



GSX13N65E

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

Super Junction MOSFET

650V Super Junction Power Transistor

GSX13N65E

Data Sheet

Ver 1.1

2019-3-20

650V 13A Power MOSFET

Description

GroupSemiconductor(GS) has series Multi-EPI Super-Junction power MOSFET platforms for voltage up 500V to 1000 volts, both with design service and manufacturing capability, including cell, termination design and simulation.

The GS 650V 13A Power MOSFET is a Low voltage N channel Multi-EPI Super-Junction power MOSFET sample with advanced technology to have better characteristics, such as fast switching time, low Ciss and Crss, low on resistance and excellent avalanche characteristics, making it especially suitable for applications which require superior power density and outstanding efficiency.

Features

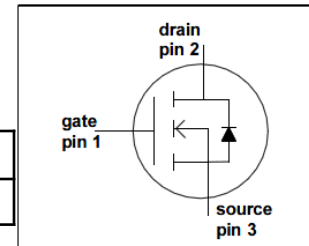
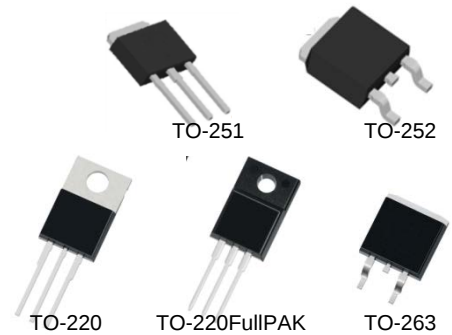
$R_{DS(ON)} = 0.38\Omega$ @ $V_{GS} = 10V$

$V_{DS} = 650V$

I_D (@ $V_{GS} = 10V$) = 6.5A

PKG

GSA13N65E	GSP13N65E	GSB13N65E	GSD13N65E	GSS13N65E
TO-220Fullpak	TO-220	TO-263	TO-252	TO-251



Absolute Maximum Ratings (TC = 25° C, unless otherwise specified)

Symbol	Parameter	GSP13N65E	GSA13N65E	Unit
V_{DS}	Drain-Source Voltage	650		V
I_D	Drain Current -Continuous (TC = 25°C) -Continuous (TC = 100°C)	13* 9*		A
I_{DM}	Drain Current - Pulsed (Note 1)	46		A
V_{GS}	Gate-Source voltage	±30		V
E_{AS}	Single Pulsed Avalanche Energy (Note 2)	280		mJ
I_{AR}	Avalanche Current (Note 1)	2.3		A
E_{AR}	Repetitive Avalanche Energy (Note 1)	1.2		mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	15		V/ns
dV_{ds}/dt	Drain Source voltage slope (Vds=480V)	50		V/ns
P_D	Power Dissipation (TC = 25°C)	151	35	W
T_J, T_{STG}	Operating and Storage Temperature Range	-55 to +150		°C
T_L	Max. Lead Temperature for Soldering Purpose, 1/8" from Case for 5 Seconds	300		°C

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■ Thermal Characteristics

Symbol	Parameter	GSA13N65E	GSP13N65E	Unit
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	1.2	1.2	$^{\circ}\text{C}/\text{W}$
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink Typ.	0.5	0.5	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	62	62	$^{\circ}\text{C}/\text{W}$

Symbol	Parameter	Value (TO220)	Unit
$R_{\theta JA}^{(6)}$	Maximum Junction-to-Ambient	82	$^{\circ}\text{C}/\text{W}$
$R_{\theta CS}^{(6)}$	Maximum Case-to-sink	0.6	$^{\circ}\text{C}/\text{W}$
$R_{\theta JC}^{(7),(8)}$	Maximum Junction-to-Case θ	4.1	$^{\circ}\text{C}/\text{W}$

1. The power dissipation PD is based on $T_J(\text{MAX})=150^{\circ}\text{C}$ in a TO251 package, using junction-to-case thermal resistance.
2. Repetitive rating, pulse width limited by junction temperature $T_J(\text{MAX})=150^{\circ}\text{C}$.
3. $L=1\text{mH}$, Starting $T_J=25^{\circ}\text{C}$.
4. $L=10\text{mH}$, starting $T_J=25^{\circ}\text{C}$.
5. $L=60\text{mH}$, starting $T_J=25^{\circ}\text{C}$.
6. The tests are performed with the device with $T_A=25^{\circ}\text{C}$.
7. The $R_{\theta JA}$ is the sum of the thermal impedance from junction to case $R_{\theta JC}$ and case to ambient.
8. These curves are based on the junction-to-case thermal impedance, assuming a maximum junction temperature of $T_J(\text{MAX})=150^{\circ}\text{C}$.

