



## SUPER-MOSFET

Super Junction Metal Oxide Semiconductor Field Effect Transistor

650V Super Junction Power MOSFET Gen-II With Fast-Recovery  
SS\*65R099SFD

Rev. 1.3

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# SSF65R099SFD/SSP65R099SFD/SSW65R099SFD 650V N-Channel Super-Junction MOSFET Gen-II With Fast-Recovery

## 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
- Fast-Recovery body diode
- Extremely Low Reverse Recovery Charge
- 700V @T<sub>J</sub> = 150 °C
- Typ. R<sub>DS(on)</sub> = 80mΩ
- Ultra Low Gate Charge (typ. Q<sub>g</sub> = 62.5nC)
- 100% avalanche tested

SSF65R099SFD



TO-220F

SSP65R099SFD

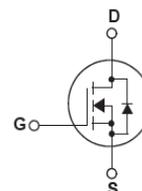


TO-220

SSW65R099SFD



TO-247



## Absolute Maximum Ratings

Symbol	Parameter	SSP_W65R099SFD	SSF65R099SFD	Unit
V <sub>DSS</sub>	Drain-Source Voltage		650	V
I <sub>D</sub>	Drain Current -Continuous (TC = 25°C) -Continuous (TC = 100°C)		34* 21.5*	A
I <sub>DM</sub>	Drain Current - Pulsed (Note 1)		136	A
V <sub>GSS</sub>	Gate-Source voltage		±30	V
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)		1600	mJ
I <sub>AS</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> max)		8	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)	220	38	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_W65R099SFD	SSF65R099SFD	Unit
R <sub>θJC</sub>	Thermal Resistance, Junction-to-Case	0.57	3.3	°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

SSF65R099SFD/SSP65R099SFD/SSW65R099SFD 650V N-Channel Super-Junction MOSFET Gen-II With Fast-Recovery

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> = 1.5mA, T <sub>J</sub> = 150°C	700	-	-	V
ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	Breakdown Voltage Temperature Coefficient	I <sub>D</sub> = 1.5mA, 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>J</sub> = 125°C	-	1 300	5 -	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	3.0	4.0	5.0	V
R <sub>DS(on)</sub>	Static Drain-Source On-Resistance	V <sub>GS</sub> = 10V, I <sub>D</sub> = 17A	-	80	99	mΩ
<b>Dynamic Characteristics</b>						
C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 100V, V <sub>GS</sub> = 0V, f = 1.0MHz	-	2960	-	pF
C <sub>oss</sub>	Output Capacitance		-	107	-	pF
C <sub>rss</sub>	Reverse Transfer Capacitance		-	1.5	-	pF
Q <sub>g</sub>	Total Gate Charge	V <sub>DS</sub> = 400V, I <sub>D</sub> = 17A, V <sub>GS</sub> = 10V (Note 4)	-	62.5	-	nC
Q <sub>gs</sub>	Gate-Source Charge		-	17.2	-	nC
Q <sub>gd</sub>	Gate-Drain Charge		-	21.4	-	nC
V <sub>plateau</sub>	Gate plateau voltage		-	5.8	-	V
R <sub>g</sub>	Gate resistance	f=1 MHz, open drain	-	7.8	-	Ω
<b>Switching Characteristics</b>						
t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DS</sub> = 400V, I <sub>D</sub> = 17A R <sub>G</sub> = 5Ω, V <sub>GS</sub> = 10V (Note 4)	-	23	-	ns
t <sub>r</sub>	Turn-On Rise Time		-	14	-	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		-	98	-	ns
t <sub>f</sub>	Turn-Off Fall Time		-	18	-	ns
<b>Drain-Source Diode Characteristics and Maximum Ratings</b>						
I <sub>S</sub>	Maximum Continuous Drain-Source Diode Forward Current		-	-	34	A
I <sub>SM</sub>	Maximum Pulsed Drain-Source Diode Forward Current		-	-	136	A
V <sub>SD</sub>	Drain-Source Diode Forward Voltage	V <sub>GS</sub> = 0V, I <sub>S</sub> = 34A	-	1.0	1.4	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 400V, I <sub>S</sub> = 17A, diF/dt = 100A/μs	-	140	-	ns
Q <sub>rr</sub>	Reverse Recovery Charge		-	0.7	-	μC
I <sub>rrm</sub>	Peak Reverse Recovery Current		-	9	-	A

## NOTES:

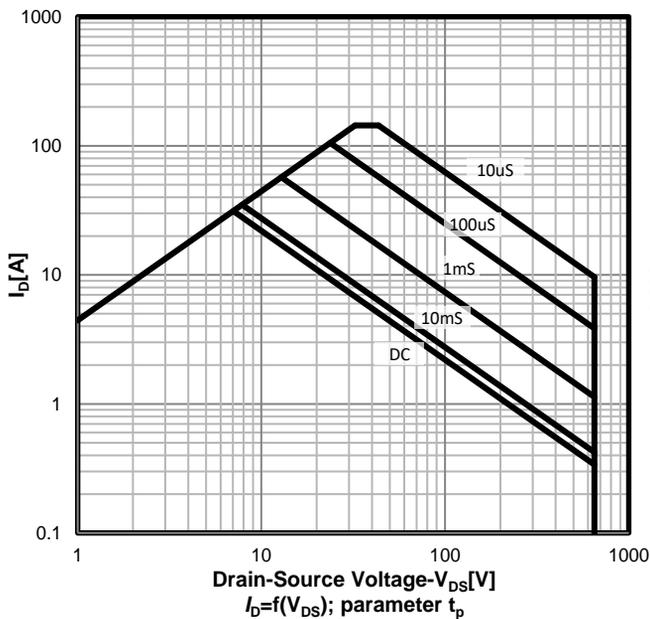
1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. I<sub>D</sub>=I<sub>AS</sub>, V<sub>DD</sub>=100V, L=50mH, Starting T<sub>J</sub>=25 °C
3. I<sub>SD</sub>≤I<sub>D</sub>, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ BV<sub>DSS</sub>, Starting T<sub>J</sub> = 25 °C
4. Essentially Independent of Operating Temperature Typical Characteristics



