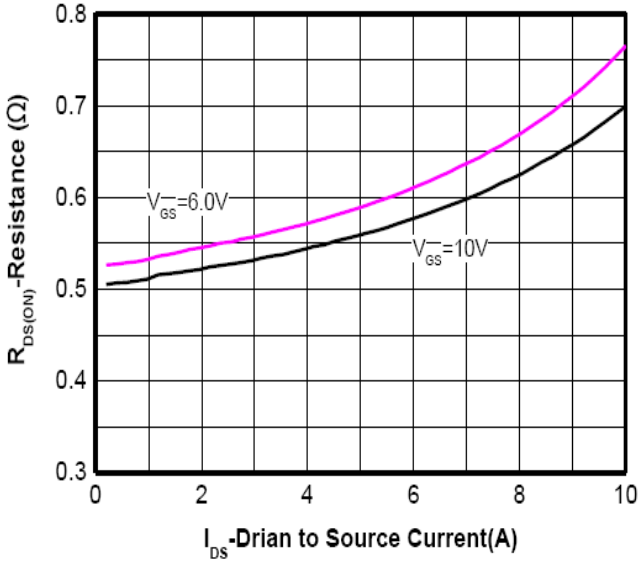
Typ. transfer characteristics



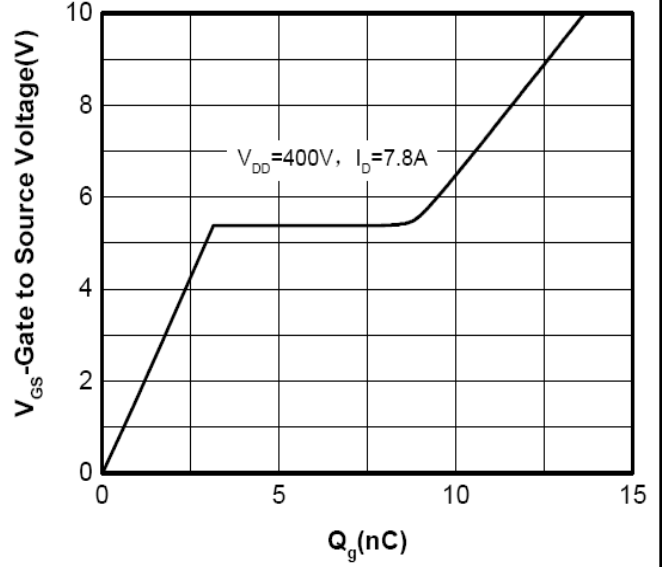


# Typical Performance Characteristics

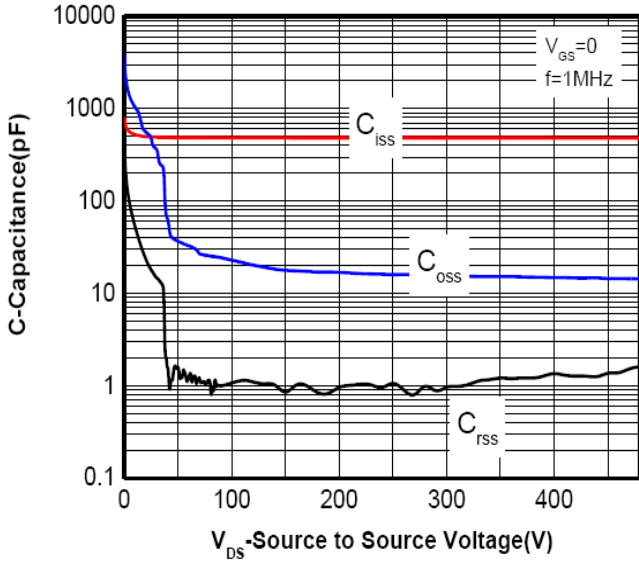
