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May, 2019

SJ-FET

TSF65R190S3/TSP65R190S3
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 @TJ = 150 ℃
- Typ. RDS(on) = 0.16Ω
- Ultra Low Gate Charge (typ. Qg = 36.5nC)
- 100% avalanche tested

TSF65R190S3
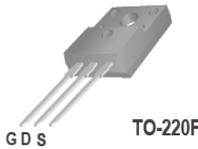
TSP65R190S3
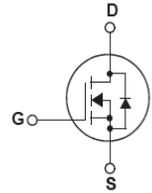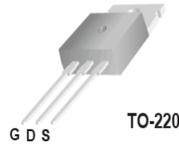
Absolute Maximum Ratings

Symbol	Parameter	TSP65R190S3	TSF65R190S3	Unit
V_{DSS}	Drain-Source Voltage	650		V
I_D	Drain Current -Continuous (TC = 25℃) -Continuous (TC = 100℃)	20* 14*		A
I_{DM}	Drain Current - Pulsed (Note 1)	60		A
V_{GSS}	Gate-Source voltage	±30		V
E_{AS}	Single Pulsed Avalanche Energy (Note 2)	62.5		mJ
I_{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by Tj max)	4.5		A
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℃)	250	35	W
T_J, T_{STG}	Operating and Storage Temperature Range	-55 to +150		℃
T_L	Maximum Lead Temperature for Soldering Purpose, 1/16" from Case for 10 Seconds	260		℃

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

Thermal Characteristics

Symbol	Parameter	TSP65R190S3	TSF65R190S3	Unit
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	0.47	3.7	℃/W
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink Typ.	0.5	-	℃/W
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	65	62.5	℃/W

Electrical Characteristics TC = 25℃ unless otherwise noted

| Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Off Characteristics						
BVDSS	Drain-Source Breakdown Voltage	VGS = 0V, ID = 250μA, TJ = 25℃	650	-	-	V
		VGS = 0V, ID = 250μA, TJ = 150℃	-	700	-	V
ΔBVDSS/ΔTJ	Breakdown Voltage Temperature Coefficient	ID = 250μA, Referenced to 25℃	-	0.6	-	V/℃
IDSS	Zero Gate Voltage Drain Current	VDS = 650V, VGS = 0V	-	-	1	μA
		-TC = 125℃	-	-	100	μA
IGSSF	Gate-Body Leakage Current, Forward	VGS = 30V, VDS = 0V	-	-	100	nA
IGSSR	Gate-Body Leakage Current, Reverse	VGS = -30V, VDS = 0V	-	-	-100	nA
On Characteristics						
VGS(th)	Gate Threshold Voltage	VDS = VGS, ID = 250μA	2.0	3.0	4.0	V
RDS(on)	Static Drain-Source On-Resistance	VGS = 10V, ID = 10A	-	0.16	0.19	Ω
Dynamic Characteristics						
Ciss	Input Capacitance	VDS = 100V, VGS = 0V, f = 1.0MHz	-	1805	-	pF
Coss	Output Capacitance		-	68	-	pF
Crss	Reverse Transfer Capacitance		-	2.1	-	pF
Qg	Total Gate Charge	VDS = 480V, ID = 10A, VGS = 10V (Note 4)	-	36.5	-	nC
Qgs	Gate-Source Charge		-	8.7	-	nC
Qgd	Gate-Drain Charge		-	12.5	-	nC
Rg	Gate resistance	f=1 MHz, open drain	-	9.8	-	Ω
Switching Characteristics						
td(on)	Turn-On Delay Time	VDS = 400V, ID = 10A RG = 3.3Ω, VGS = 10V (Note 4)	-	38	-	ns
tr	Turn-On Rise Time		-	39	-	ns
td(off)	Turn-Off Delay Time		-	170	-	ns
tf	Turn-Off Fall Time		-	47	-	ns
Drain-Source Diode Characteristics and Maximum Ratings						
Is	Maximum Continuous Drain-Source Diode Forward Current		-	-	20	A
ISM	Maximum Pulsed Drain-Source Diode Forward Current		-	-	65	A
VSD	Drain-Source Diode Forward Voltage	VGS = 0V, Is = 20A	-	0.9	1.4	V
trr	Reverse Recovery Time	VGS = 0V, VDS = 400V, Is = 10A, dIF/dt =100A/μs	-	318	-	ns
Qrr	Reverse Recovery Charge		-	5.5	-	μC
Irrm	Peak Reverse Recovery Current		-	24.9	-	A