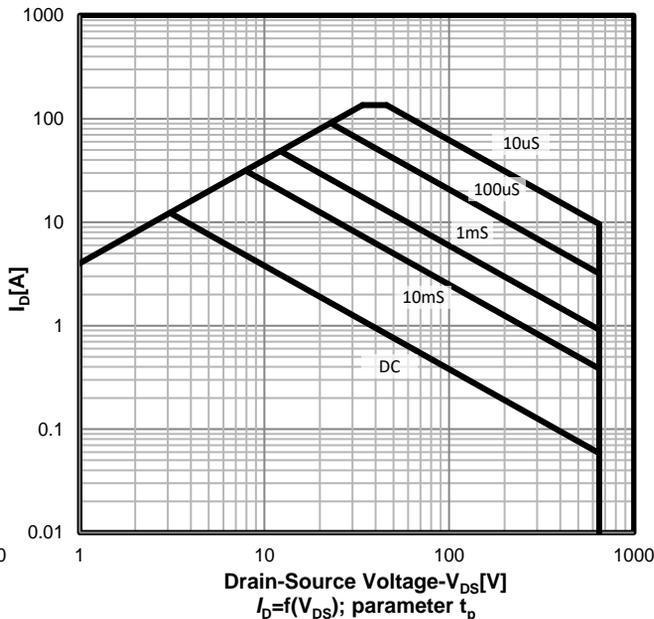
# Typical Performance Characteristics

SSF65R099SFD/SSP65R099SFD/SSW65R099SFD 650V N-Channel Super-Junction MOSFET Gen-II With Fast-Recovery

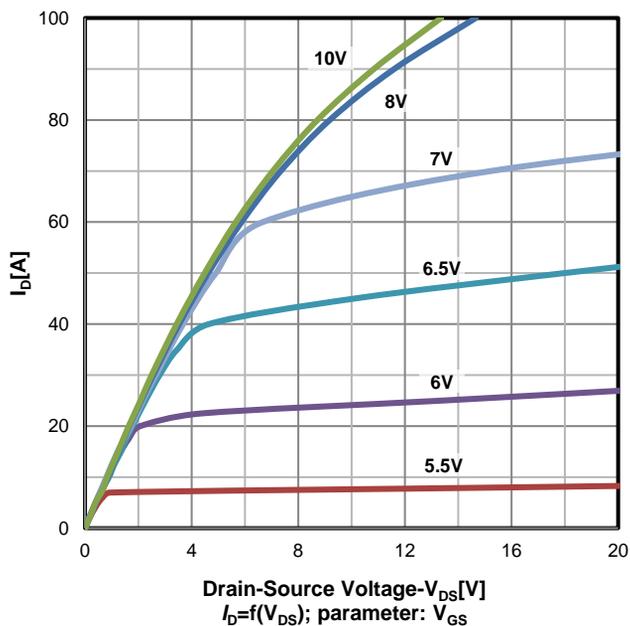
Safe operating area TC=25 °C  
TO-220, TO-247



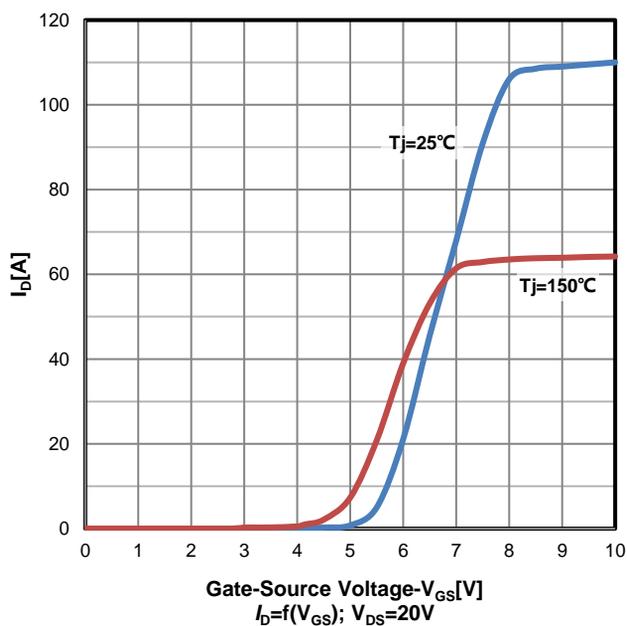
Safe operating area TC=25 °C  
TO-220FullPAK