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■ Electrical Characteristics (T_J=25° C unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Off Characteristics						
BV _{DSS}	Drain-Source Breakdown Voltage	V _{GS} = 0V, I _D = 250μA, T _J = 25°C	650	--	--	V
		V _{GS} = 0V, I _D = 250μA, T _J = 150°C	--	700	--	V
ΔBV _{DSS} /ΔT _J	Breakdown Voltage Temperature Coefficient	I _D = 250μA, Referenced to 25°C	--	0.6	--	V/°C
I _{DSS}	Zero Gate Voltage Drain Current	V _{DS} = 650V, V _{GS} = 0V -T _J = 150°C	--	-- 10	1 -	μA μA
I _{GSSF}	Gate-Body Leakage Current, Forward	V _{GS} = 30V, V _{DS} = 0V	--	--	100	nA
I _{GSSR}	Gate-Body Leakage Current, Reverse	V _{GS} = -30V, V _{DS} = 0V	--	--	-100	nA
On Characteristics						
V _{GS(th)}	Gate Threshold Voltage	V _{DS} = V _{GS} , I _D = 250μA	2.5	--	4.5	V
R _{DS(on)}	Static Drain-Source On-Resistance	V _{GS} = 10V, I _D = 6.5A	--	0.34	0.38	Ω
g _{FS}	Forward Transconductance	V _{DS} = 40V, I _D = 6.5A	--	16	--	S
Dynamic Characteristics						
C _{iss}	Input Capacitance	V _{DS} = 25V, V _{GS} = 0V, f = 1.0MHz	--	780	-	pF
C _{oss}	Output Capacitance		--	23	-	pF
C _{rss}	Reverse Transfer Capacitance		--	1.9	--	pF
Switching Characteristics						
t _{d(on)}	Turn-On Delay Time	V _{DD} = 400V, I _D = 6.5A R _G = 20Ω (Note 4)	--	17	--	ns
t _r	Turn-On Rise Time		--	12	--	ns
t _{d(off)}	Turn-Off Delay Time		--	130	--	ns
t _f	Turn-Off Fall Time		--	10	--	ns
Q _g	Total Gate Charge	V _{DS} = 400V, I _D = 6.5A V _{GS} = 10V (Note 4)	--	34	--	nC
Q _{gs}	Gate-Source Charge		--	4.5	--	nC
Q _{gd}	Gate-Drain Charge		--	19	--	nC
Drain-Source Diode Characteristics and Maximum Ratings						
I _S	Maximum Continuous Drain-Source Diode Forward Current		--	--	10	A
I _{SM}	Maximum Pulsed Drain-Source Diode Forward Current		--	--	35	A
V _{SD}	Drain-Source Diode Forward Voltage	V _{GS} = 0V, I _S = 6.5A	--	0.9	1.5	V
t _{rr}	Reverse Recovery Time	V _{GS} = 0V, I _S = 6.5A	--	300	--	ns
Q _{rr}	Reverse Recovery Charge	dI _F /dt =100A/μs	--	3.5	--	μC

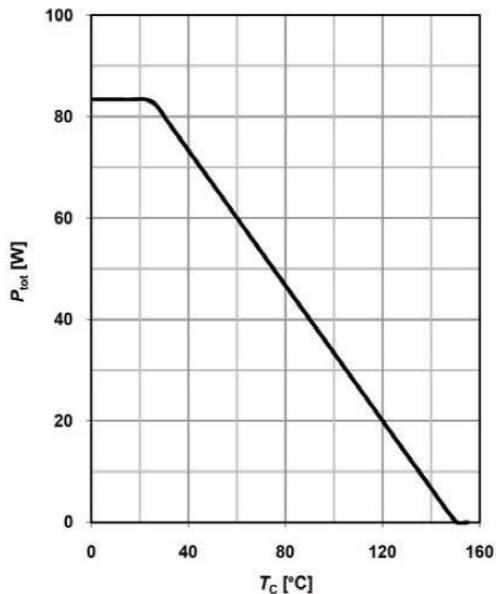
NOTES:

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. L=60mH, I_{AS}=3A, V_{DD}=150V, Starting T_J=25 °C
3. I_{SD}≤4.5A, di/dt ≤ 200A/μs, V_{DD} ≤ BV_{DSS}, Starting T_J = 25 °C
4. Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%
5. Essentially Independent of Operating Temperature Typical Characteristics