NOTES:

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. ID=I_{AS}, VDD=100V, Starting TJ=25 ℃
3. I_{SD}≤ID, di/dt ≤ 200A/us, V_{DD} ≤ BV_{DSS}, Starting TJ = 25 ℃
4. Essentially Independent of Operating Temperature Typical Characteristics

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## Safe operating area TC=25 ℃ parameter: tp; TO-220
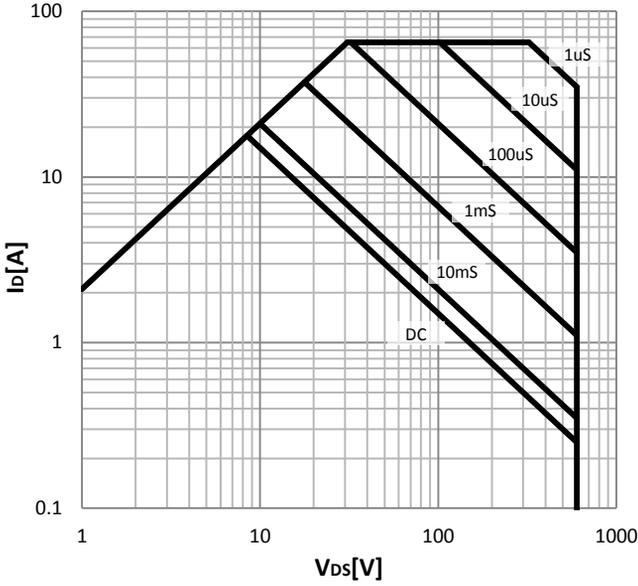
## Safe operating area TC=25 ℃ parameter: tp; TO-220FullPAK
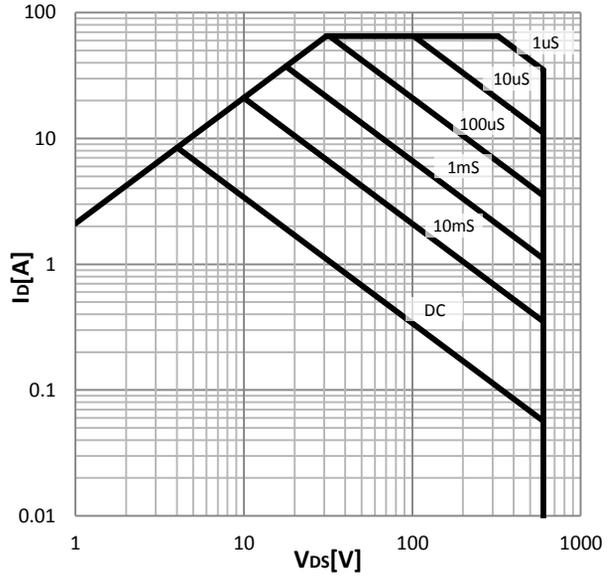
Typ. output characteristics T_j=25 ℃ parameter: V_{GS}
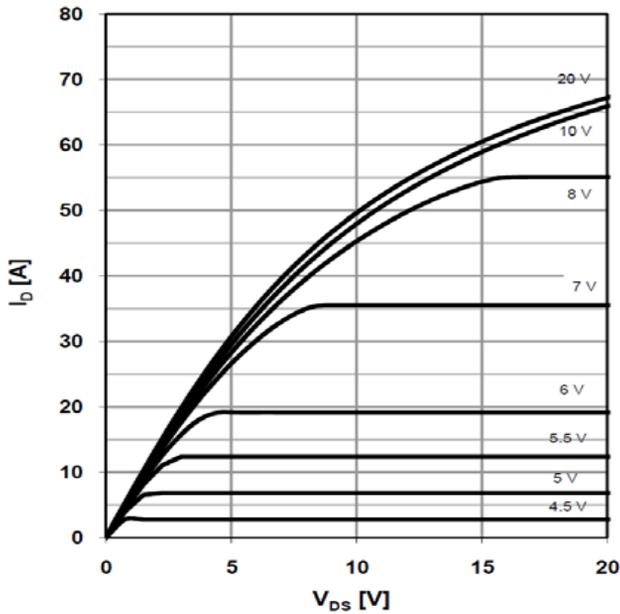