Typ. output characteristics  $T_j=25\text{ }^\circ\text{C}$



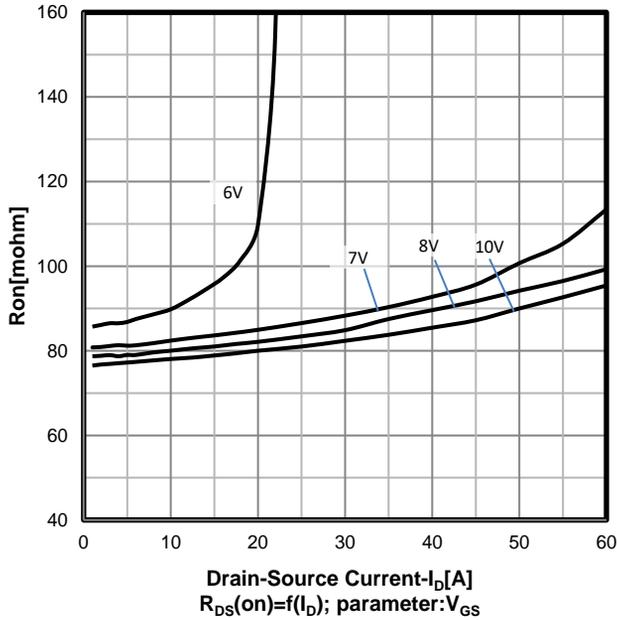
Transfer characteristics



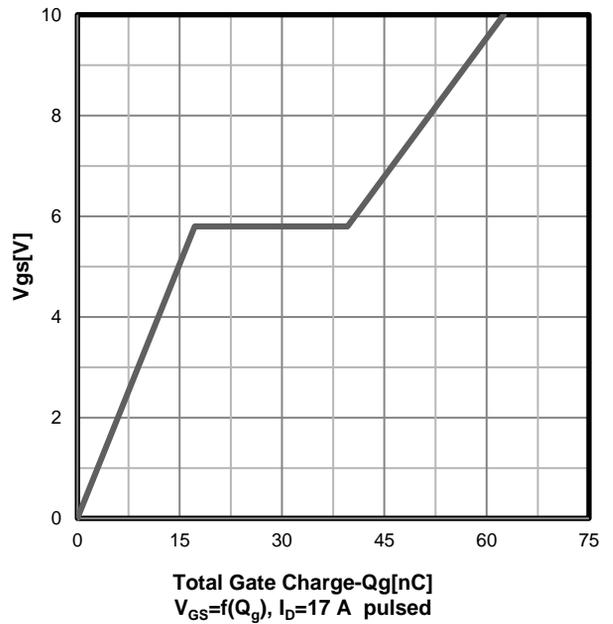


# Typical Performance Characteristics

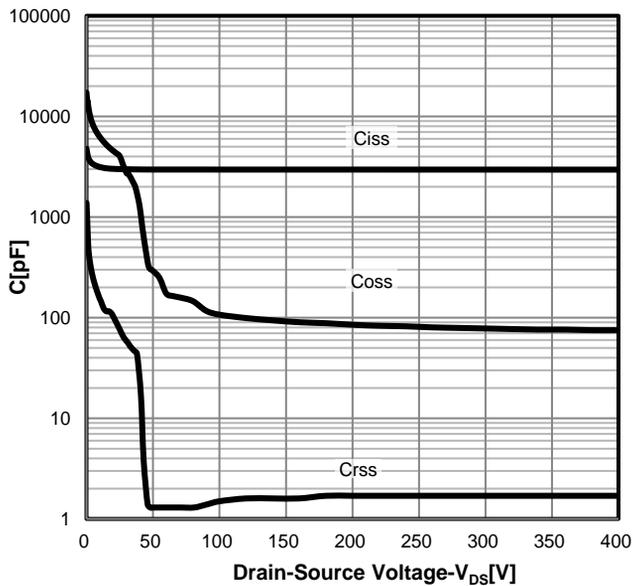
Typ. drain-source on-state resistance



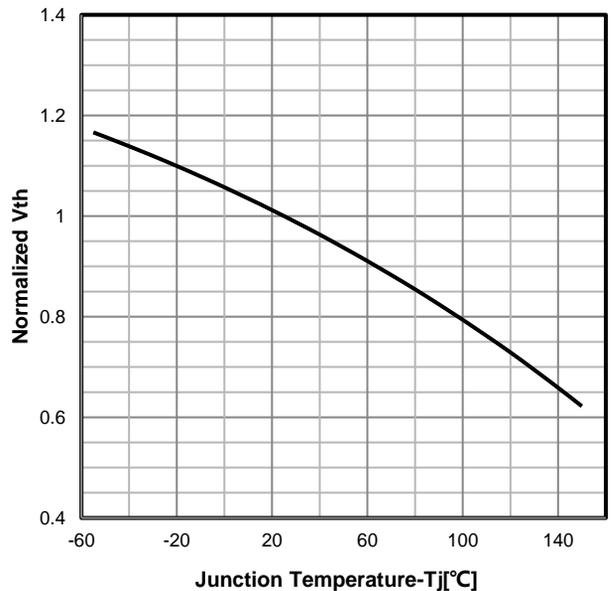
Typ. gate charge characteristics



