



SUPER-SEMI



## SUPER-MOSFET

Super Junction Metal Oxide Semiconductor Field Effect Transistor

650V Super Junction Power MOSFET Gen- II  
SS\*65R190S2

Rev. 1.4  
Mar. 2020

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# SSF65R190S2/SSP65R190S2/SSW65R190S2 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) = 0.16Ω
- Ultra Low Gate Charge (typ. Q<sub>g</sub> = 36.5nC)
- 100% avalanche tested

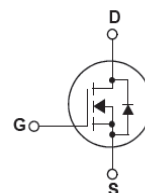
SSF65R190S2



SSP65R190S2



SSW65R190S2



## Absolute Maximum Ratings

Symbol	Parameter	SSP_W65R190S2	SSF65R190S2	Unit
V <sub>DSS</sub>	Drain-Source Voltage	650		V
I <sub>D</sub>	Drain Current -Continuous (TC = 25°C) -Continuous (TC = 100°C)	20* 12.6*		A
I <sub>DM</sub>	Drain Current - Pulsed (Note 1)	65		A
V <sub>GSS</sub>	Gate-Source voltage	±30		V
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)	506		mJ
I <sub>AS</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> max)	4.5		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)	150	34	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_W65R190S2	SSF65R190S2	Unit
R <sub>θJC</sub>	Thermal Resistance, Junction-to-Case	0.83	3.7	°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

SSF65R190S2/SSP65R190S2/SSW65R190S2 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> = 10A	-	0.16	0.19	Ω
<b>Dynamic Characteristics</b>						
C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 100V, V <sub>GS</sub> = 0V, f = 1.0MHz	-	1505	-	pF
C <sub>oss</sub>	Output Capacitance		-	68	-	pF
C <sub>rss</sub>	Reverse Transfer Capacitance		-	2.1	-	pF
Q <sub>g</sub>	Total Gate Charge	V <sub>DS</sub> = 480V, I <sub>D</sub> = 10A, V <sub>GS</sub> = 10V (Note 4)	-	36.5	-	nC
Q <sub>gs</sub>	Gate-Source Charge		-	8.7	-	nC
Q <sub>gd</sub>	Gate-Drain Charge		-	12.5	-	nC
R <sub>g</sub>	Gate resistance	f=1 MHz, open drain	-	9.8	-	Ω
<b>Switching Characteristics</b>						
t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DS</sub> = 400V, I <sub>D</sub> = 10A R <sub>G</sub> = 15Ω, V <sub>GS</sub> = 12V (Note 4)	-	21	-	ns
t <sub>r</sub>	Turn-On Rise Time		-	18	-	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		-	102	-	ns
t <sub>f</sub>	Turn-Off Fall Time		-	22	-	ns
<b>Drain-Source Diode Characteristics and Maximum Ratings</b>						
I <sub>S</sub>	Maximum Continuous Drain-Source Diode Forward Current		-	-	20	A
I <sub>SM</sub>	Maximum Pulsed Drain-Source Diode Forward Current		-	-	65	A
V <sub>SD</sub>	Drain-Source Diode Forward Voltage	V <sub>GS</sub> = 0V, I <sub>S</sub> = 20A	-	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> = 10A, dI <sub>F</sub> /dt = 100A/μs	-	318	-	ns
Q <sub>rr</sub>	Reverse Recovery Charge		-	5.5	-	μC
I <sub>rrm</sub>	Peak Reverse Recovery Current		-	24.9	-	A

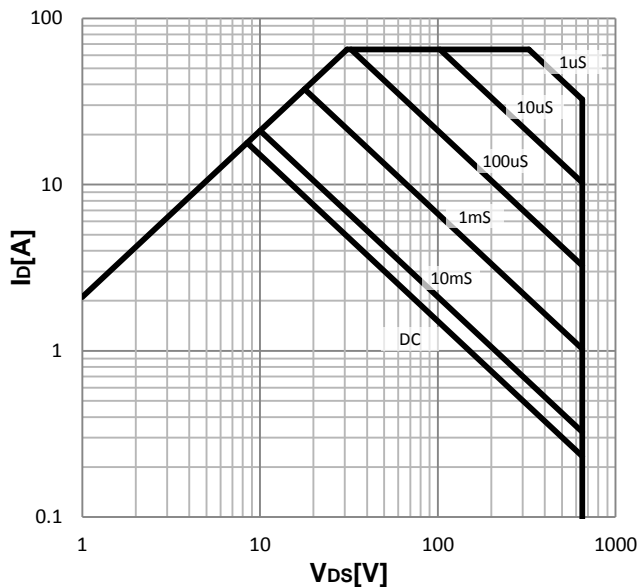
## NOTES:

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

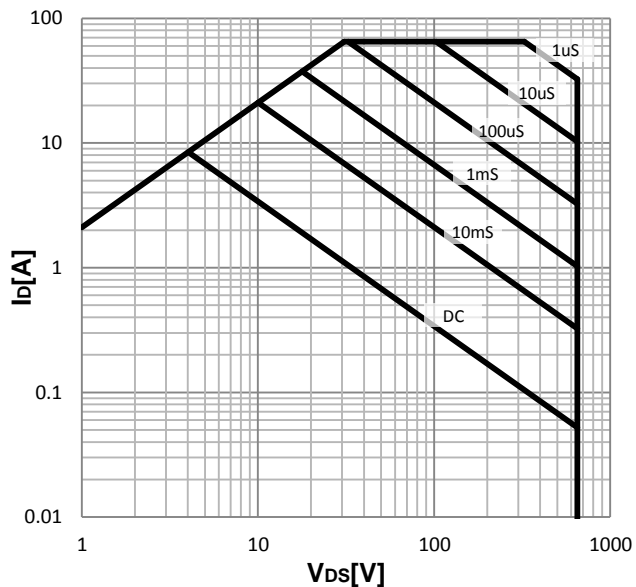


# Typical Performance Characteristics

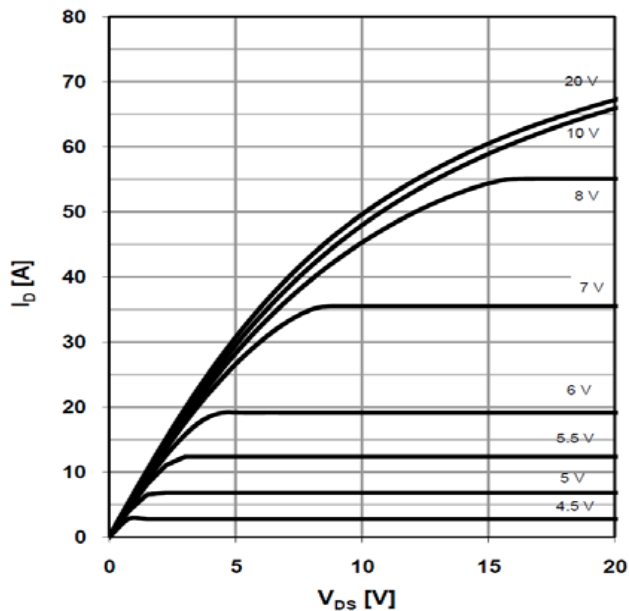
Safe operating area TC=25 °C  
parameter: tp; TO-220, TO-247



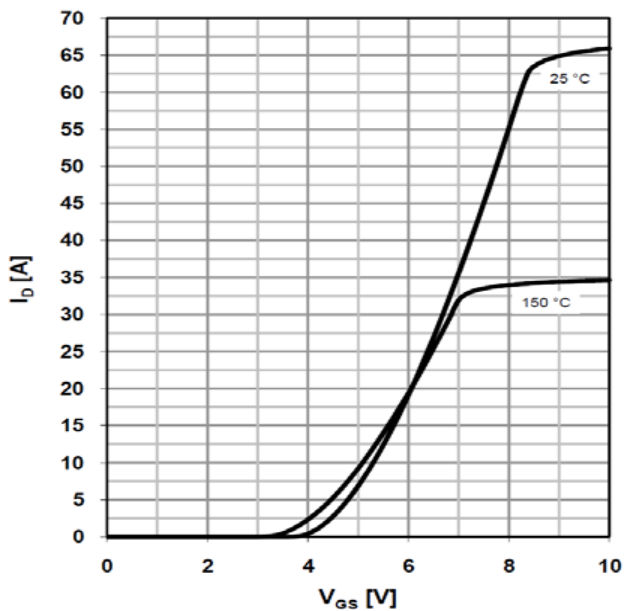
Safe operating area TC=25 °C  
parameter: tp; TO-220FullPAK



Typ. output characteristics  $T_j=25\text{ }^\circ\text{C}$   
parameter:  $V_{GS}$