Typ. transfer characteristics

Typical Performance Characteristics
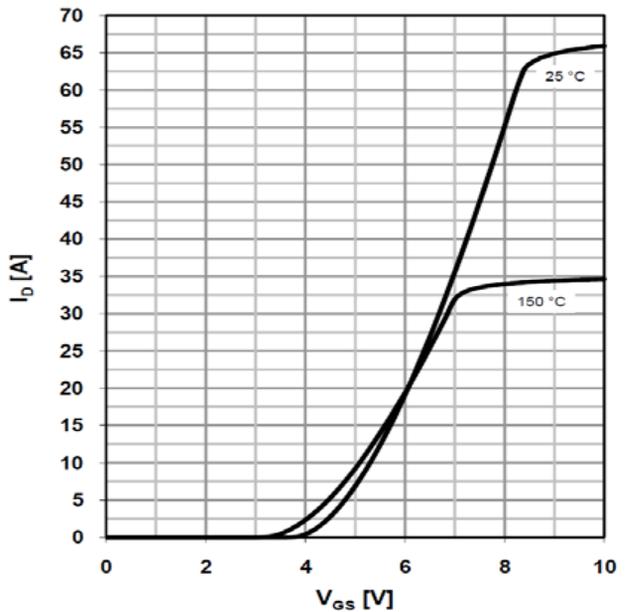
### Typ. drain-source on-state resistance parameter : VGS
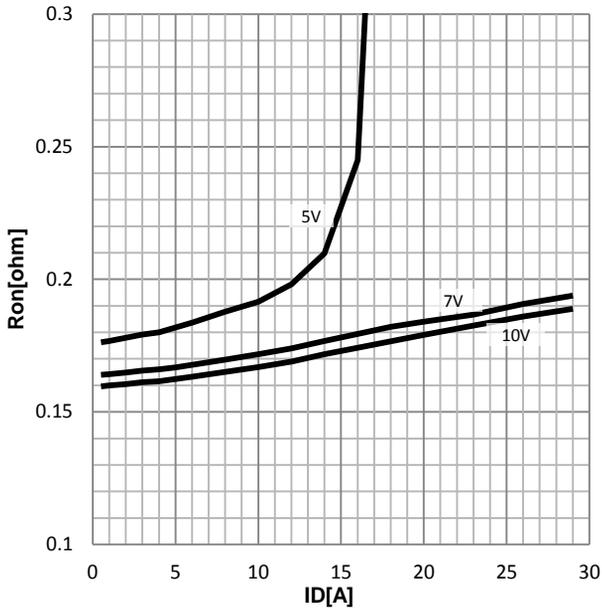
Typ. gate charge characteristics
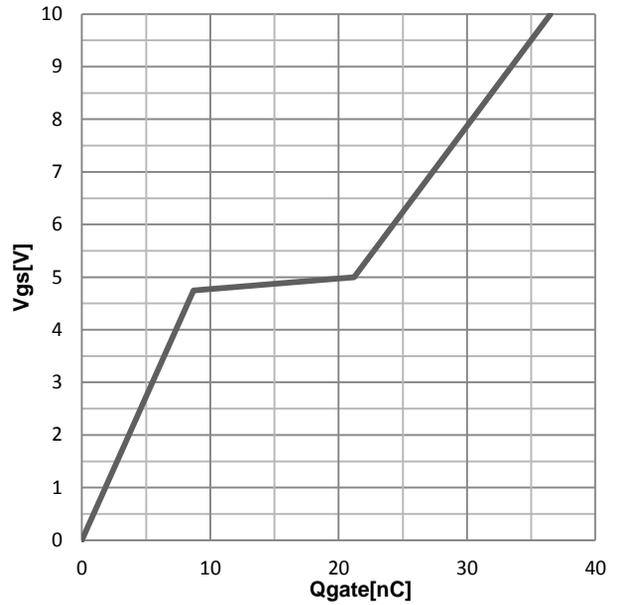
Typ. capacitances
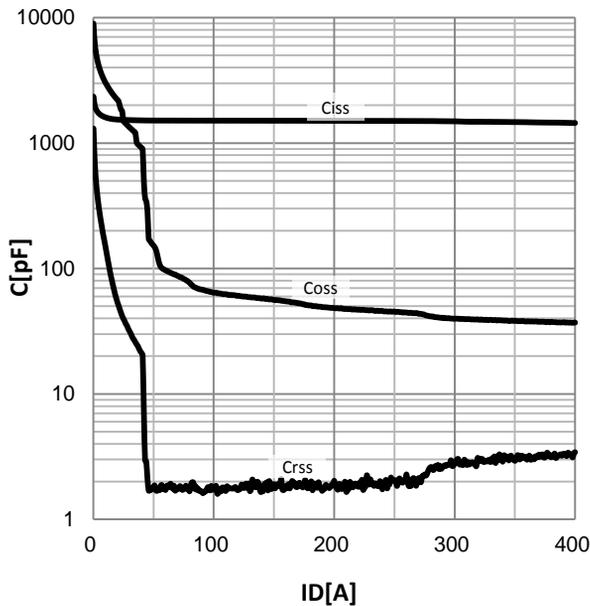
Normalized VGS(th) characteristics