Typ. drain-source on-state resistance



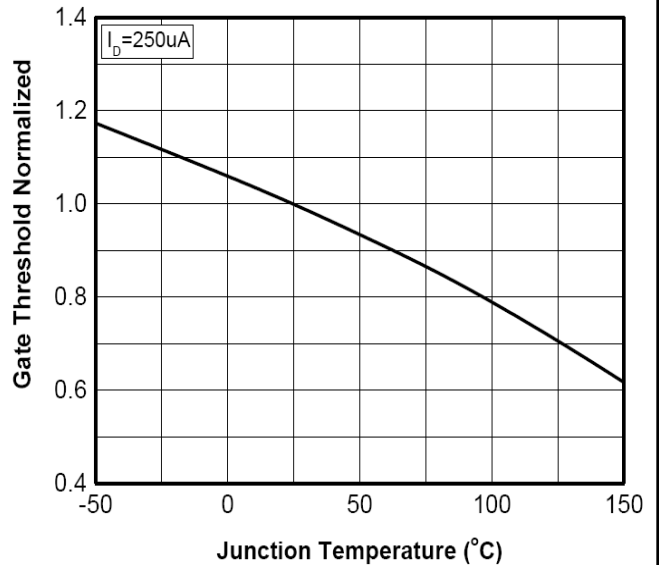
Typ. gate charge characteristics



Typ. capacitances



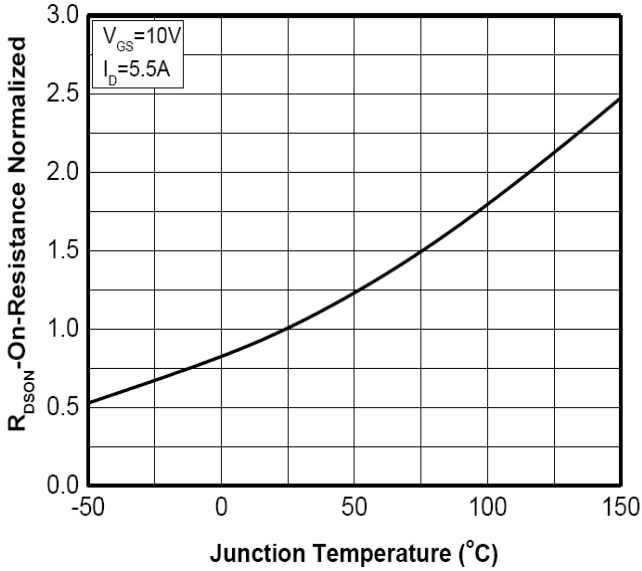
Normalized  $V_{GS(th)}$  characteristics