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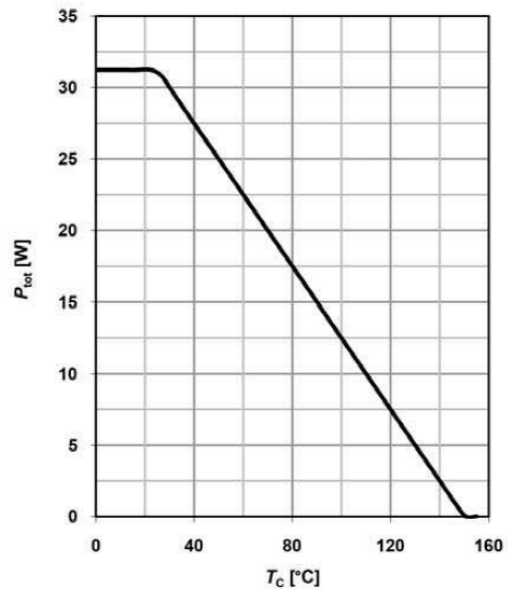
Typical Performance Characteristics

**Power dissipation
Non FullPAK**



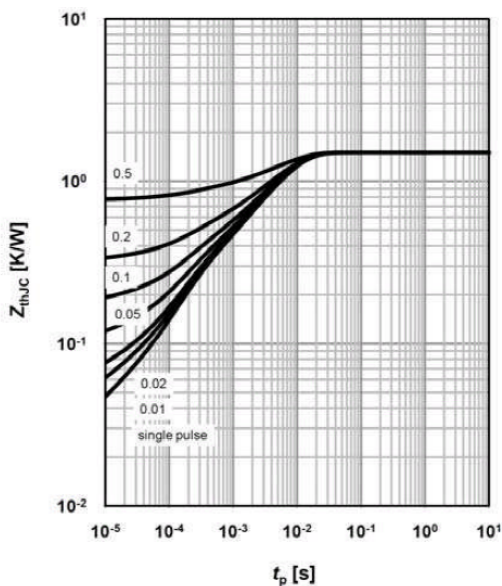
$$P_{tot} = f(T_c)$$

**Power dissipation
FullPAK**



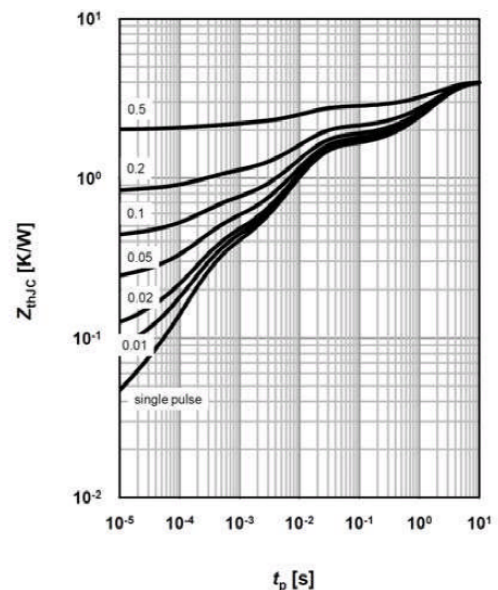
$$P_{tot} = f(T_c)$$

**Max. transient thermal impedance
Non FullPAK**



$$Z_{(thJC)} = f(t_p); \text{ parameter: } D = t_p/T$$

**Max. transient thermal impedance
FullPAK**

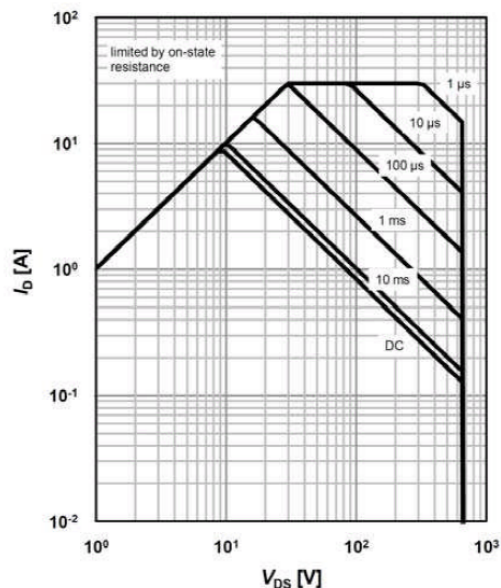


$$Z_{(thJC)} = f(t_p); \text{ parameter: } D = t_p/T$$

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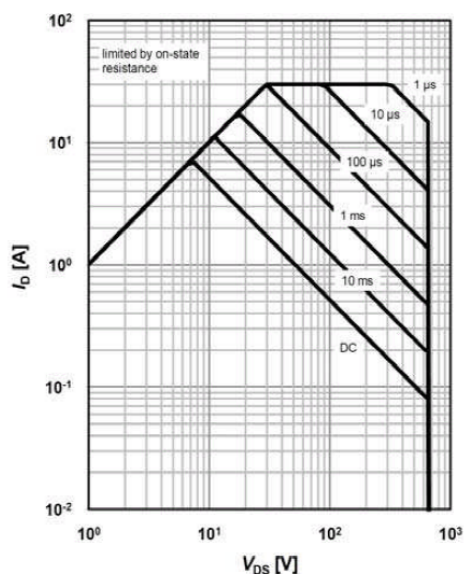
Typical Performance Characteristics

