

# TSF65R190S2/TSP65R190S2

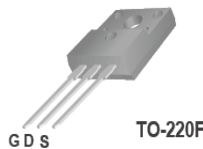
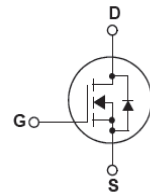
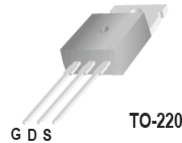
## 650V N-Channel Super-Junction MOSFET Gen-II

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

**TSF65R190S2**

**TSP65R190S2**


### Absolute Maximum Ratings

Symbol	Parameter	TSP65R190S2	TSF65R190S2	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)	485		mJ
I <sub>AS</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> max)	3.5		A
dv/dt	Peak Diode Recovery dv/dt (Note 3)	15		V/ns
dV <sub>ds</sub> /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

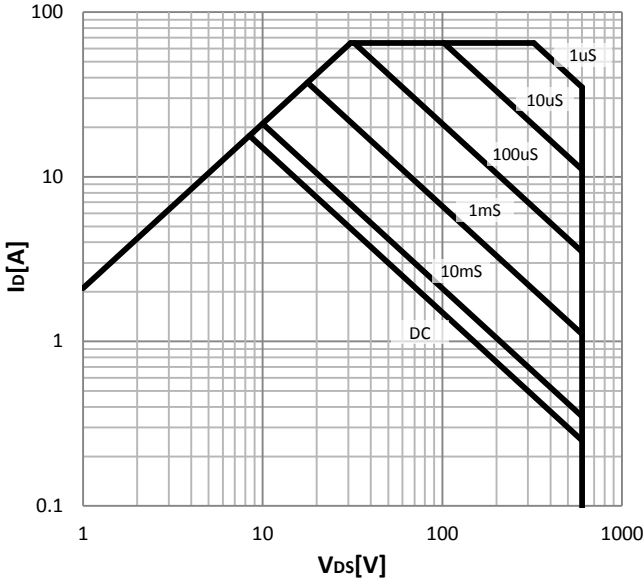
Symbol	Parameter	TSP65R190S2	TSF65R190S2	Unit
R <sub>θJC</sub>	Thermal Resistance, Junction-to-Case	0.83	3.7	°C/W
R <sub>θCS</sub>	Thermal Resistance, Case-to-Sink Typ.	0.5	-	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction-to-Ambient	62	80	°C/W

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> = 600V, 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	-	1805	-	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> = 3.3Ω, V <sub>GS</sub> = 10V (Note 4)	-	38	-	ns
t <sub>r</sub>	Turn-On Rise Time		-	39	-	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		-	170	-	ns
t <sub>f</sub>	Turn-Off Fall Time		-	47	-	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