Typ. transfer characteristics

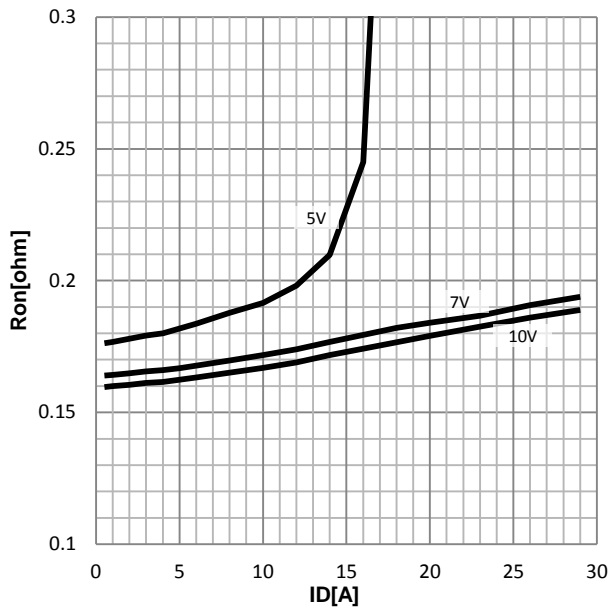


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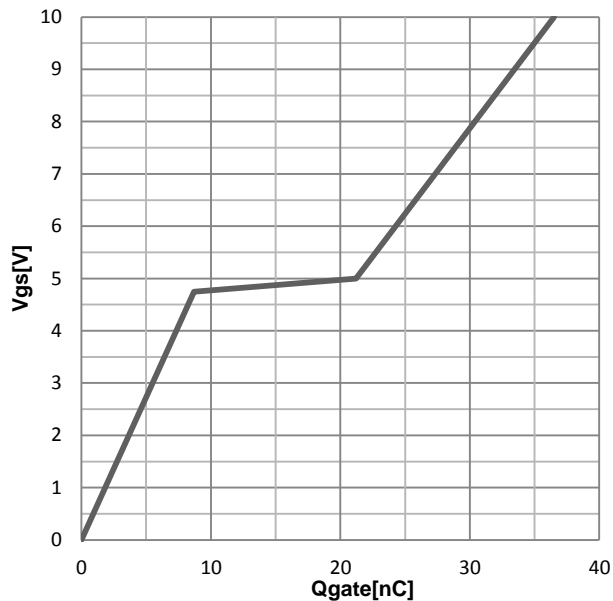


# Typical Performance Characteristics

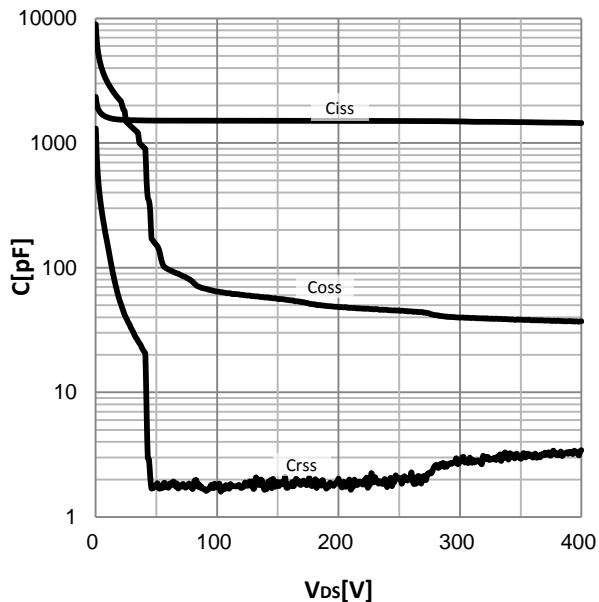
Typ. drain-source on-state resistance parameter :  $V_{GS}$