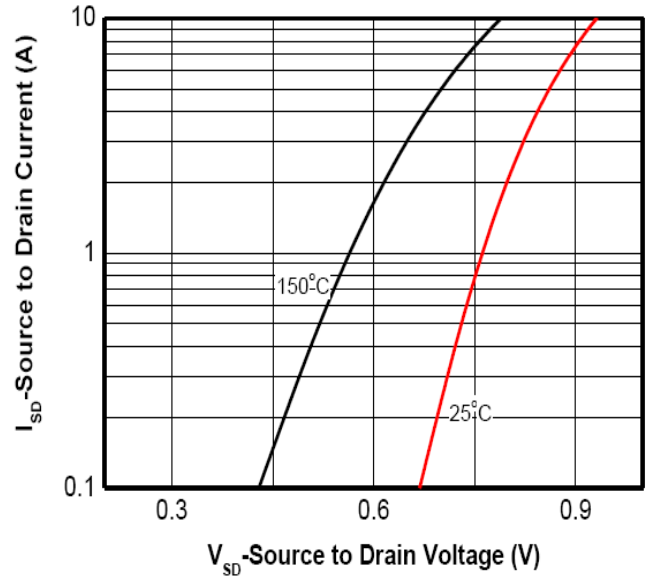


# Typical Performance Characteristics

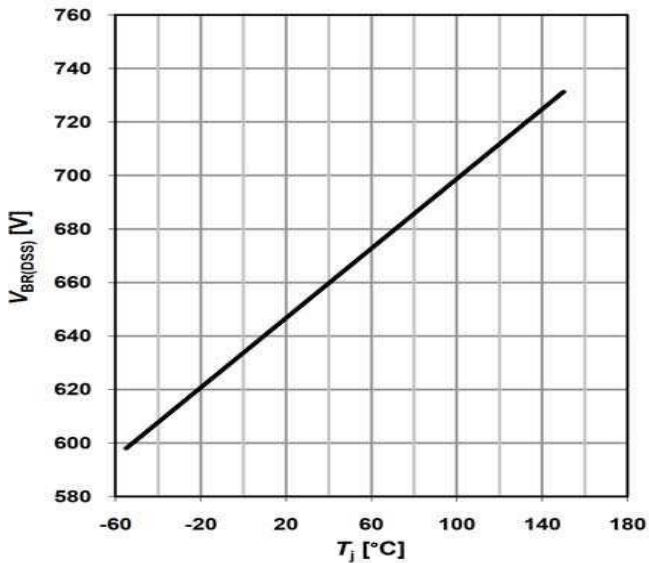
Normalized on-resistance vs temperature



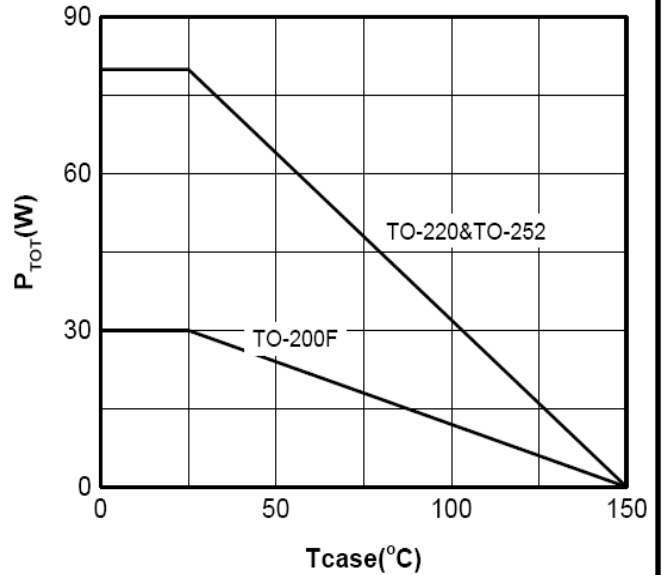
Forward characteristics of reverse diode