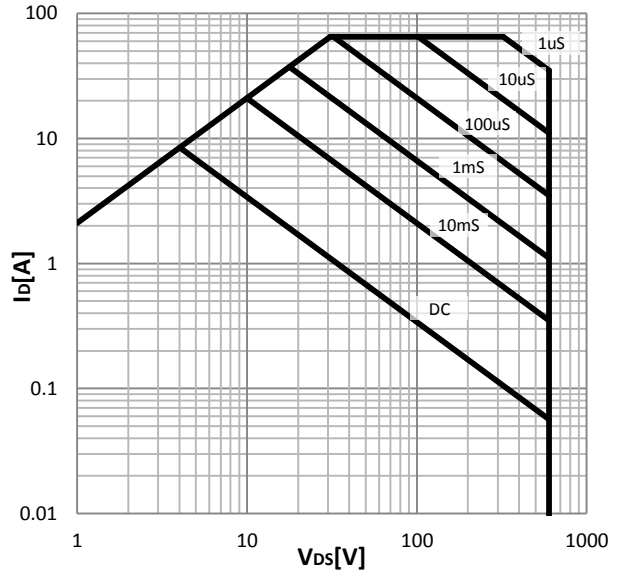
**NOTES:**

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

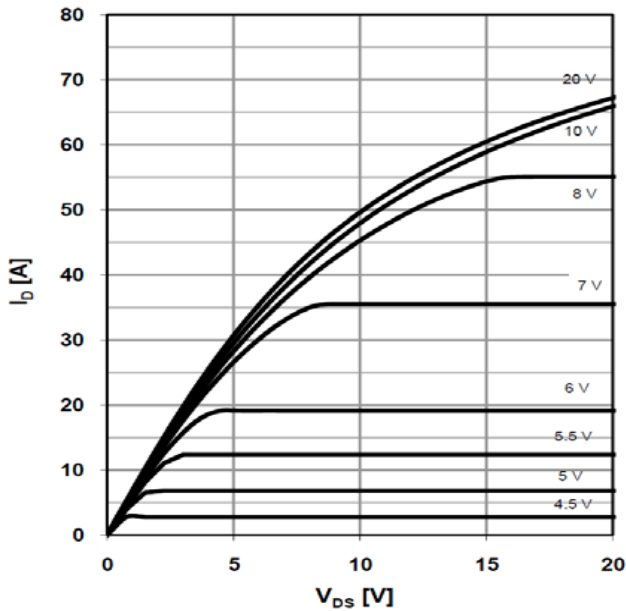
Safe operating area  $T_C=25\text{ }^\circ\text{C}$   
parameter: tp; TO-220



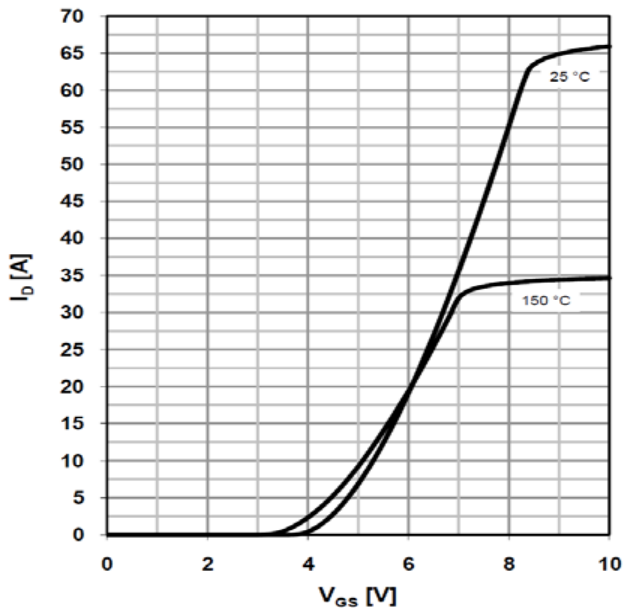
Safe operating area  $T_C=25\text{ }^\circ\text{C}$   
parameter: tp; TO-220FullPAK



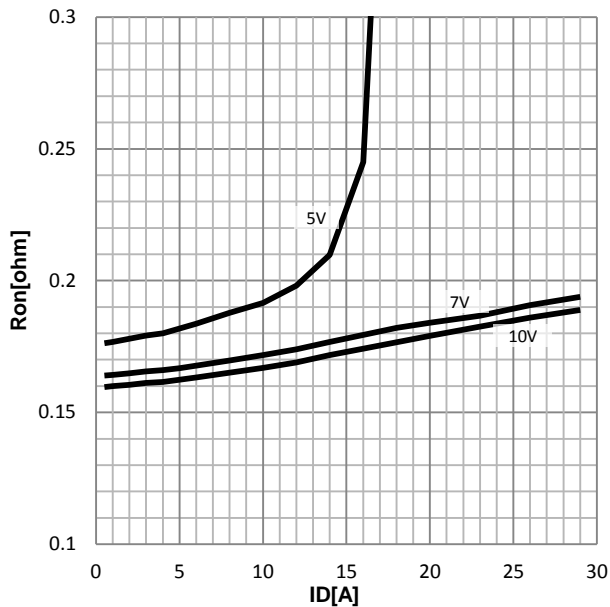
Typ. output characteristics  $T_J=25\text{ }^\circ\text{C}$   
parameter:  $V_{GS}$