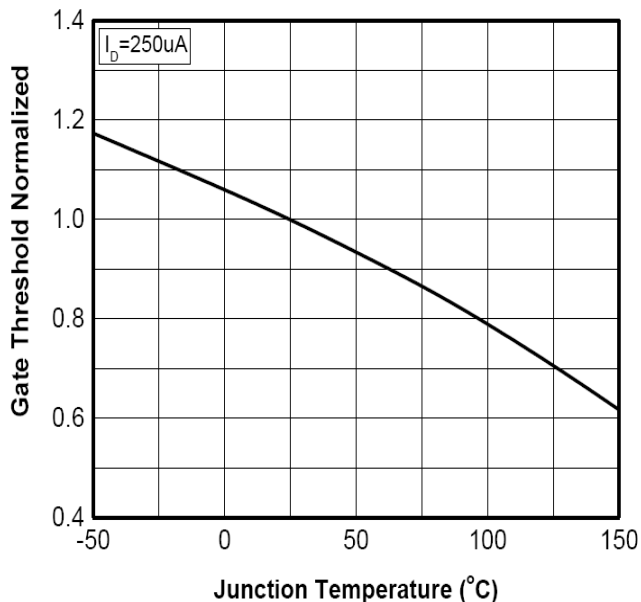
Typ. gate charge characteristics



Typ. capacitances



Normalized  $V_{GS(th)}$  characteristics

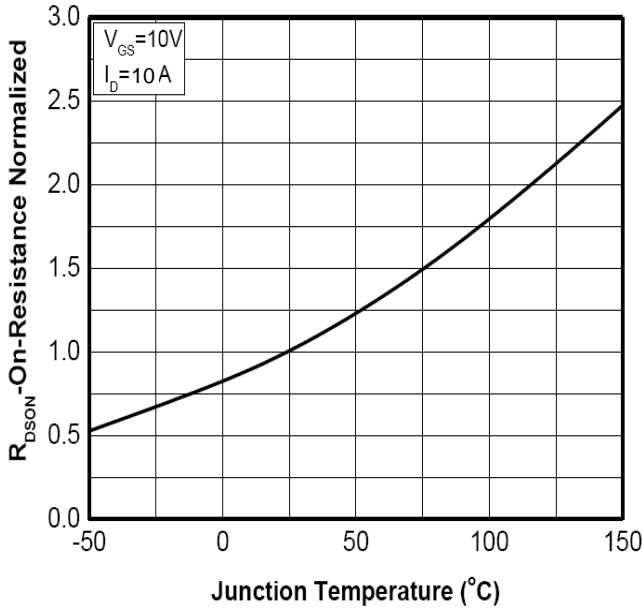


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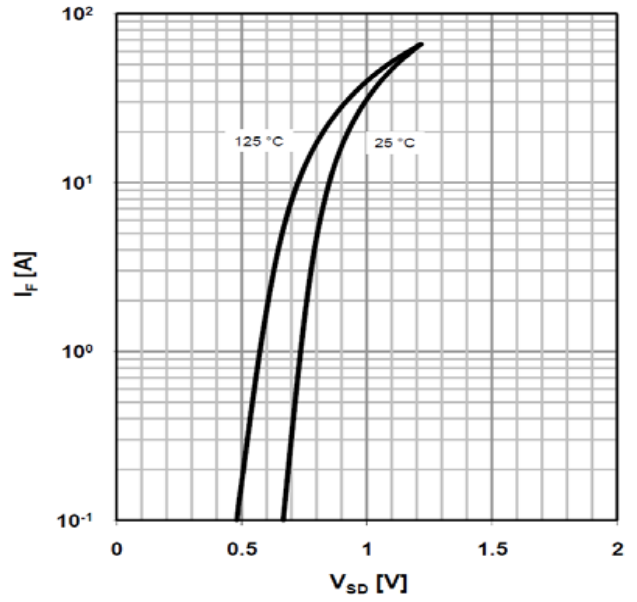


# Typical Performance Characteristics

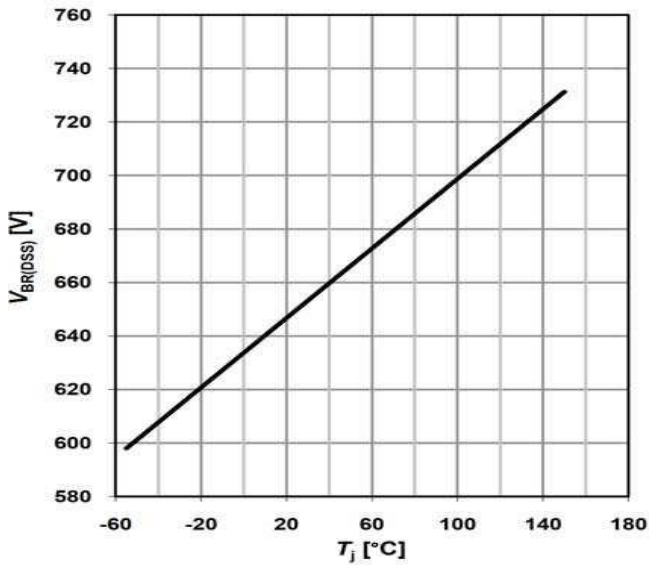
Normalized on-resistance vs temperature



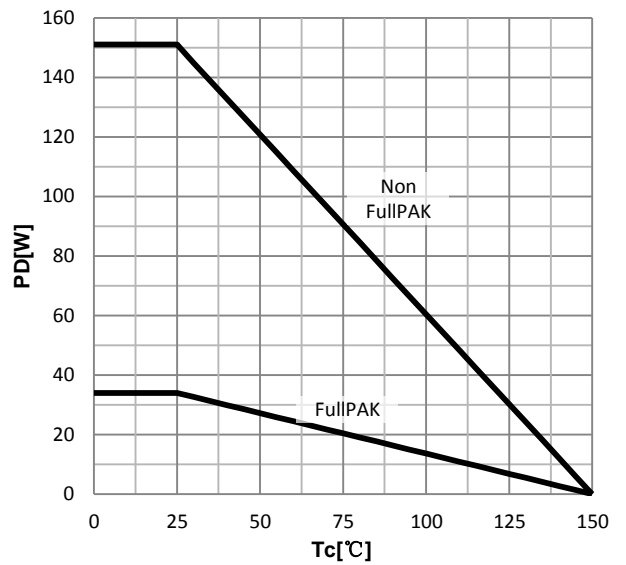
Forward characteristics of reverse diode



