

650V N-Channel MOSFET

General Features

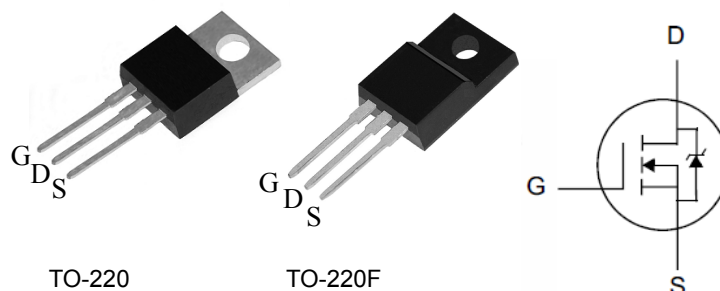
- Proprietary New Planar Technology
- $R_{DS(ON),typ.} = 0.38 \Omega @ V_{GS}=10V$
- Low Gate Charge Minimize Switching Loss
- Fast Recovery Body Diode

BV_{DSS}	$R_{DS(ON),typ.}$	I_D
650V	0.38Ω	20A

Applications

- Adaptor
- TV Main Power
- SMPS Power Supply
- LCD Panel Power

Ordering Information



Part Number	Package
SK20N65AT	TO-220
SK20N65ATF	TO-220F

Absolute Maximum Ratings

$T_c=25^\circ\text{C}$ unless otherwise specified

Symbol	Parameter	TO-220	TO-220F	Unit
V_{DSS}	Drain-to-Source Voltage ^[1]	650		V
V_{GSS}	Gate-to-Source Voltage	±30		
I_D	Continuous Drain Current	20		A
$I_D @ T_c=100^\circ\text{C}$	Continuous Drain Current @ $T_c=100^\circ\text{C}$	Figure 3		
I_{DM}	Pulsed Drain Current at $V_{GS}=10V$ ^[2]	Figure 6		
E_{AS}	Single Pulse Avalanche Energy	1200		mJ
dv/dt	Peak Diode Recovery dv/dt ^[3]	5.0		V/ns
P_D	Power Dissipation	160	65	W
	Derating Factor above 25°C	1.28	0.52	
T_L T_{PAK}	Maximum Temperature for Soldering Leads at 0.063in (1.6mm) from Case for 10 seconds, Package Body for 10 seconds	300 260		°C
T_J & T_{STG}	Operating and Storage Temperature Range	-55 to 150		

Caution: Stresses greater than those listed in the "Absolute Maximum Ratings" may cause permanent damage to the device.

Thermal Characteristics

Symbol	Parameter	TO-220	TO-220F	Unit
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	0.78	1.92	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	62	100	

OFF Characteristics $T_J = 25^\circ\text{C}$ unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	650	--	--	V	$V_{GS}=0V, I_D=250\mu A$
I_{DSS}	Drain-to-Source Leakage Current	--	--	1	μA	$V_{DS}=650V, V_{GS}=0V$
		--	--	100		$V_{DS}=520V, V_{GS}=0V, T_J=125^\circ\text{C}$
I_{GSS}	Gate-to-Source Leakage Current	--	--	+100	nA	$V_{GS}=+30V, V_{DS}=0V$
		--	--	-100		$V_{GS}=-30V, V_{DS}=0V$

ON Characteristics

 $T_J = 25^\circ\text{C}$ unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
$R_{DS(ON)}$	Static Drain-to-Source On-Resistance ^[4]	--	0.38	0.50	Ω	$V_{GS}=10V, I_D=10A$
$V_{GS(TH)}$	Gate Threshold Voltage	2.0	--	4.0	V	$V_{DS}=V_{GS}, I_D=250\mu A$
gfs	Forward Transconductance ^[4]	--	15	--	S	$V_{DS}=15V, I_D=10A$

Dynamic Characteristics

Essentially independent of operating temperature

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
C_{iss}	Input Capacitance	--	2600	--	pF	$V_{GS}=0V, V_{DS}=25V, f=1.0MHz$
C_{rss}	Reverse Transfer Capacitance	--	36	--		
C_{oss}	Output Capacitance	--	230	--		
Q_g	Total Gate Charge	--	65	--	nC	$V_{DD}=325V, I_D=20A, V_{GS}=0 \text{ to } 10V$
Q_{gs}	Gate-to-Source Charge	--	12	--		
Q_{gd}	Gate-to-Drain (Miller) Charge	--	25	--		