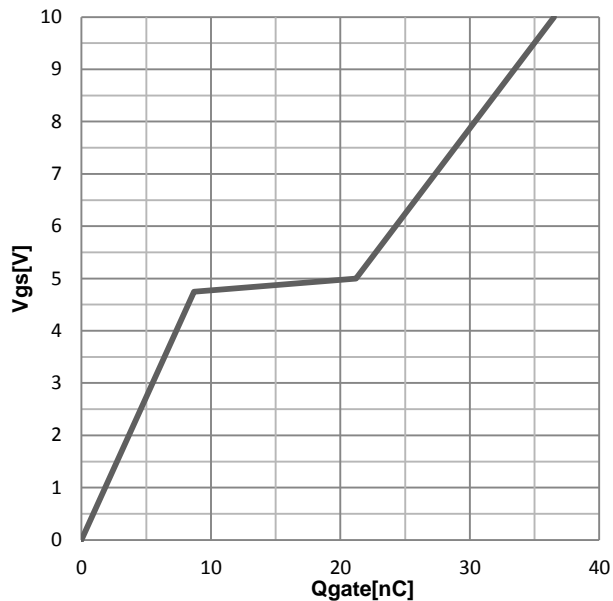
Typ. transfer characteristics



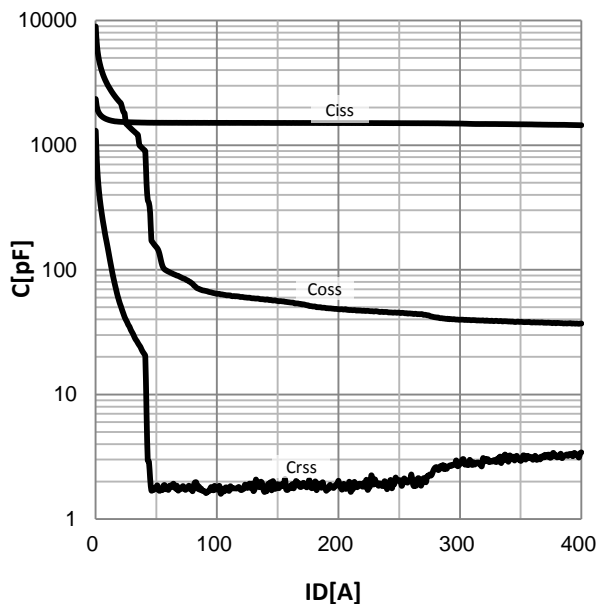
Typ. drain-source on-state resistance parameter :  $V_{GS}$