**Safe operating area $T_C=25\text{ }^{\circ}\text{C}$
Non FullPAK**



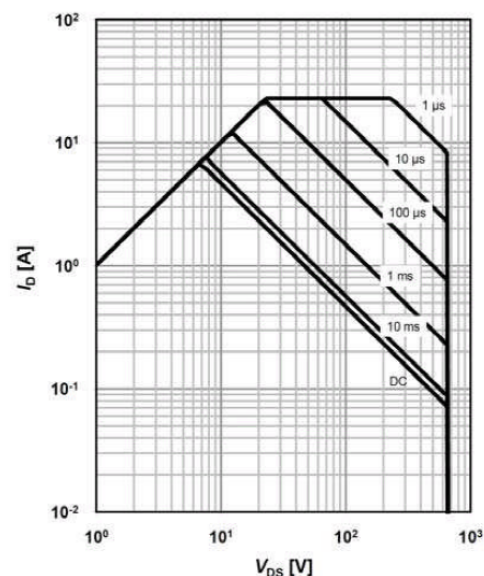
$I_D=f(V_{DS}); T_C=25\text{ }^{\circ}\text{C}; V_{GS} > 7\text{V}; D=0$; parameter t_p

**Safe operating area $T_C=25\text{ }^{\circ}\text{C}$
FullPAK**



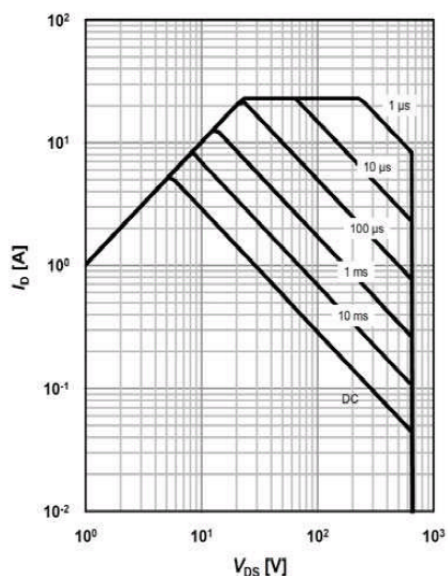
$I_D=f(V_{DS}); T_C=25\text{ }^{\circ}\text{C}; V_{GS} > 7\text{V}; D=0$; parameter t_p

**Safe operating area $T_C=80\text{ }^{\circ}\text{C}$
Non FullPAK**



$I_D=f(V_{DS}); T_C=80\text{ }^{\circ}\text{C}; V_{GS} > 7\text{V}; D=0$; parameter t_p

**Safe operating area $T_C=80\text{ }^{\circ}\text{C}$
FullPAK**

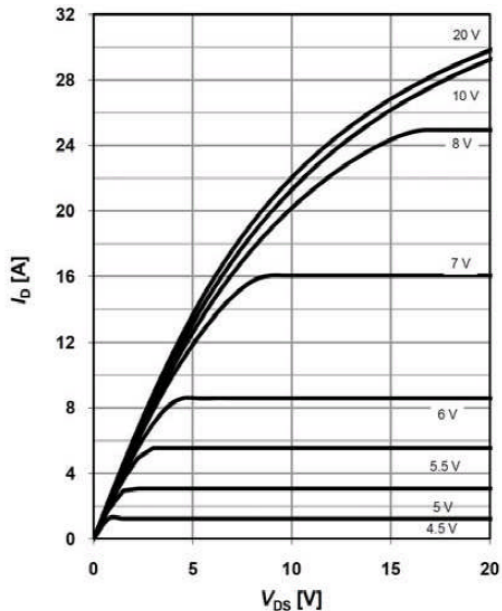


$I_D=f(V_{DS}); T_C=80\text{ }^{\circ}\text{C}; V_{GS} > 7\text{V}; D=0$; parameter t_p