Typical Performance Characteristics
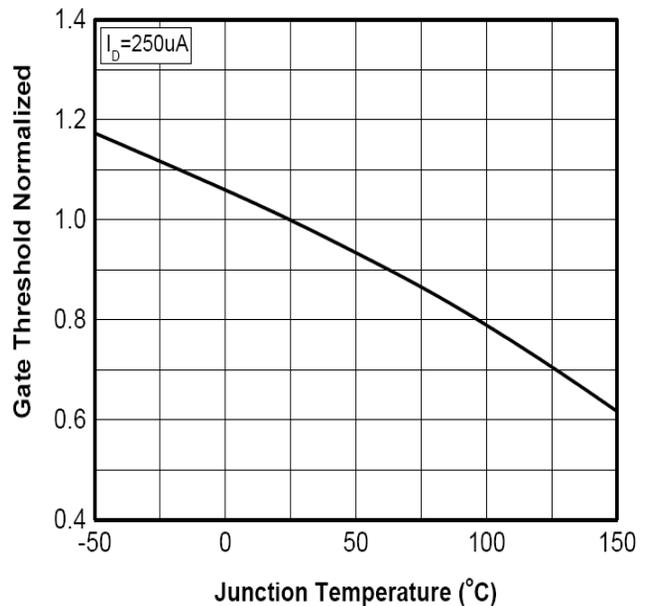
### Normalized on resistance vs temperature

V_{GS}=10V
I_D=10A
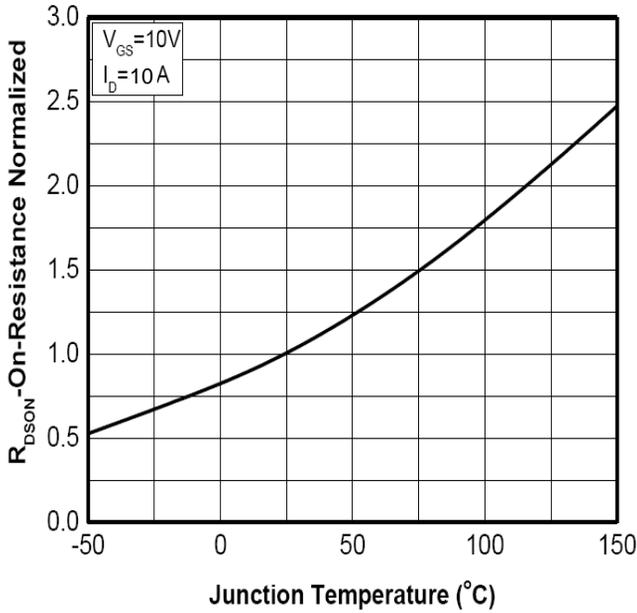
Forward characteristics of reverse diode
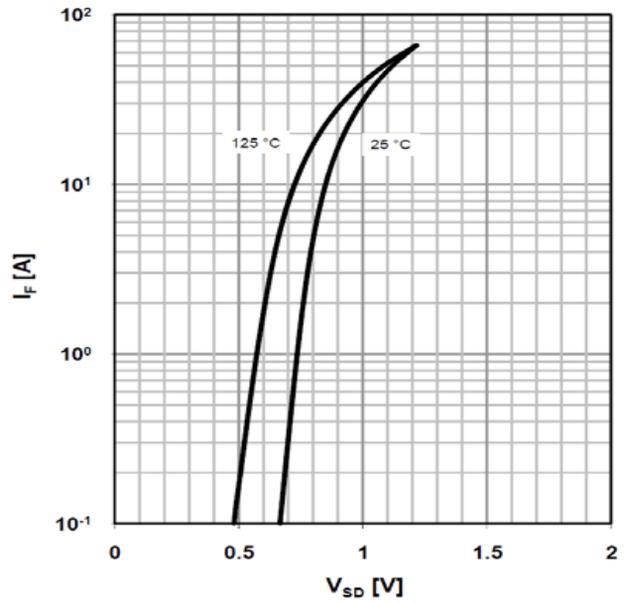
Drain-source breakdown voltage