Drain-source breakdown voltage



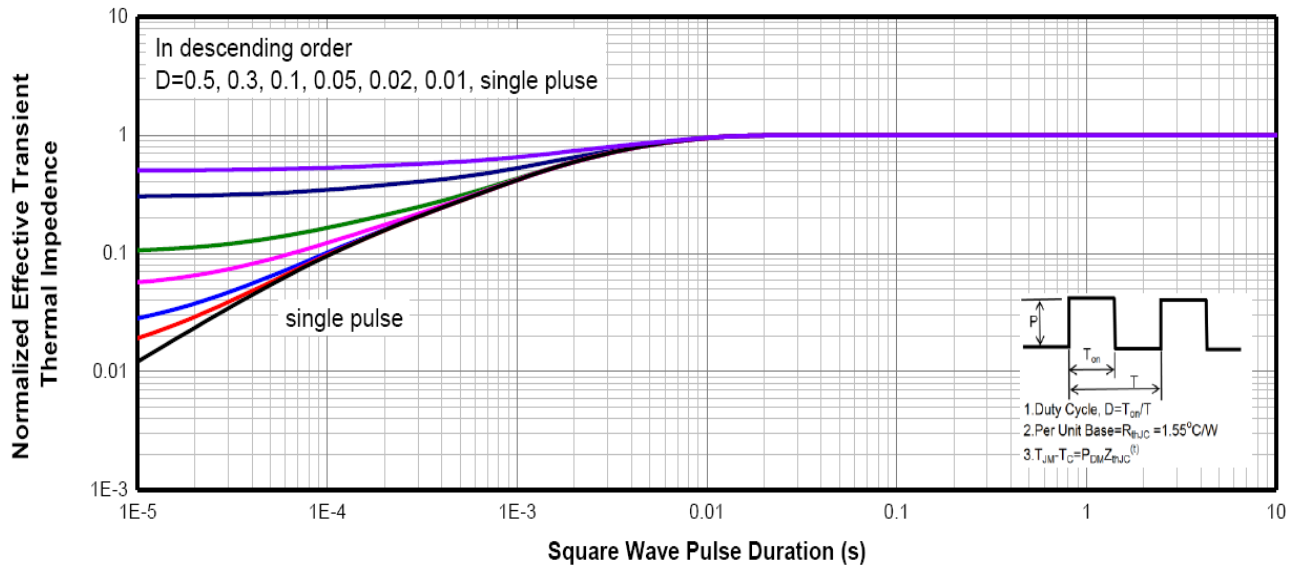
Power dissipation



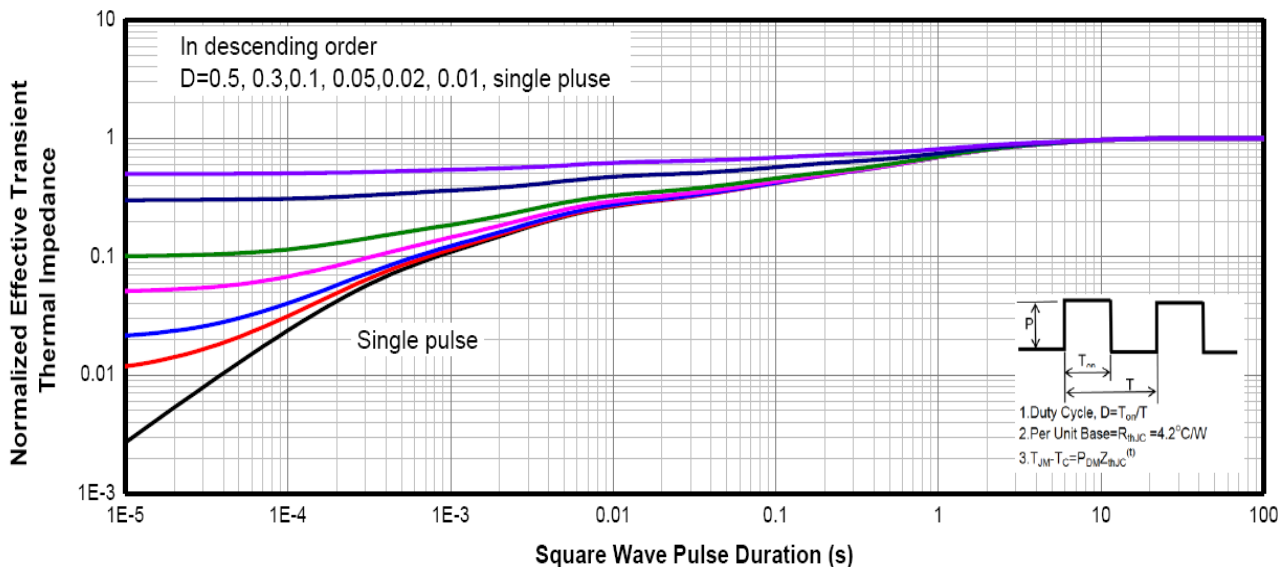


# Typical Performance Characteristics

Max. transient thermal impedance  
TO-220, TO-252



Max. transient thermal impedance  
TO-220FullPAK

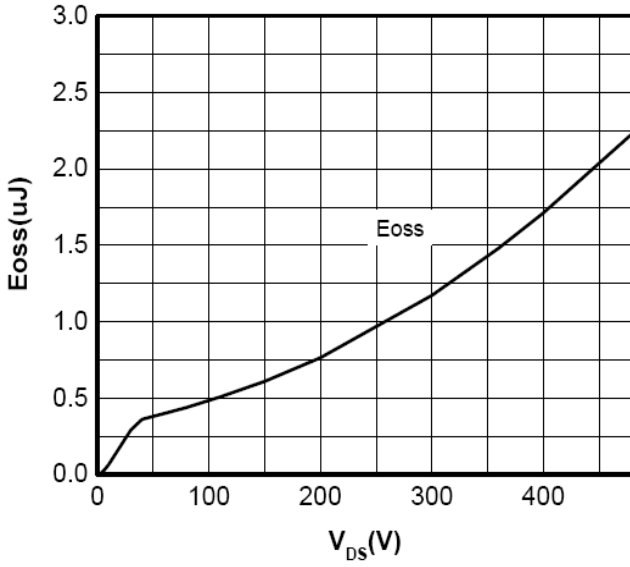


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# Typical Performance Characteristics