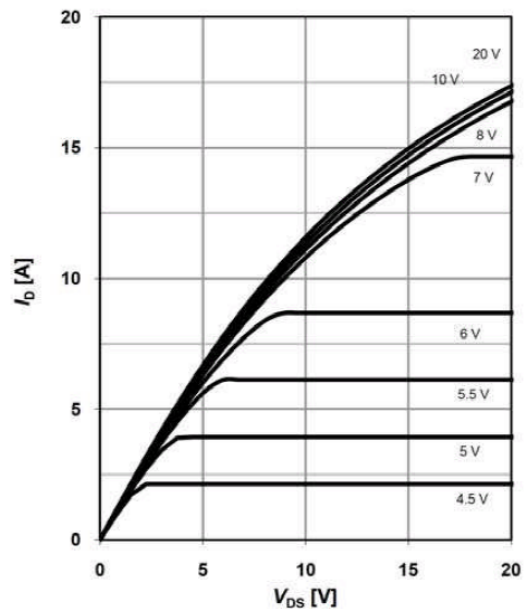
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Typical Performance Characteristics

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



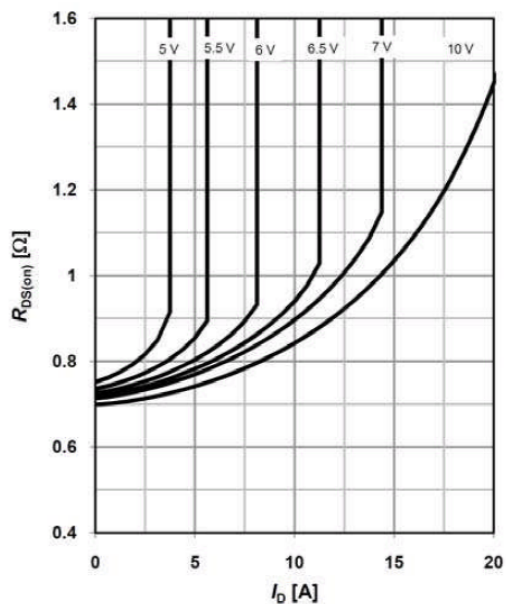
Typ. output characteristics $T_j=125\text{ }^{\circ}\text{C}$



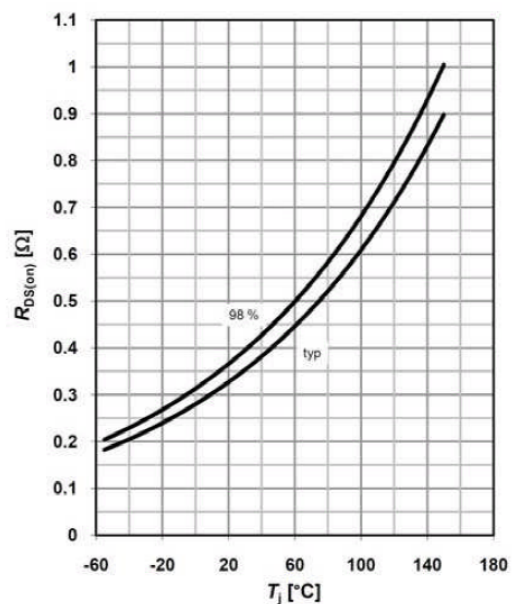
$I_D=f(V_{DS}); T_j=25\text{ }^{\circ}\text{C};$ parameter: V_{GS}

$I_D=f(V_{DS}); T_j=125\text{ }^{\circ}\text{C};$ parameter: V_{GS}

Typ. drain-source on-state resistance



Drain-source on-state resistance



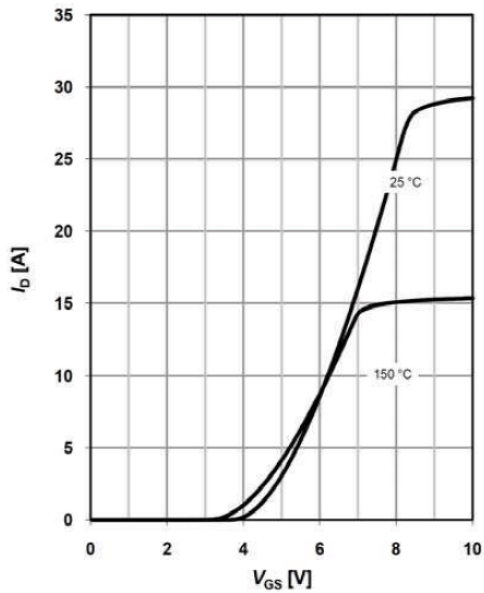
$R_{DS(on)}=f(I_D); T_j=125\text{ }^{\circ}\text{C};$ parameter: V_{GS}