Drain-source breakdown voltage



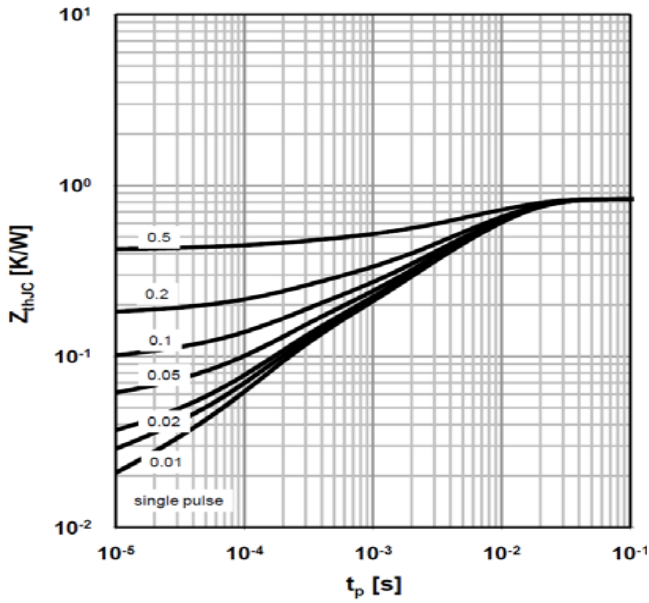
Power dissipation



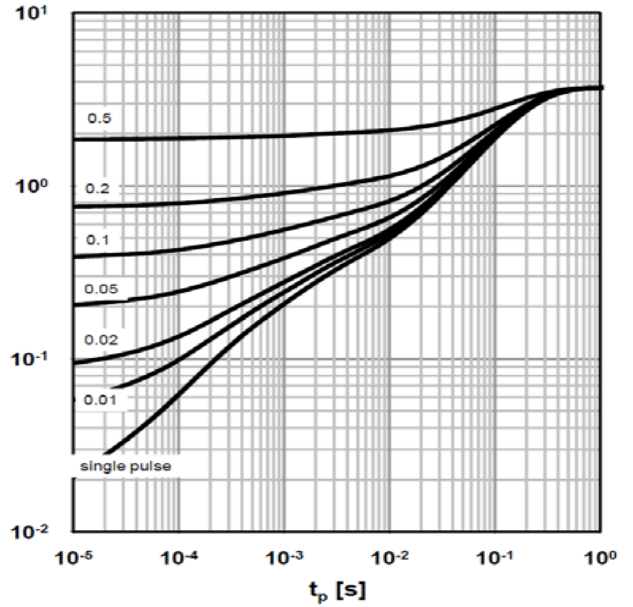


# Typical Performance Characteristics

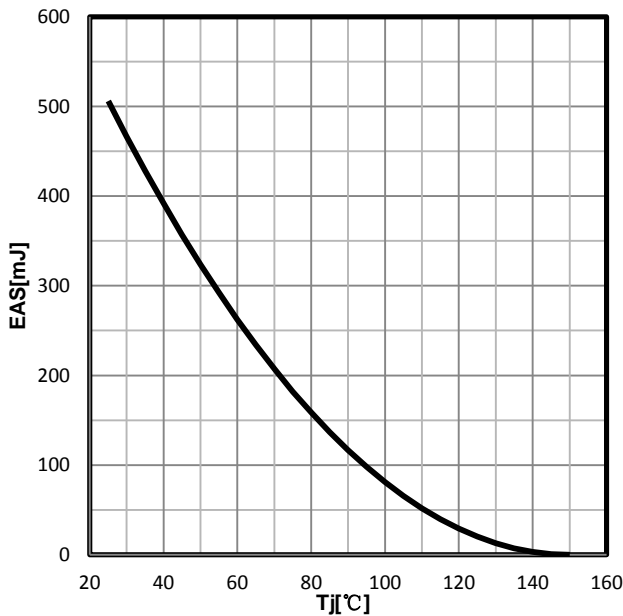
Max. transient thermal impedance parameter:  $D=tp/T$ ; TO-220, TO-247