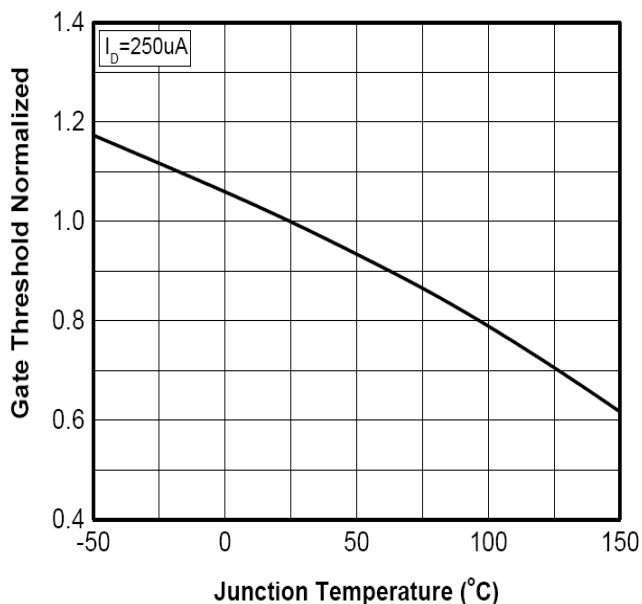
Typ. gate charge characteristics



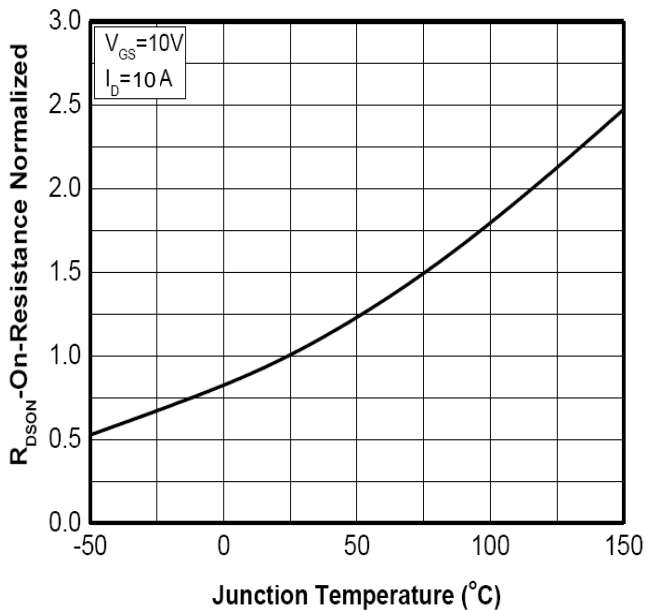
Typ. capacitances



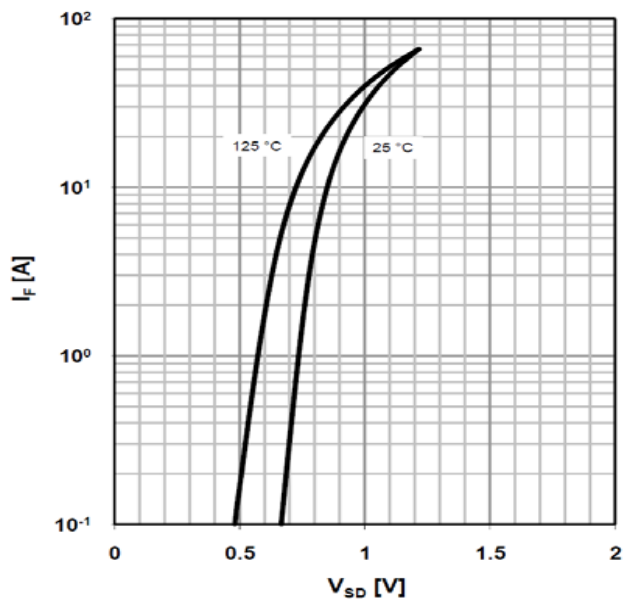
Normalized  $V_{GS(th)}$  characteristics



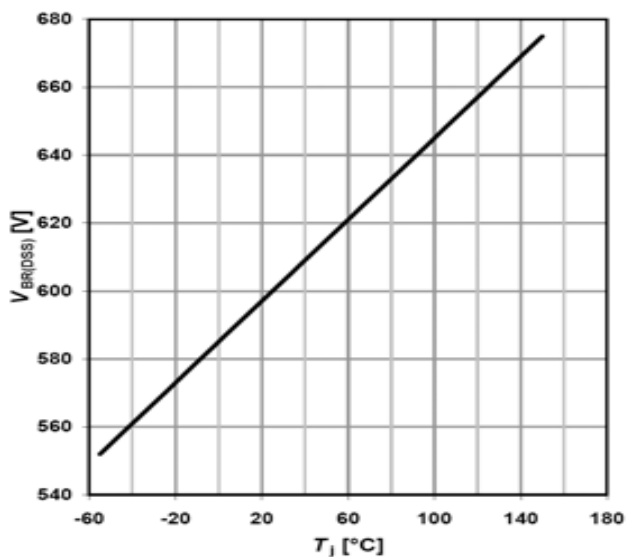
Normalized on-resistance vs temperature



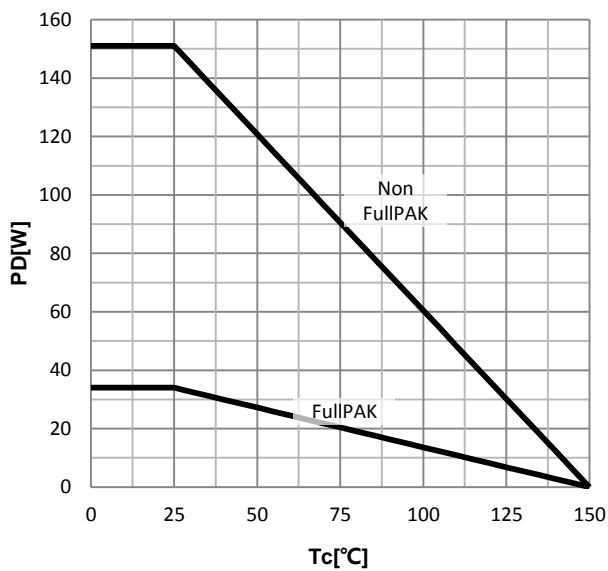
Forward characteristics of reverse diode