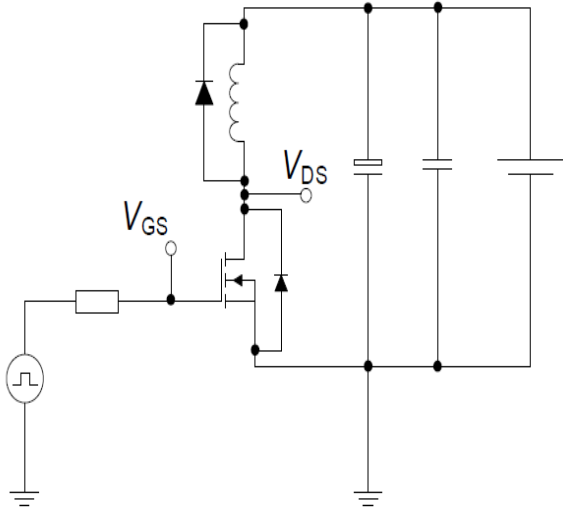
Coss stored energy



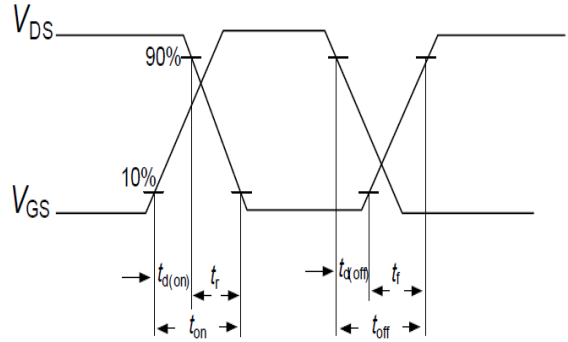


## Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load

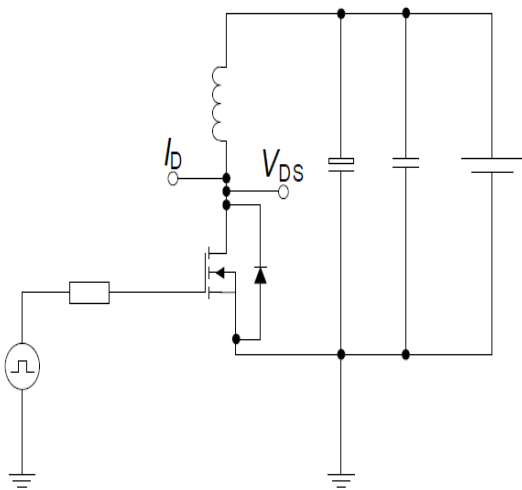


Switching time waveform

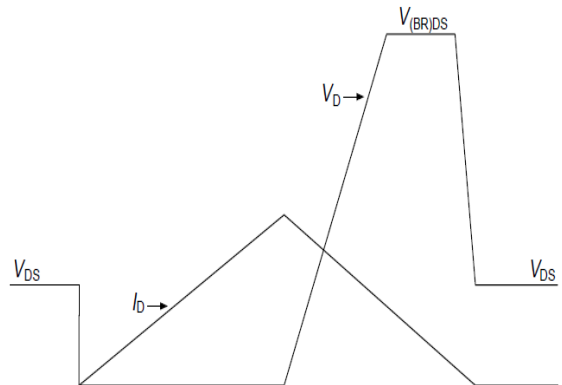