Typ. capacitances



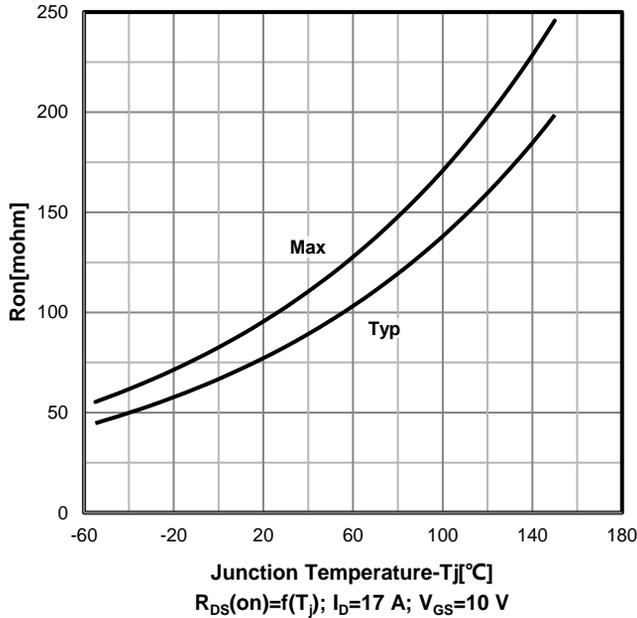
Normalized  $V_{GS(th)}$  characteristics



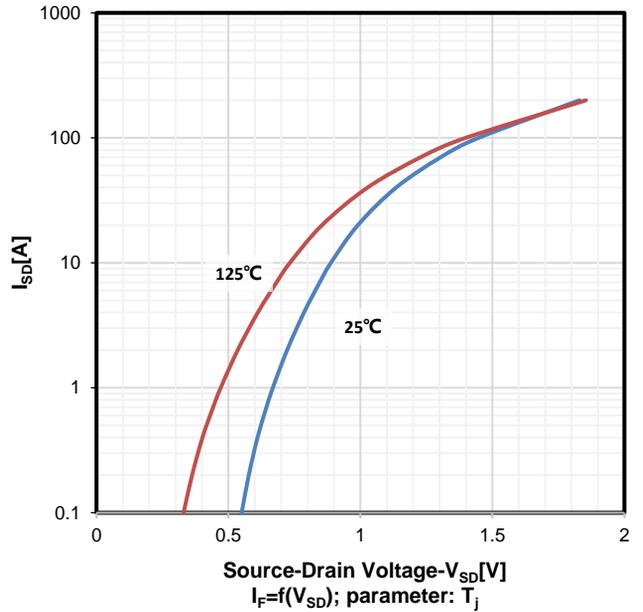


# Typical Performance Characteristics

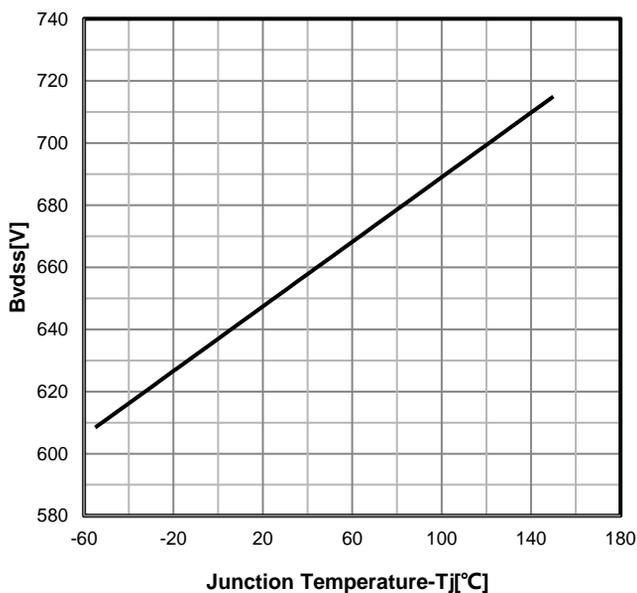
### On-resistance vs temperature



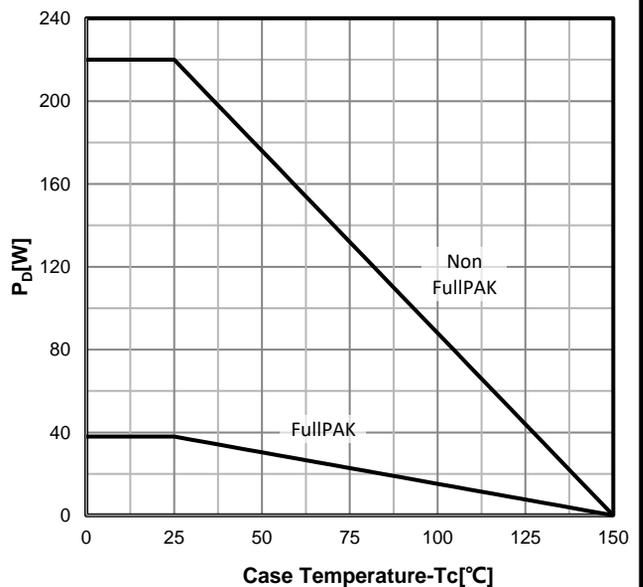
### Forward characteristics of reverse diode