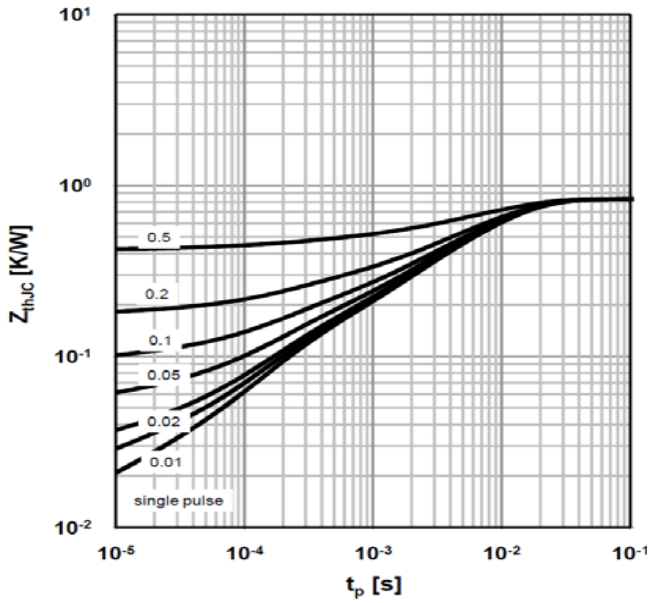
Drain-source breakdown voltage



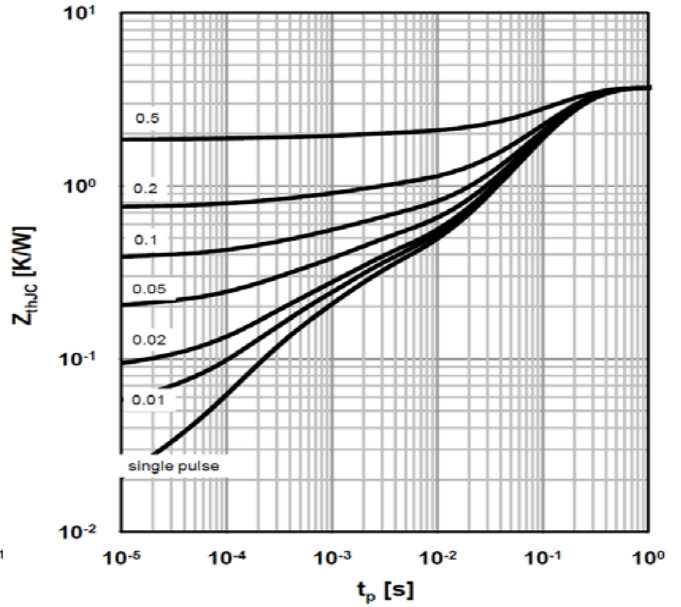
Power dissipation



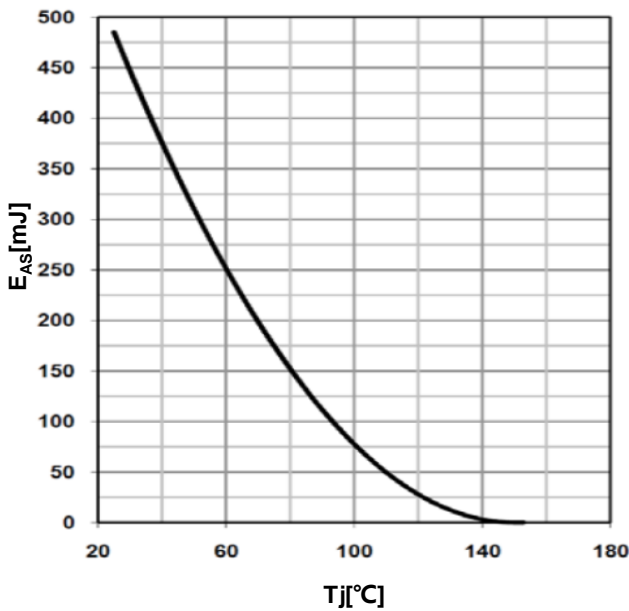
Max. transient thermal impedance  
parameter:  $D=t_p/T$ ; TO-220