$R_{DS(on)}=f(T_j); I_D=4.9\text{ A}; V_{GS}=10\text{ V}$

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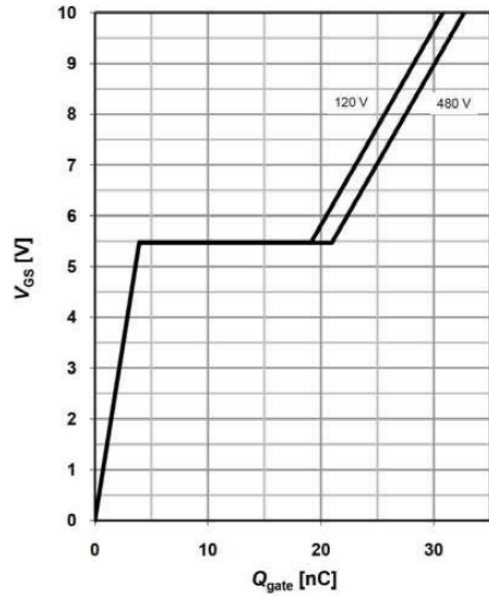
Typical Performance Characteristics

Typ. transfer characteristics



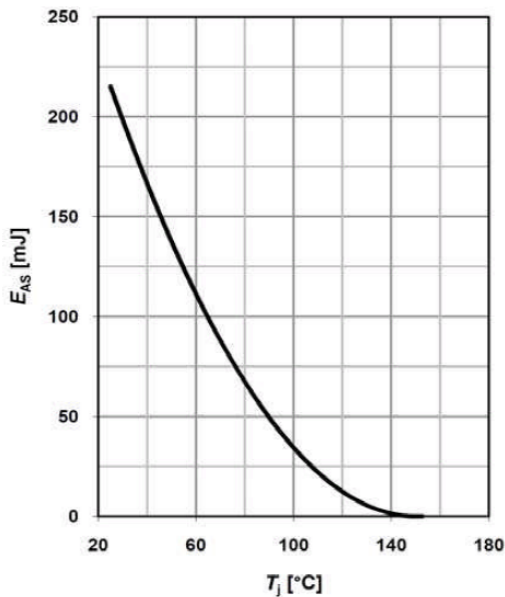
$$I_D = f(V_{GS}); V_{DS} = 20V$$

Typ. gate charge



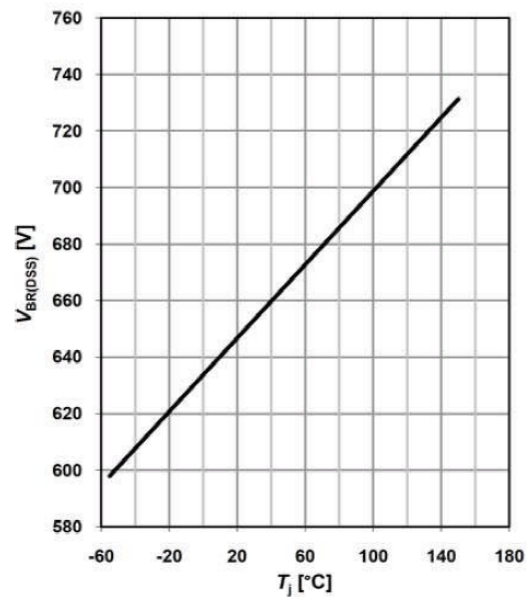
$$V_{GS} = f(Q_{gate}); I_D = 4.9 A \text{ pulsed}$$