Power dissipation

Non FullPAK

FullPAK

Typical Performance Characteristics
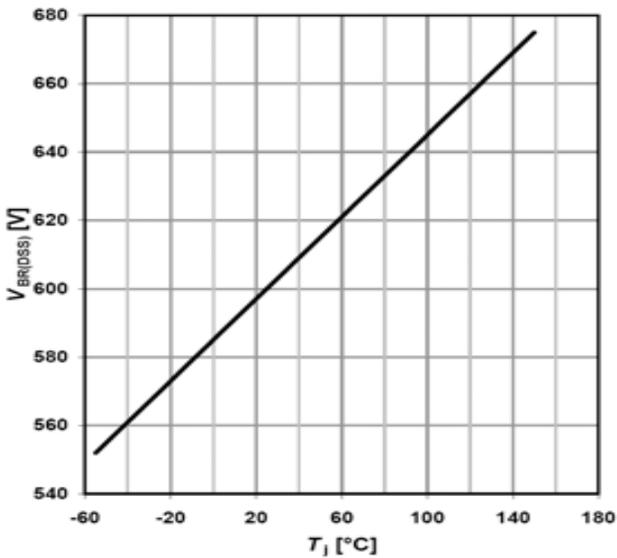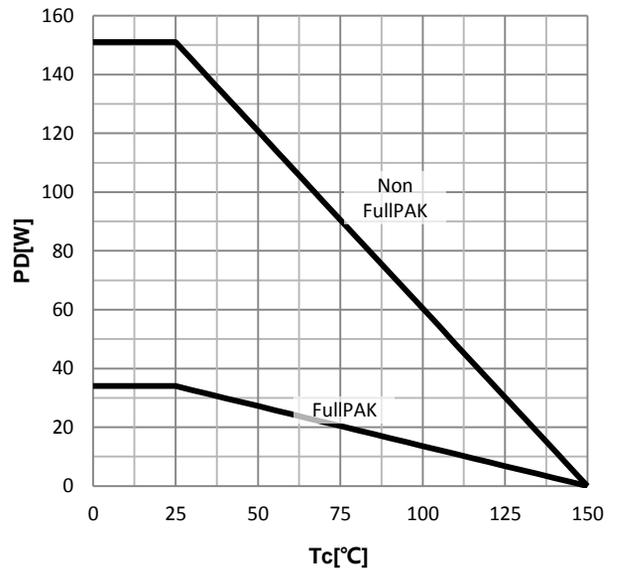
Max. transient thermal impedance
parameter: D=tp/T; TO-220
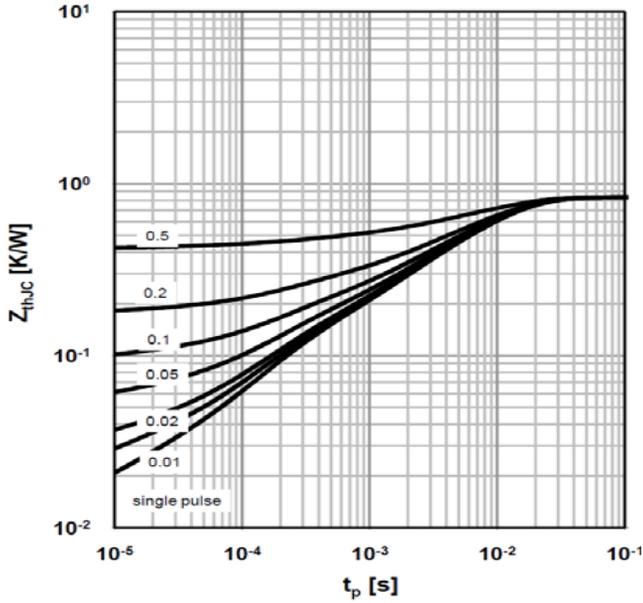
Max. transient thermal impedance
parameter: D=tp/T; TO-220FullPAK
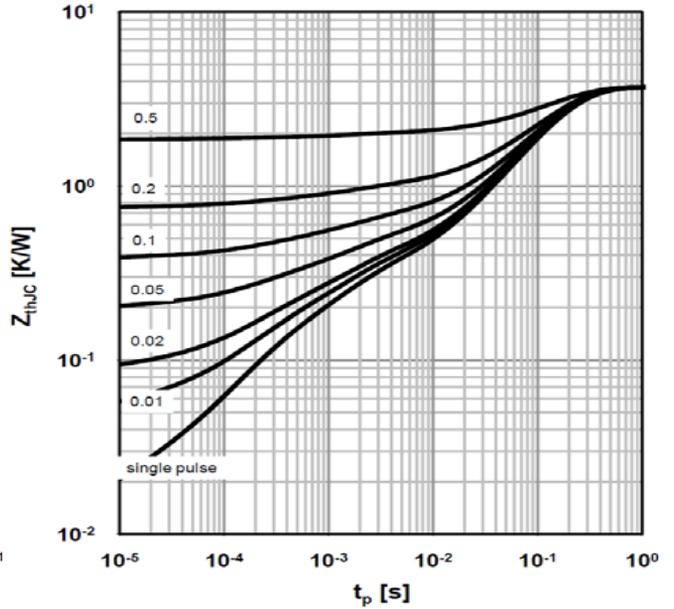
Avalanche energy
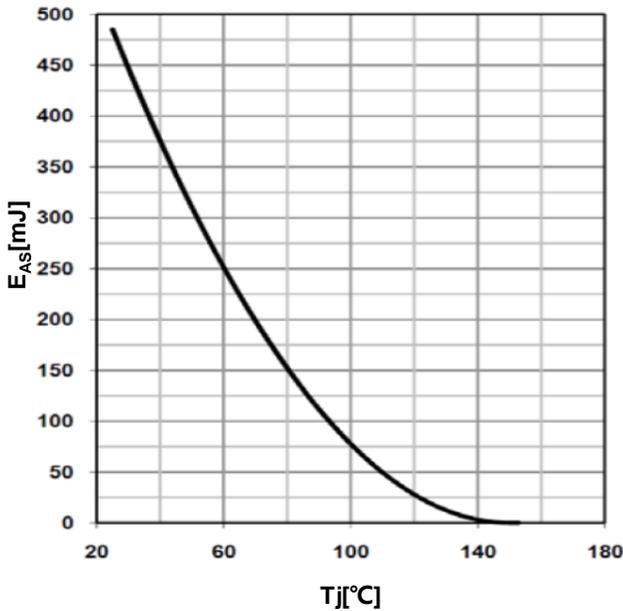
Test circuits

Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load

V_{DS}

V_{GS}
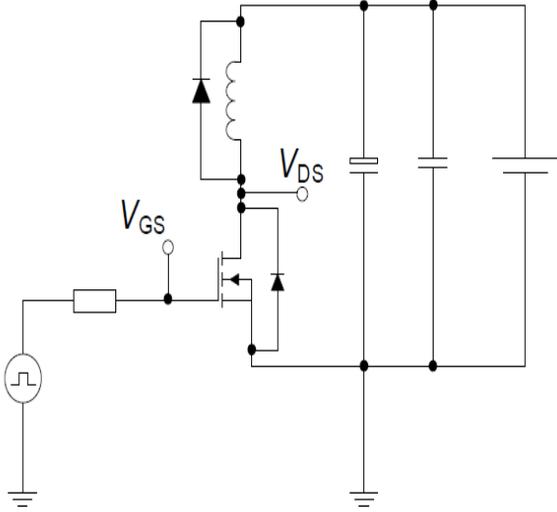
Switching time waveform

V_{DS}

90%

V_{GS}

10%

$t_{d(on)}$ t_r $t_{d(off)}$ t_f

t_{on} t_{off}
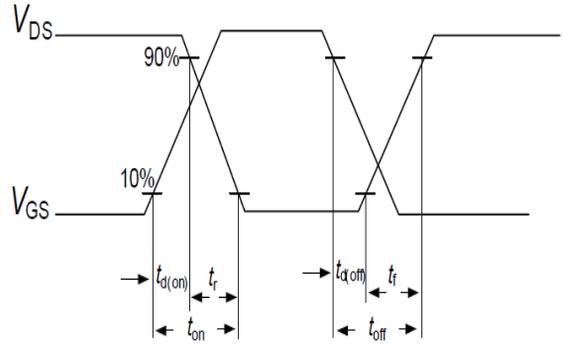
Unclamped inductive load test circuit and waveform