Resistive Switching Characteristics

Essentially independent of operating temperature

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
$t_{d(ON)}$	Turn-on Delay Time	--	35	--	nS	$V_{DD}=325V, I_D=20A, V_{GS}=10V, R_G=25\Omega$
t_{rise}	Rise Time	--	190	--		
$t_{d(OFF)}$	Turn-Off Delay Time	--	75	--		
t_{fall}	Fall Time	--	130	--		

Source-Drain Body Diode Characteristics

$T_J=25^{\circ}\text{C}$ unless otherwise specified

Symbol	Parameter	Min	Typ.	Max.	Unit	Test Conditions
I_{SD}	Continuous Source Current ^[4]	--	--	20	A	Integral PN-diode in MOSFET
I_{SM}	Pulsed Source Current ^[4]	--	--	80		
V_{SD}	Diode Forward Voltage	--	--	1.5	V	$I_S=20\text{A}$, $V_{GS}=0\text{V}$
t_{rr}	Reverse recovery time	--	800	--	ns	$V_{GS}=0\text{V}$, $I_F=20\text{A}$, $di/dt=100\text{A}/\mu\text{s}$
Q_{rr}	Reverse recovery charge	--	3.5	--	μC	

Note:

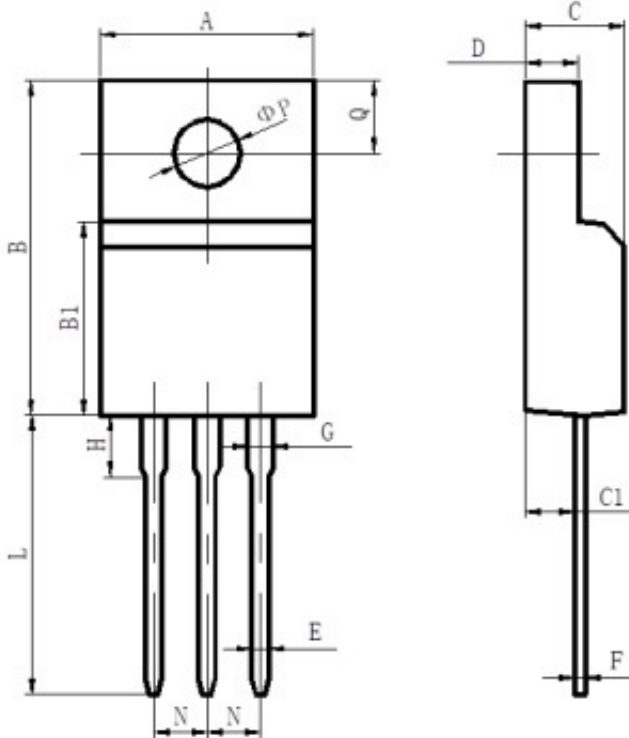
[1] $T_J=+25^{\circ}\text{C}$ to $+150^{\circ}\text{C}$

[2] Repetitive rating; pulse width limited by maximum junction temperature.

[3] $I_{SD}=20\text{A}$ $di/dt < 100\text{A}/\mu\text{s}$, $V_{DD} < BV_{DSS}$, $T_J=+150^{\circ}\text{C}$.

[4] Pulse width $\leq 380\mu\text{s}$; duty cycle $\leq 2\%$.

TO-220F PACKAGE SIZE (Unit: mm)



SYMBOL	mm	
	MIN	MAX
A	9.70	10.30
B	15.50	16.10
B1	8.99	9.39
C	4.40	4.80
C1	2.15	2.55
D	2.50	2.90
E	0.70	0.90
F	0.40	0.60
G	1.12	1.42
H	3.40	3.80
L	12.6	13.6
N	2.34	2.74
Q	3.15	3.55
ϕP	3.00	3.30