Avalanche energy



$$E_{AS} = f(T_J); I_D = 1.8 A; V_{DD} = 50 V$$

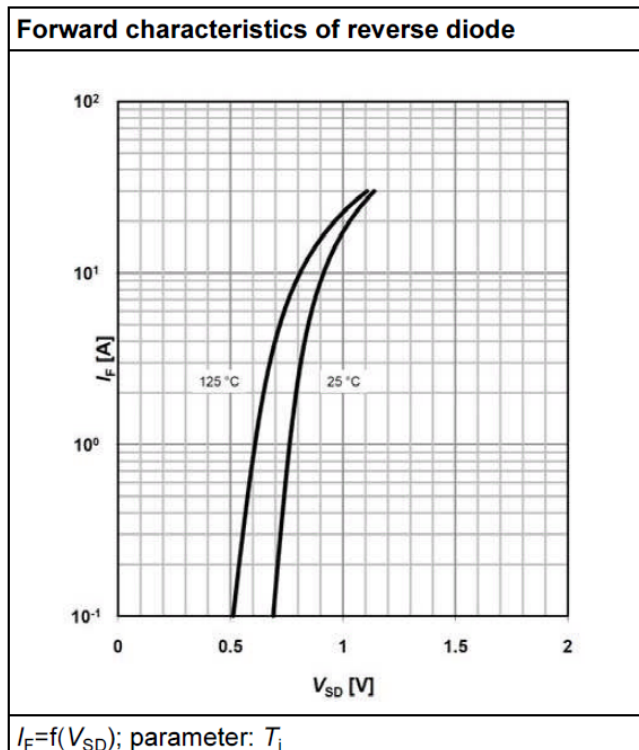
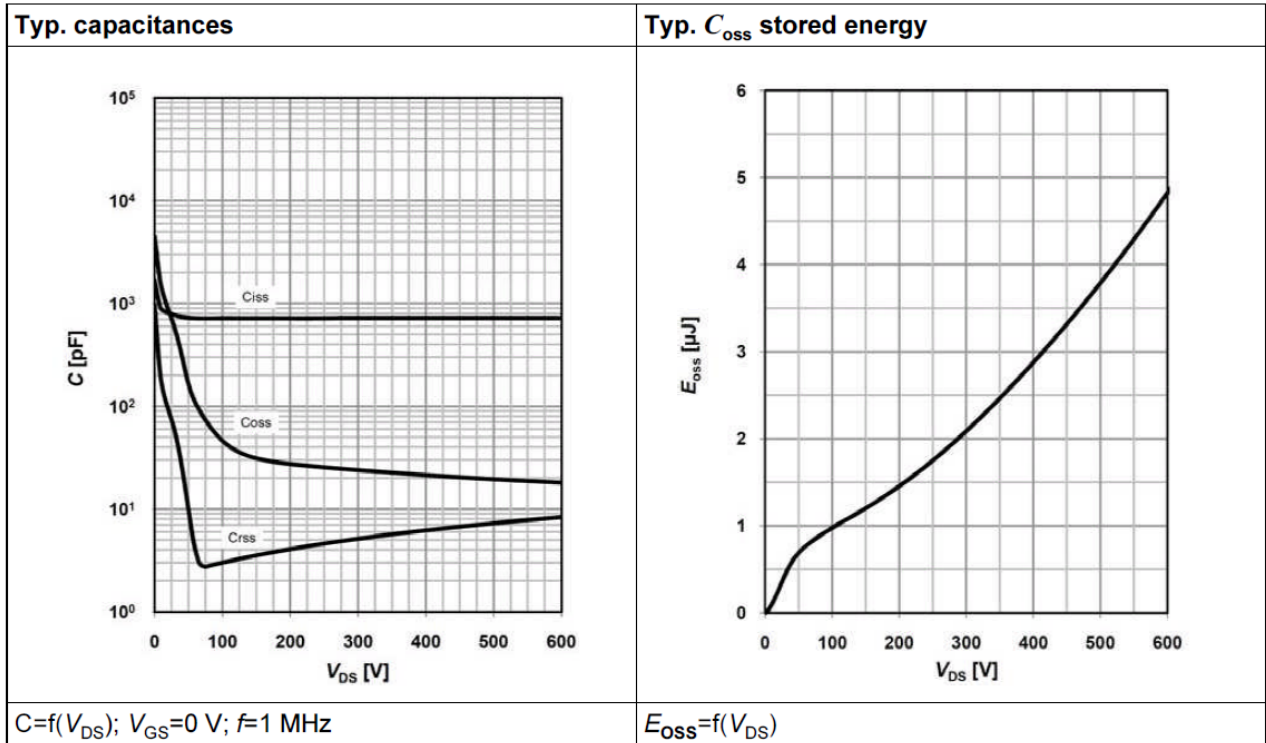
Drain-source breakdown voltage



$$V_{BR(DSS)} = f(T_J); I_D = 1.0 mA$$

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Typical Performance Characteristics



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Table 20 Switching times test circuit and waveform for inductive load