### Drain-source breakdown voltage



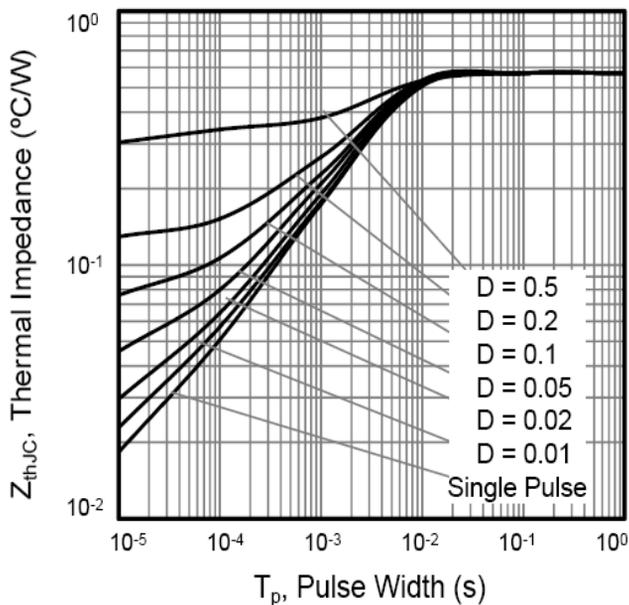
### Power dissipation



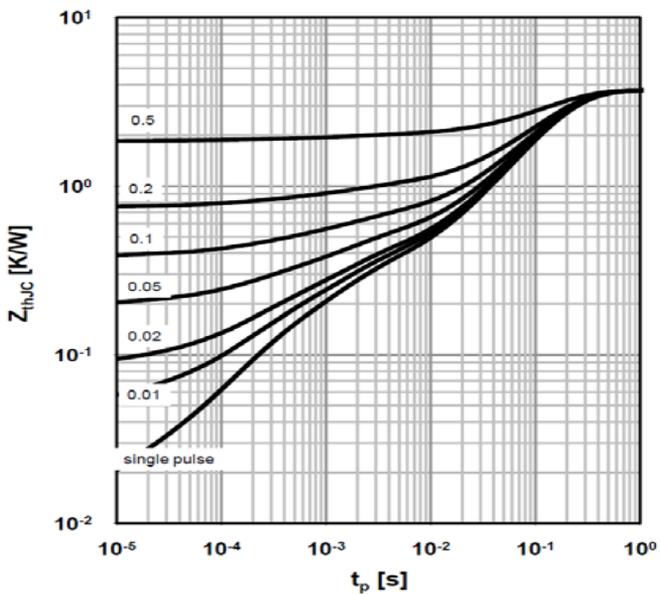


# Typical Performance Characteristics

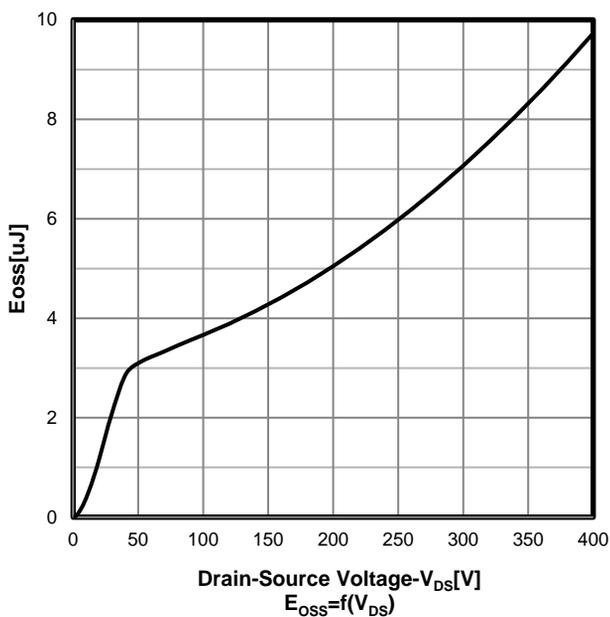
Max. transient thermal impedance  
TO-220, TO-247



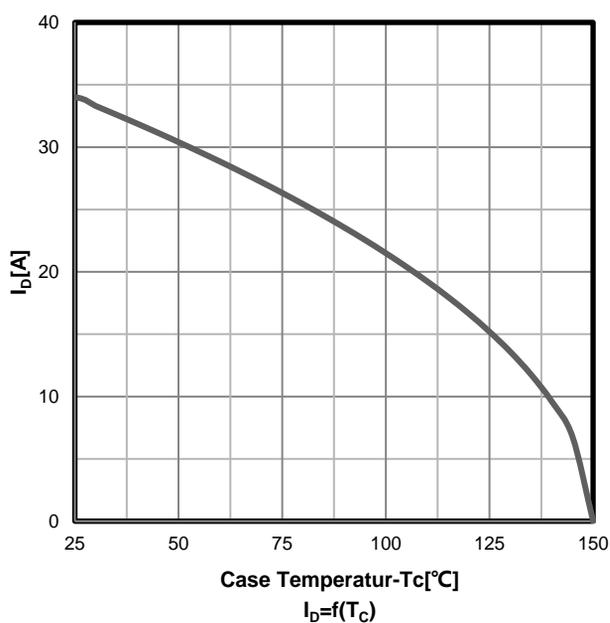
Max. transient thermal impedance  
TO-220FullPAK