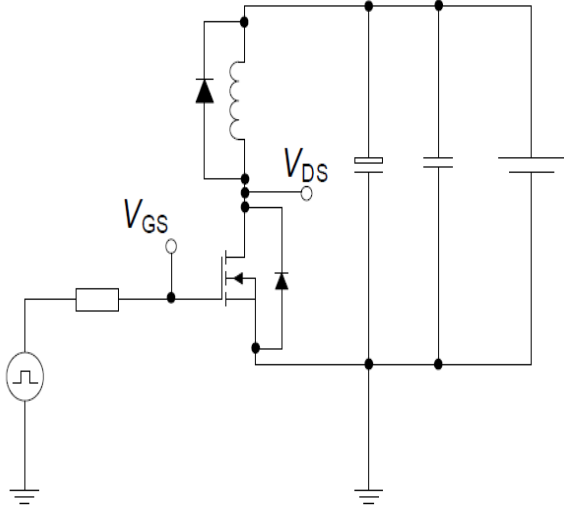
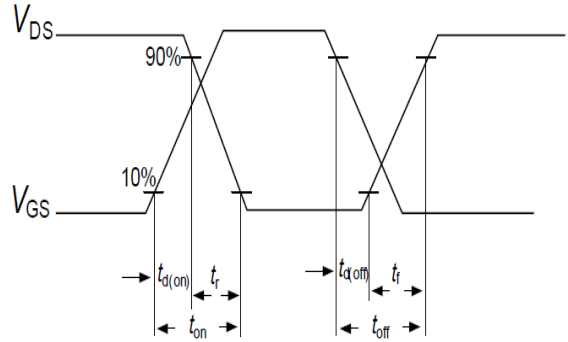
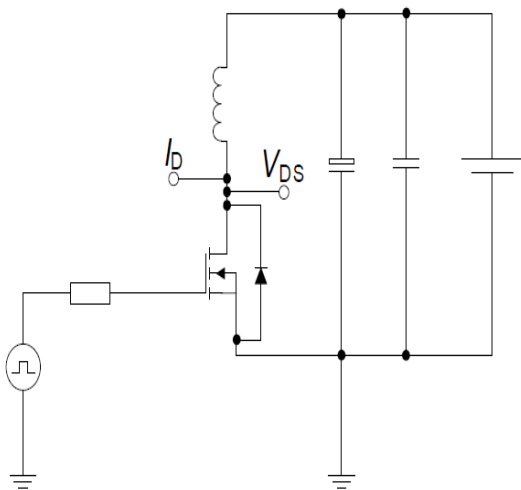
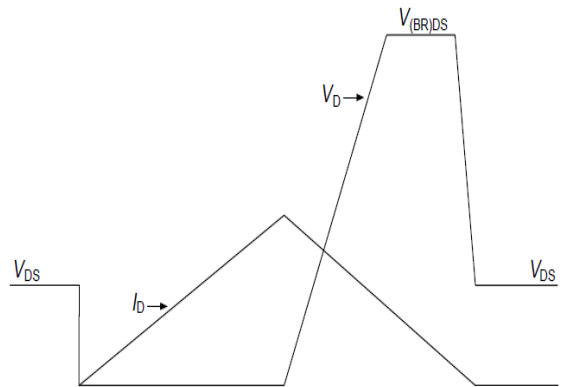


Max. transient thermal impedance  
parameter:  $D=t_p/T$ ; TO-220FullPAK



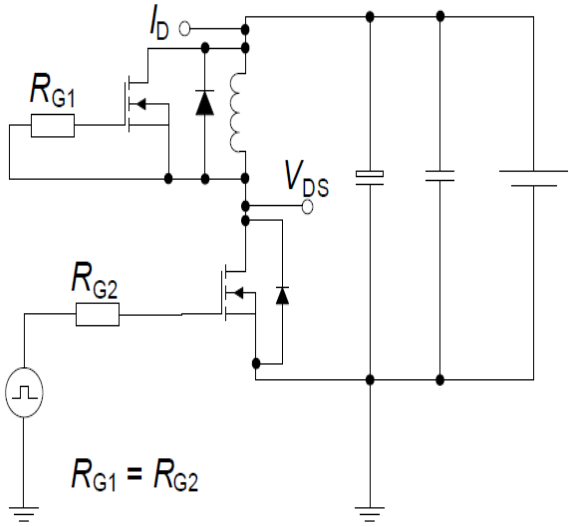
Avalanche energy



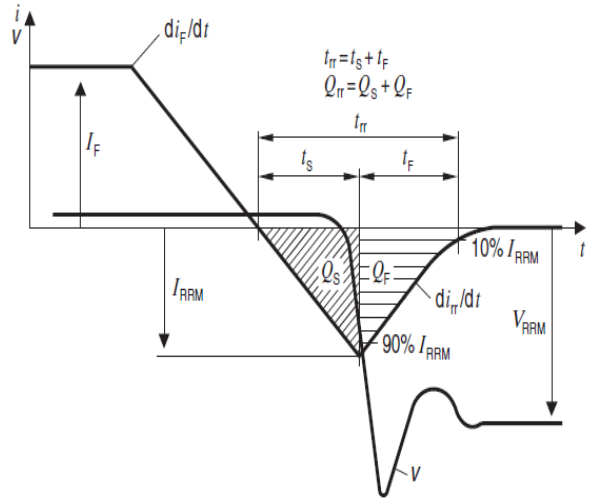
**Switching times test circuit and waveform for inductive load**
**Switching times test circuit for inductive load**

**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







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