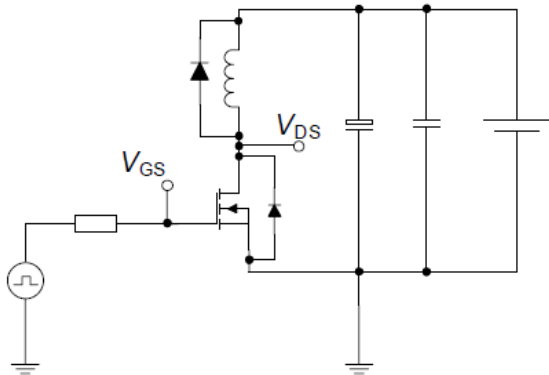
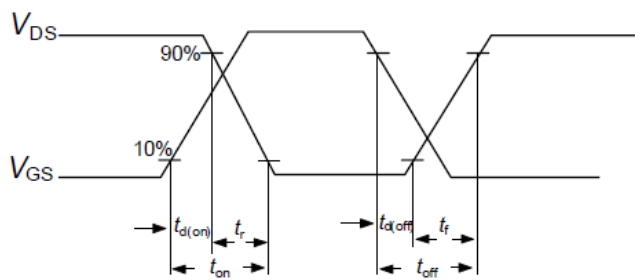
Switching times test circuit for inductive load	Switching time waveform
	

Table 21 Unclamped inductive load test circuit and waveform

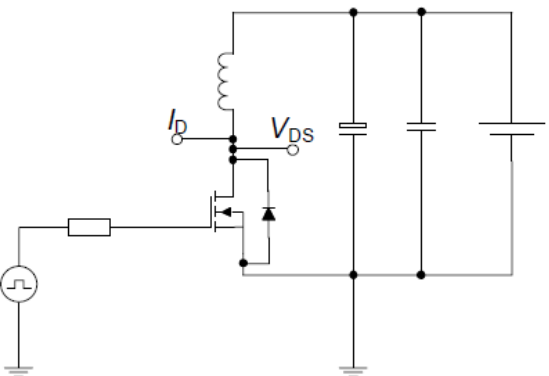
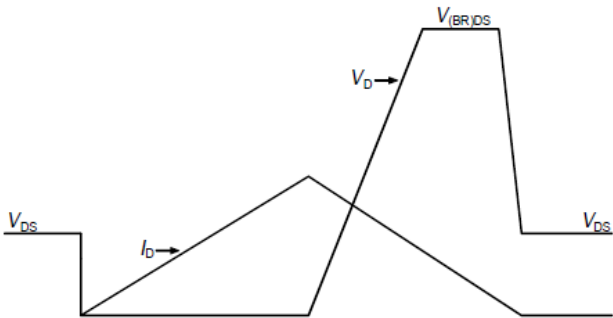
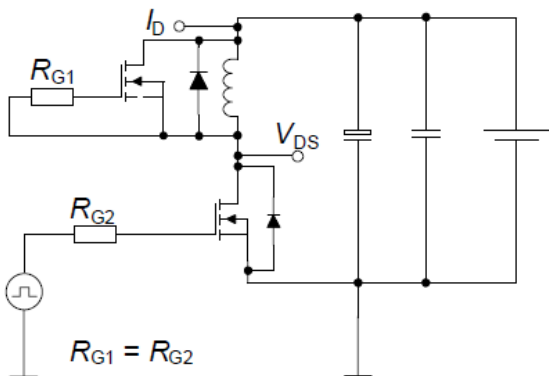
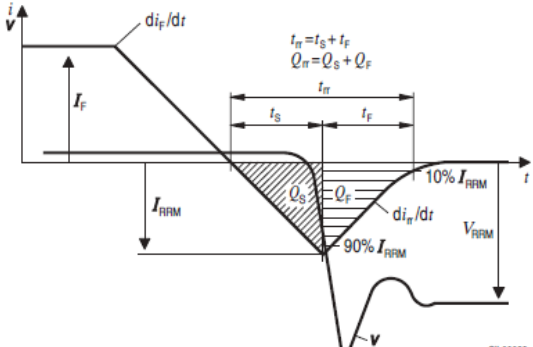
Unclamped inductive load test circuit	Unclamped inductive waveform
	

Table 22 Test circuit and waveform for diode characteristics

Test circuit for diode characteristics	Diode recovery waveform
 $R_{G1} = R_{G2}$	 $t_{rr} = t_s + t_f$ $Q_{rr} = Q_s + Q_f$