Coss stored energy

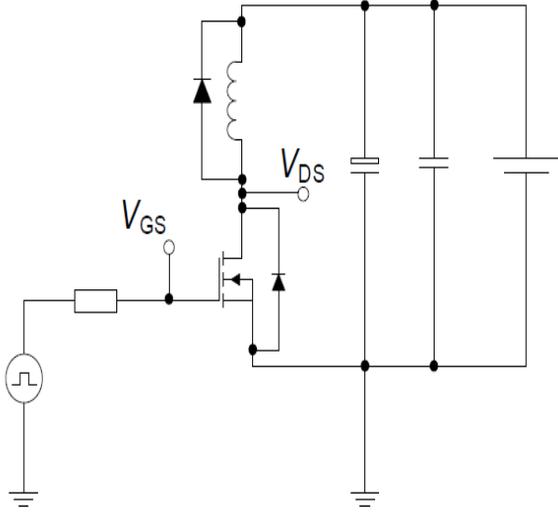


Drain current vs temperature

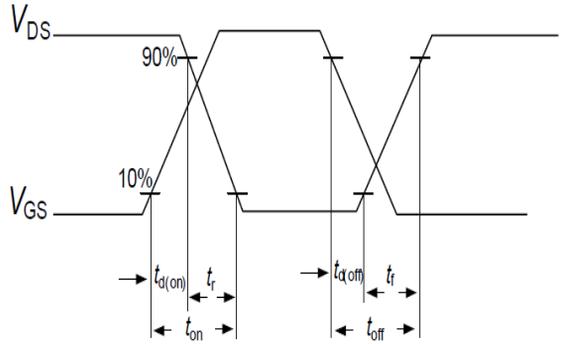


## Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load

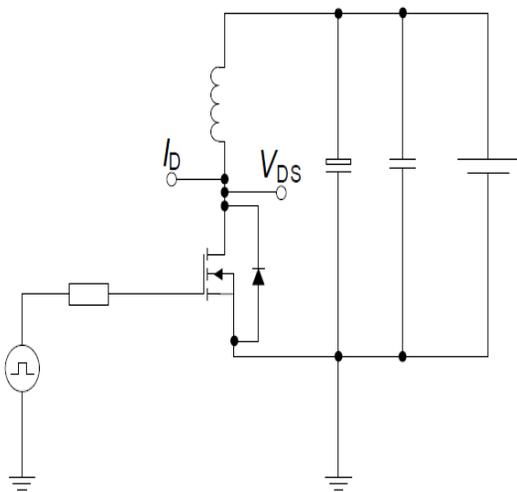


Switching time waveform

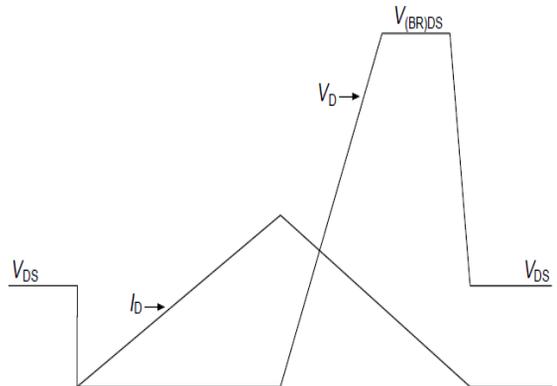