## Unclamped inductive load test circuit and waveform

Unclamped inductive load test circuit

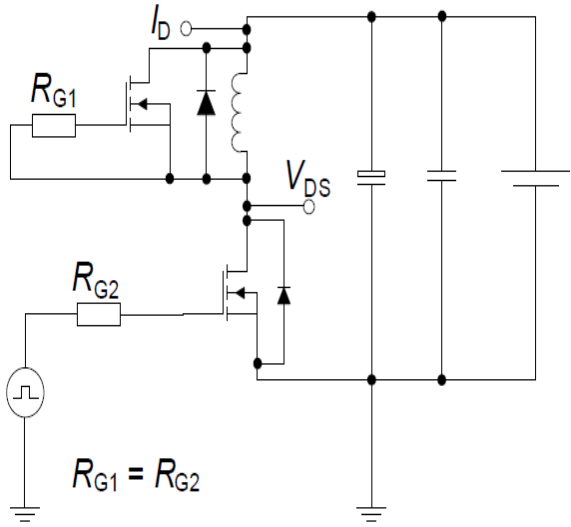


Unclamped inductive waveform

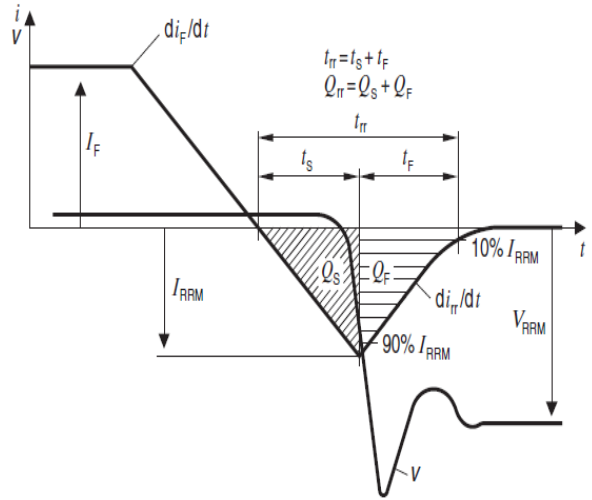


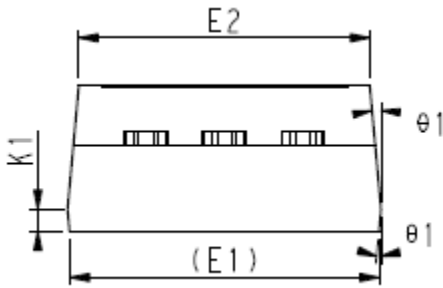
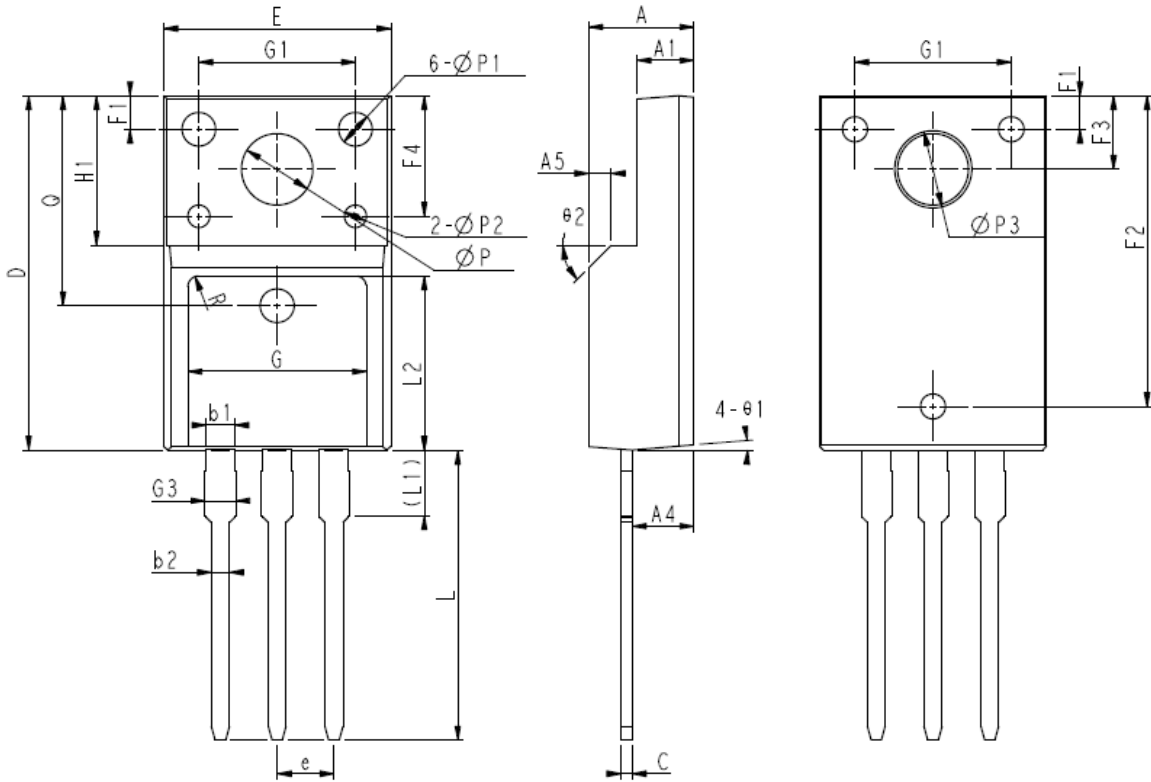
## Test circuit and waveform for diode characteristics