Max. transient thermal impedance parameter:  $D=tp/T$ ; TO-220FullPAK

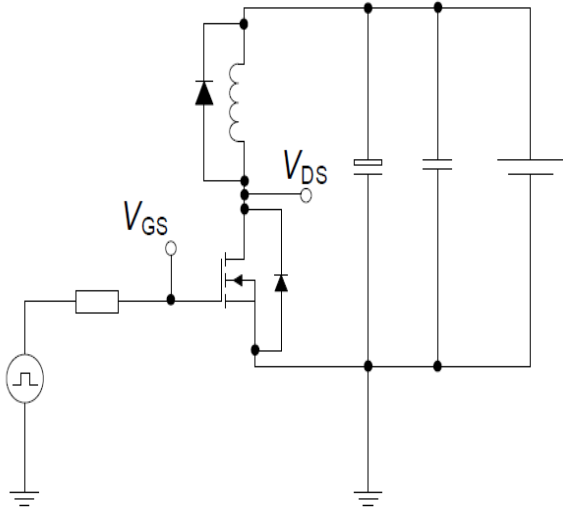


## Avalanche energy

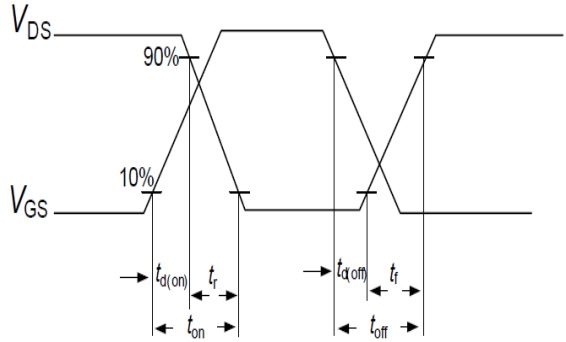


## Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load

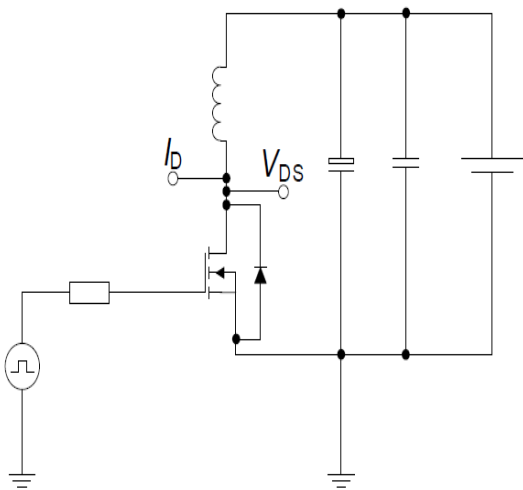


Switching time waveform

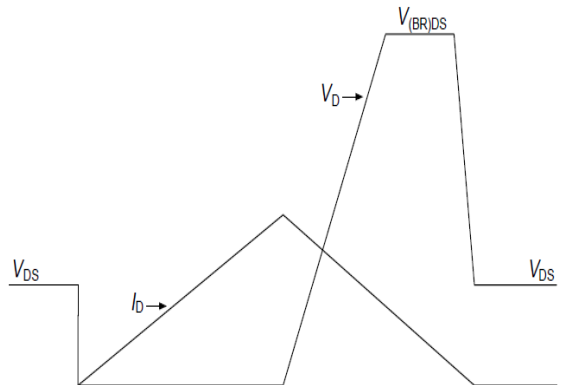


## Unclamped inductive load test circuit and waveform

Unclamped inductive load test circuit