## Unclamped inductive load test circuit and waveform

Unclamped inductive load test circuit

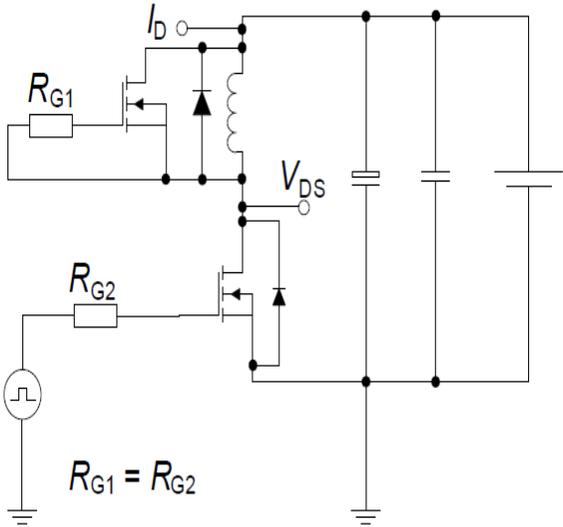


Unclamped inductive waveform

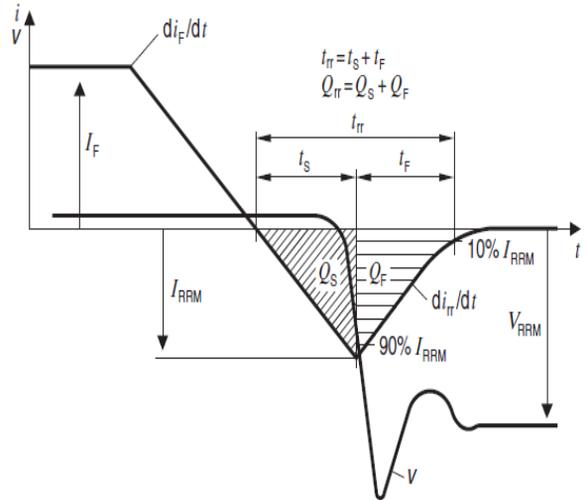


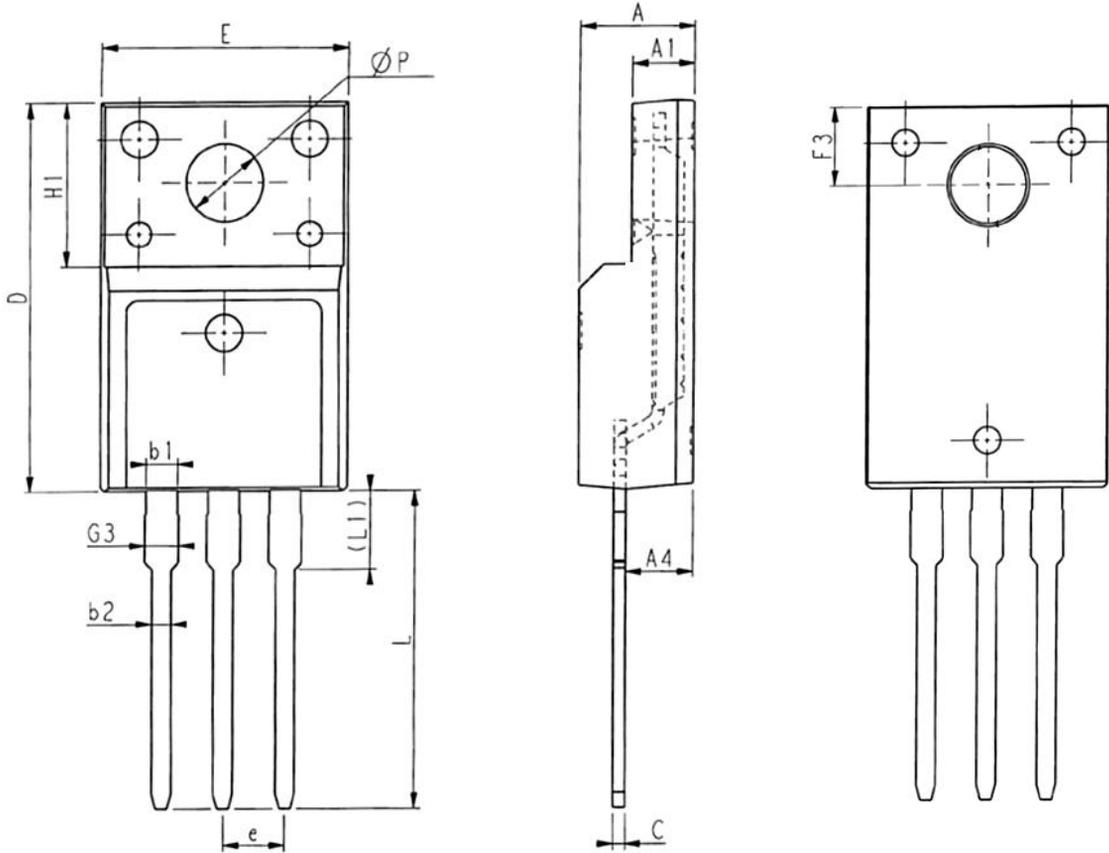
## Test circuit and waveform for diode characteristics