Test circuit for diode characteristics



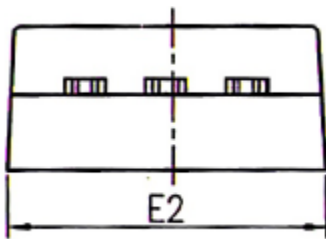
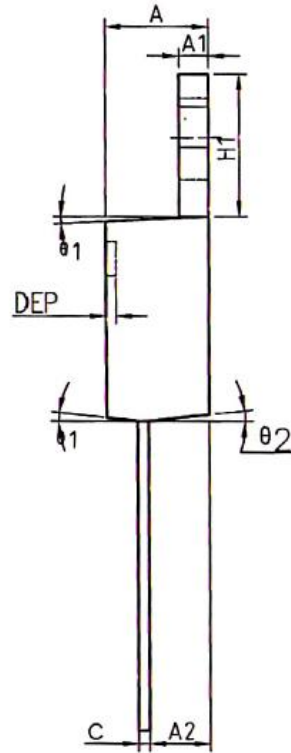
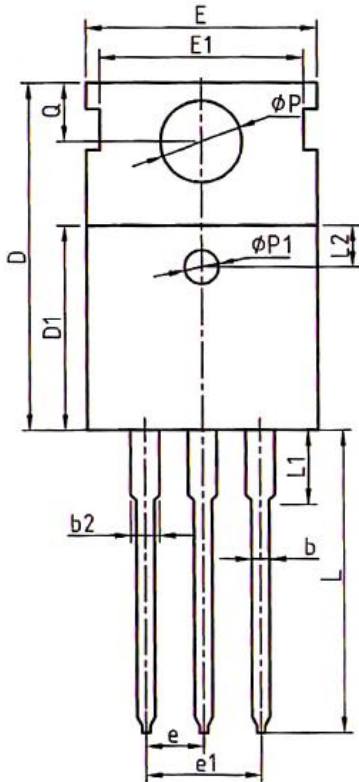
Diode recovery waveform





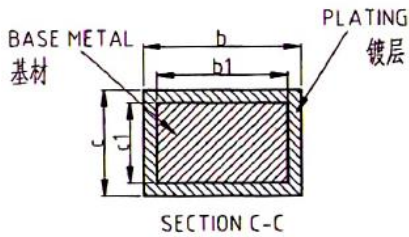
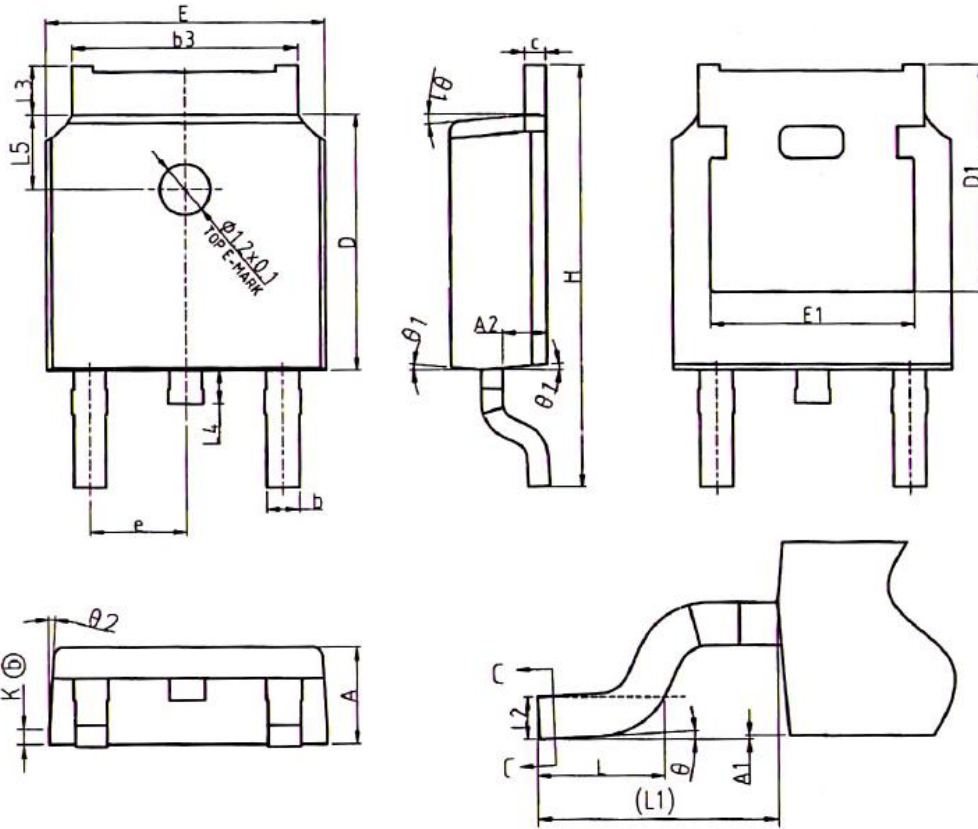
COMMON DIMENSIONS