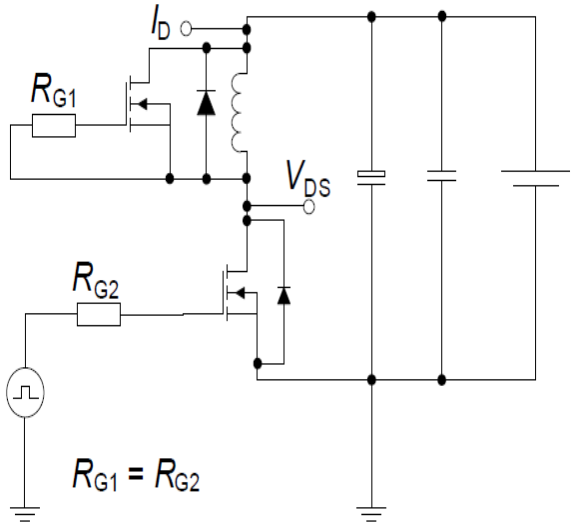
Unclamped inductive waveform



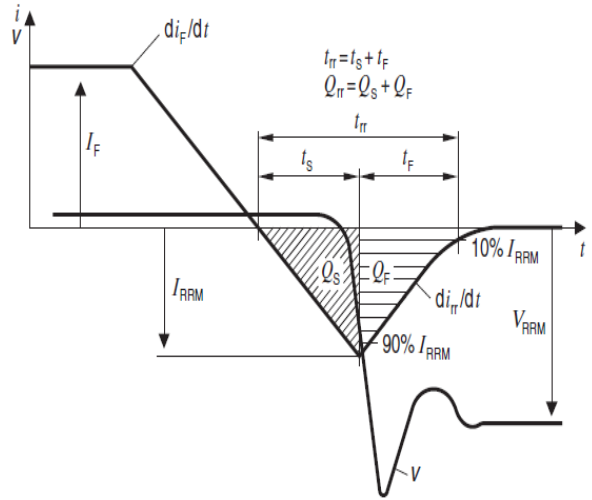


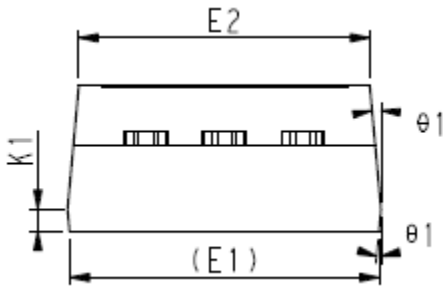
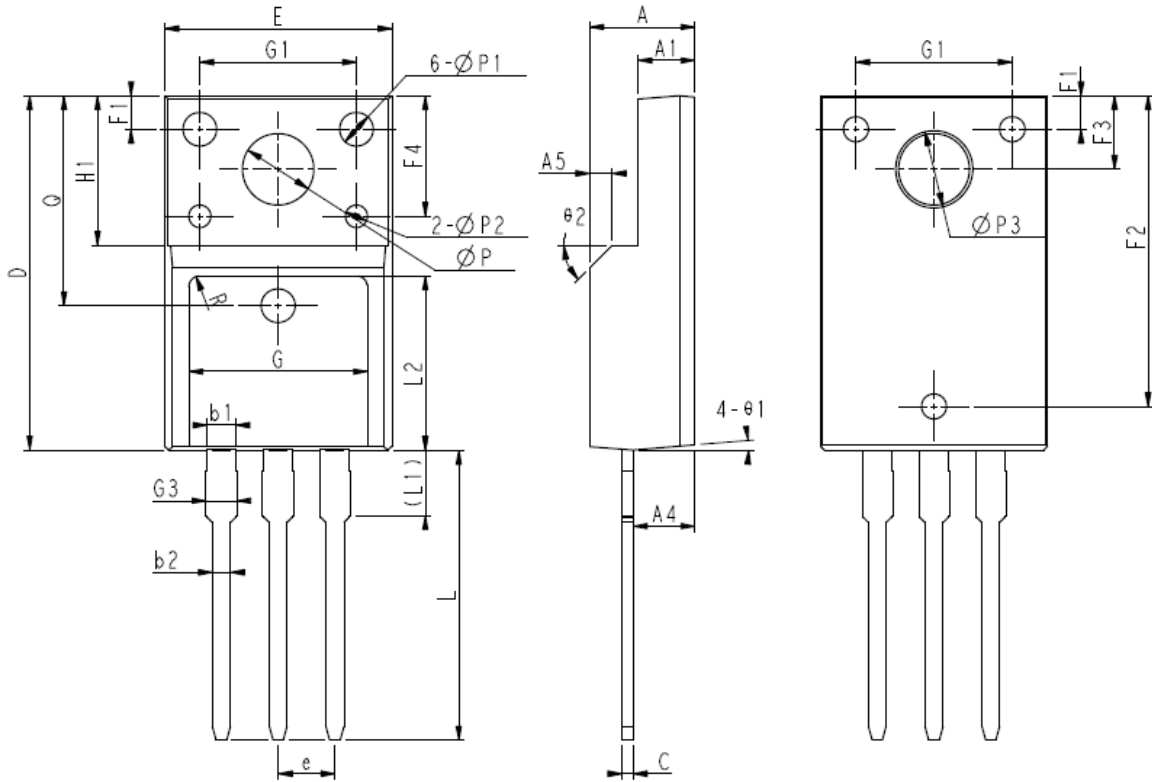
## Test circuit and waveform for diode characteristics

Test circuit for diode characteristics



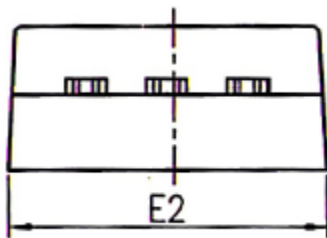
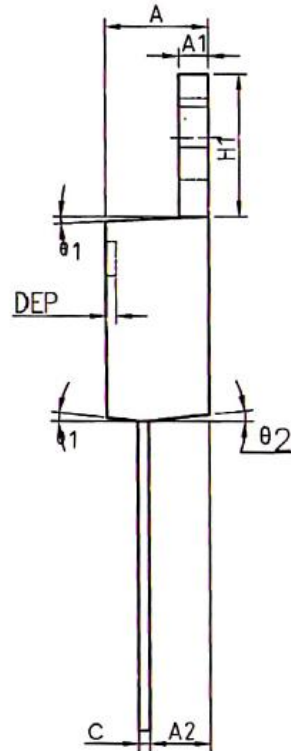
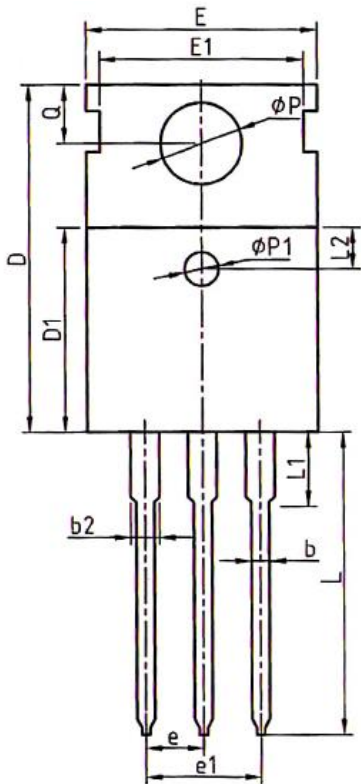
Diode recovery waveform