Unclamped inductive load test circuit

I_D V_{DS}
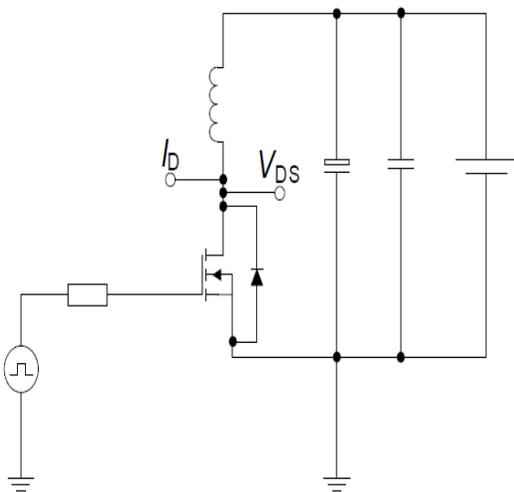
Unclamped inductive waveform

$V_{(BR)DS}$

V_D

V_{DS}

I_D

V_{DS}
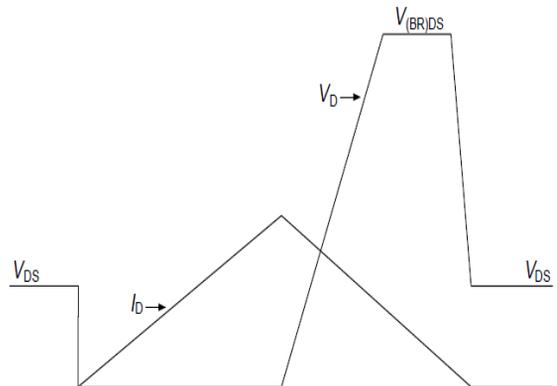
Test circuits

Test circuit and waveform for diode characteristics

Test circuit for diode characteristics

$R_{G1} = R_{G2}$
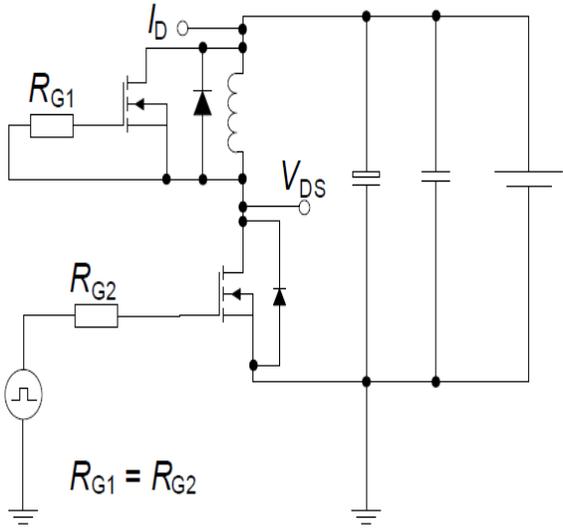
Diode recovery waveform

$t_{rr} = t_S + t_F$
$Q_{rr} = Q_S + Q_F$
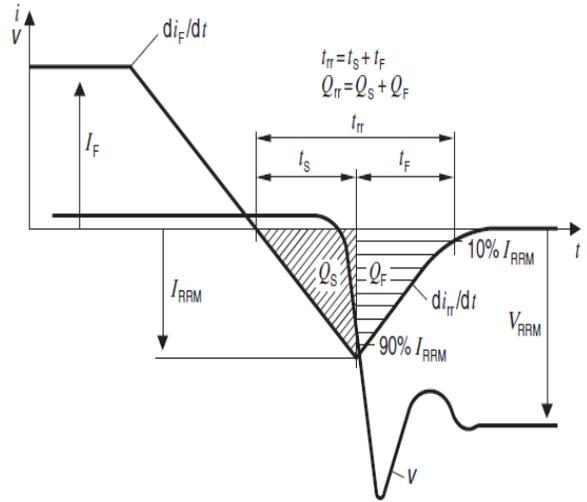
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