SYMBOL	MM		
	MIN	NOM	MAX
E	10.00	10.16	10.32
E1	9.94	10.04	10.14
E2	9.36	9.46	9.56
A	4.50	4.70	4.90
A1	2.34	2.54	2.74
A4	2.66	2.76	2.86
A5	1.00REF		
c	0.45	0.50	0.60
D	15.67	15.87	16.07
Q	9.40REF		
H1	6.70REF		
e	2.54BSC		
$\Phi$ P	3.18REF		
L	12.78	12.98	13.18
L1	2.83	2.93	3.03
L2	7.70	7.80	7.90
$\Phi$ P1	1.40	1.50	1.60
$\Phi$ P2	0.95	1.00	1.05
$\Phi$ P3	3.45REF		
$\theta 1$	3°	5°	7°
$\theta 2$	-	45°	-
F1	1.00	1.50	2.00
F2	13.80	13.90	14.00
F3	3.20	3.30	3.40
F4	5.30	5.40	5.50
G	7.80	8.00	8.20
G1	6.90	7.00	7.10
G3	1.25	1.35	1.45
b1	1.23	1.28	1.38
b2	0.75	0.80	0.90
K1	0.65	0.70	0.75
R	0.50REF		



### COMMON DIMENSIONS

SYMBOL	MM		
	MIN	NDM	MAX
A	4.40	4.57	4.70
A1	1.27	1.30	1.37
A2	2.35	2.40	2.50
b	0.77	0.80	0.90
b2	1.17	1.27	1.36
c	0.48	0.50	0.56
D	15.40	15.60	15.80
D1	9.00	9.10	9.20
DEP	0.05	0.10	0.20
E	9.80	10.00	10.20
E1	-	8.70	-
E2	9.80	10.00	10.20
$\phi P1$	1.40	1.50	1.60
e	2.54BSC		
e1	5.08BSC		
H1	6.40	6.50	6.60
L	12.75	13.50	13.65
L1	-	3.10	3.30
L2	2.50REF		
$\phi P$	3.50	3.60	3.63
Q	2.73	2.80	2.87
$\theta 1$	5°	7°	9°
$\theta 2$	1°	3°	5°
$\theta 3$	1°	3°	5°



COMMON DIMENSIONS

SYMBOL	MM		
	MIN	NOM	MAX
A	2.20	2.30	2.38
A1	0.00	-	0.10
A2	0.97	1.07	1.17
b	0.72	0.78	0.85
b1	0.71	0.76	0.81
b3	5.23	5.33	5.46
c	0.47	0.53	0.58
c1	0.46	0.51	0.56
D	6.00	6.10	6.20
D1	5.30REF		
E	6.50	6.60	6.70
E1	4.70	4.83	4.92
e	2.286BSC		
H	9.90	10.10	10.30
L	1.40	1.50	1.70
L1	2.90REF		
L2	0.51BSC		
L3	0.90	-	1.25
L4	0.60	0.80	1.00
L5	1.70	1.80	1.90
θ	0°	-	8°
θ1	5°	7°	9°
θ2	5°	7°	9°
K	0.40REF		



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