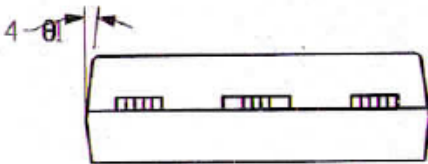
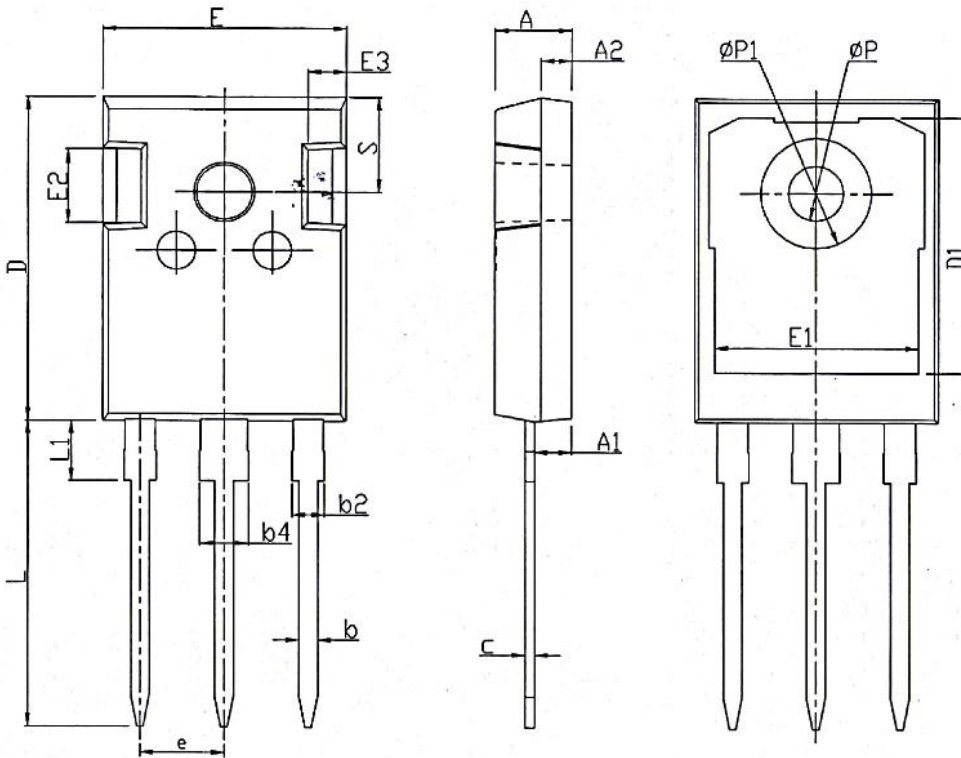
COMMON DIMENSIONS

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

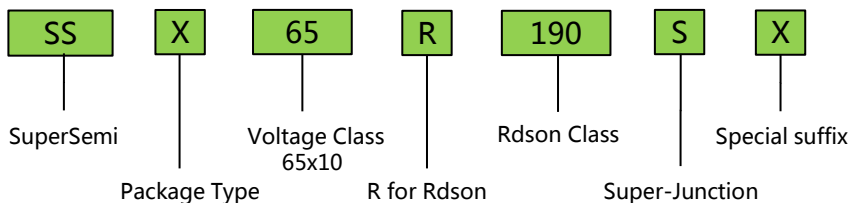
SYMBOL	MM		
	MIN	NDM	MAX
A	4.40	4.57	4.70
A1	1.27	1.30	1.37
A2	2.35	2.40	2.50
b	0.77	0.80	0.90
b2	1.17	1.27	1.36
c	0.48	0.50	0.56
D	15.40	15.60	15.80
D1	9.00	9.10	9.20
DEP	0.05	0.10	0.20
E	9.80	10.00	10.20
E1	-	8.70	-
E2	9.80	10.00	10.20
$\phi P1$	1.40	1.50	1.60
e	2.54BSC		
e1	5.08BSC		
H1	6.40	6.50	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	4.80	5.00	5.20
A1	2.21	2.41	2.61
A2	1.85	2.00	2.15
b	1.11	1.21	1.36
b2	1.91	2.01	2.21
b4	2.91	3.01	3.21
c	0.51	0.61	0.75
D	20.70	21.00	21.30
D1	16.25	16.55	16.85
E	15.50	15.80	16.10
E1	13.00	13.30	13.60
E2	4.80	5.00	5.20
E3	2.30	2.50	2.70
e	5.44BSC		
L	19.62	19.92	20.22
L1	-	-	4.30
ΦP	3.40	3.60	3.80
ΦP1	-	-	7.30
S	6.15BSC		

## Device Name



## Marking Sample (TO-220F)



WW : Working Week code ( 2digits )  
 YY : Year code ( 2digits )  
 X: Assembly code



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