Test circuit for diode characteristics



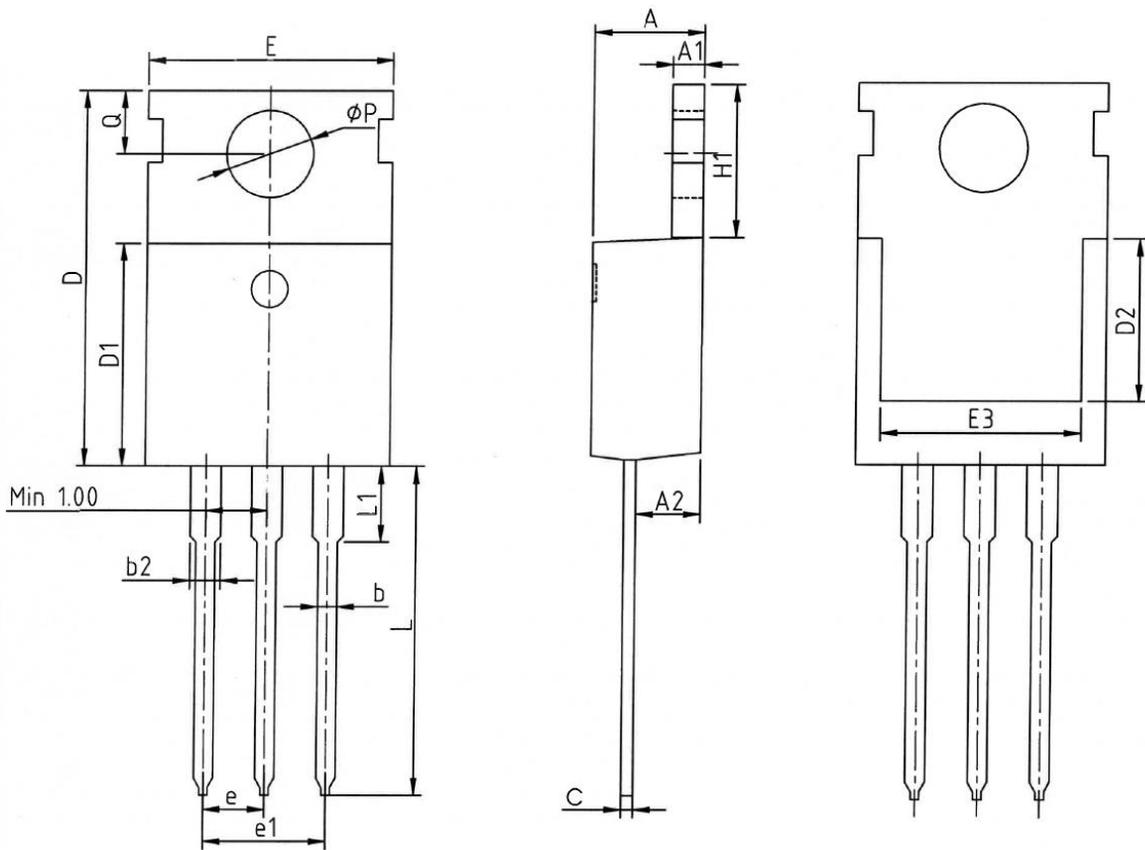
Diode recovery waveform





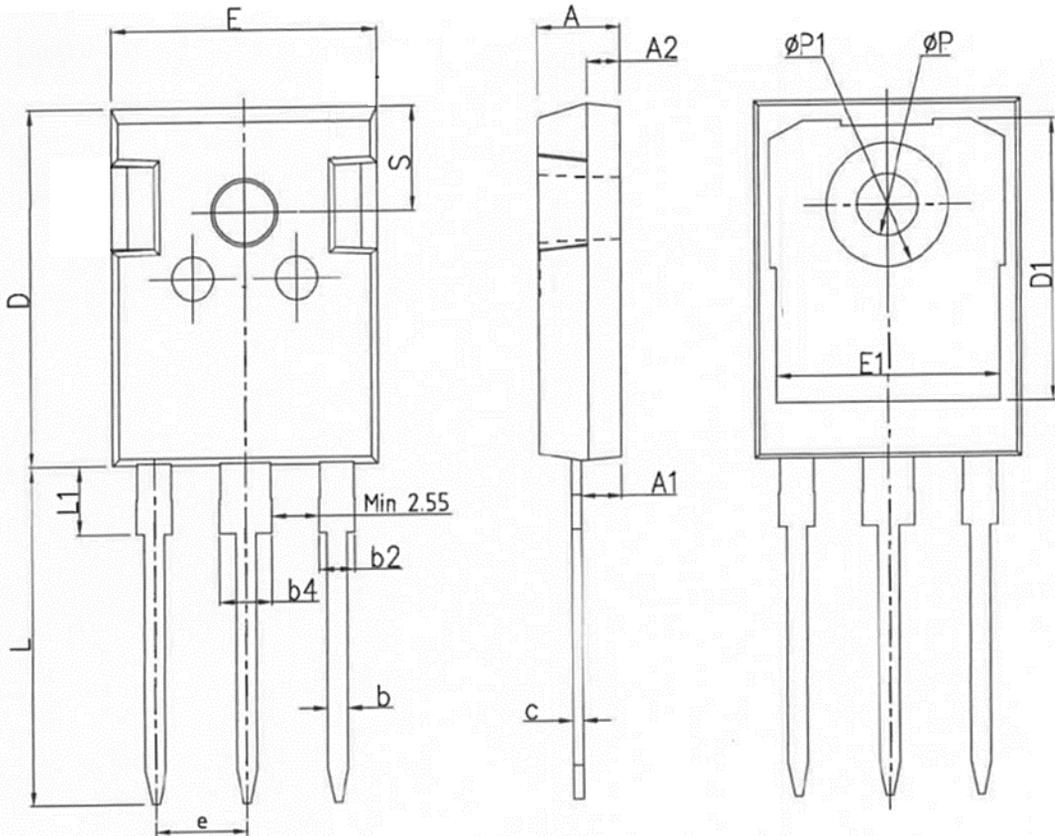
**COMMON DIMENSIONS**

SYMBOL	UNIT(mm)		
	MIN	NOM	MAX
E	9.86	10.16	10.36
A	4.50	4.70	4.90
A1	2.34	2.54	2.84
A4	2.56	2.76	2.96
C	0.35	0.50	0.65
D	15.50	15.87	16.25
H1	6.70REF		
e	2.54BSC		
L	12.60	12.98	13.35
L1	3.03	3.23	3.43
ΦP	3.00	3.20	3.40
F3	3.10	3.30	3.50
G3	1.20	1.35	1.60
b1	1.18	1.28	1.43
b2	0.70	0.80	0.95



### COMMON DIMENIONS

SYMBOL	MIN	NOM	MAX
A	4.37	4.57	4.70
A1	1.25	1.30	1.40
A2	2.20	2.40	2.60
b	0.70	0.80	0.95
b2	1.17	1.27	1.47
c	0.45	0.50	0.60
D	15.10	15.60	16.10
D1	8.80	9.10	9.40
D2	5.50	6.30	7.10
E	9.70	10.00	10.30
E3	7.00	7.80	8.60
e	2.54 BSC		
e1	5.08 BSC		
H1	6.25	6.50	6.85
L	12.75	13.50	13.80
L1	-	3.10	3.40
ΦP	3.40	3.60	3.80
Q	2.60	2.80	3.00



### COMMON DIMENSIONS

SYMBOL	UNIT(mm)		
	MIN	NOM	MAX
A	4.80	5.00	5.20
A1	2.20	2.40	2.60
A2	1.85	2.00	2.15
b	1.10	1.20	1.35
b2	1.91	2.04	2.21
b4	2.91	3.04	3.21
c	0.50	0.60	0.75
D	20.70	21.00	21.30
D1	16.20	16.55	16.90
E	15.50	15.80	16.10
E1	13.00	13.30	13.60
e	5.44BSC		
L	19.60	19.95	20.30
L1	-	-	4.30
ΦP	3.40	3.60	3.80
ΦP1	-	-	7.50
S	6.15BSC		



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