Typical Characteristics

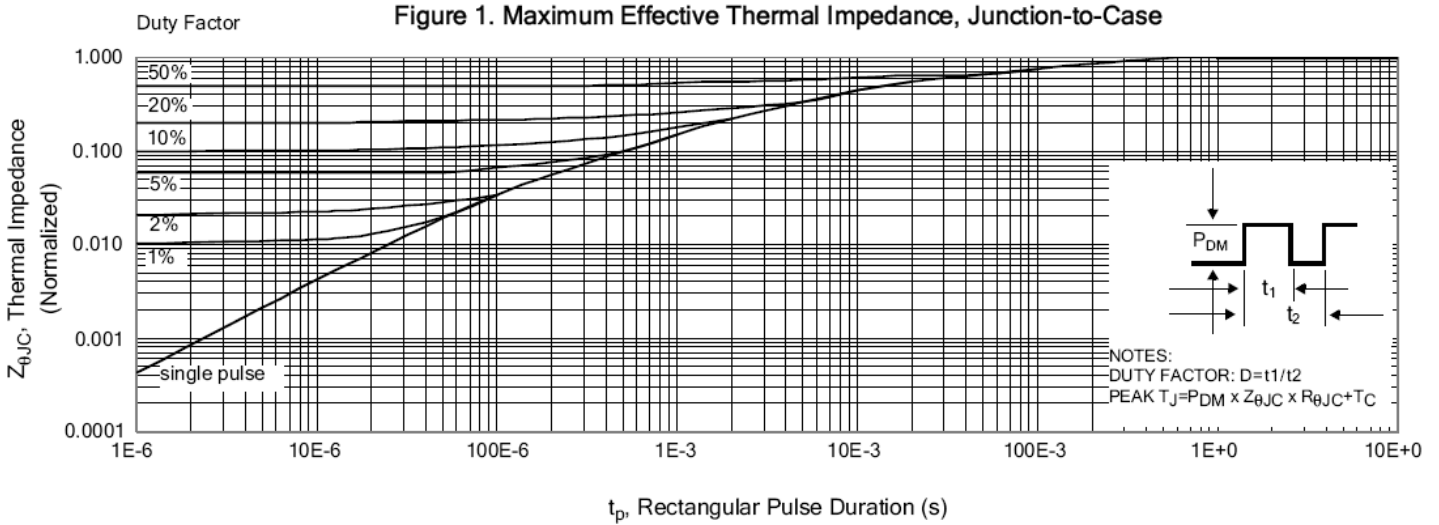


Figure 2. Maximum Power Dissipation vs Case Temperature

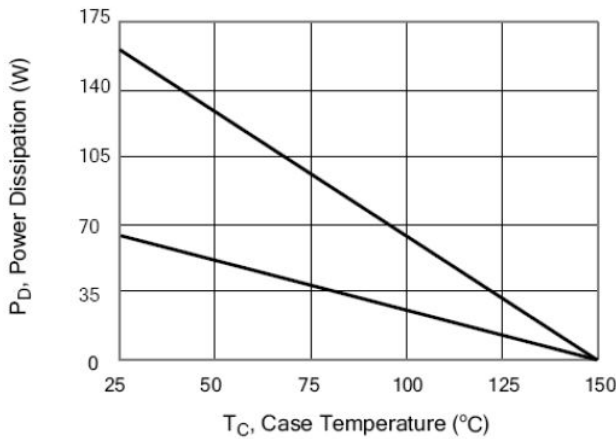


Figure 3. Maximum Continuous Drain Current vs Case Temperature

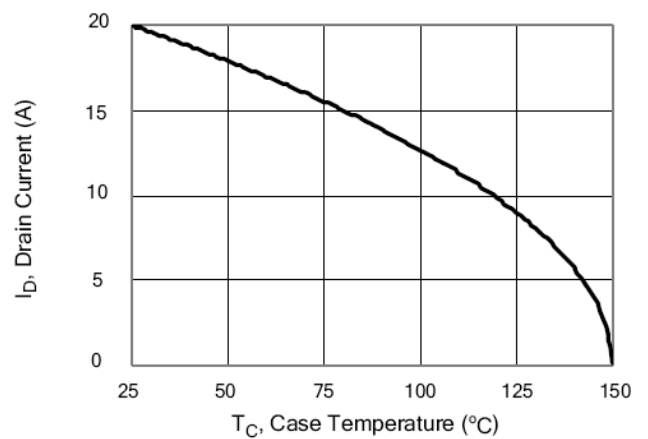


Figure 4. Typical Output Characteristics

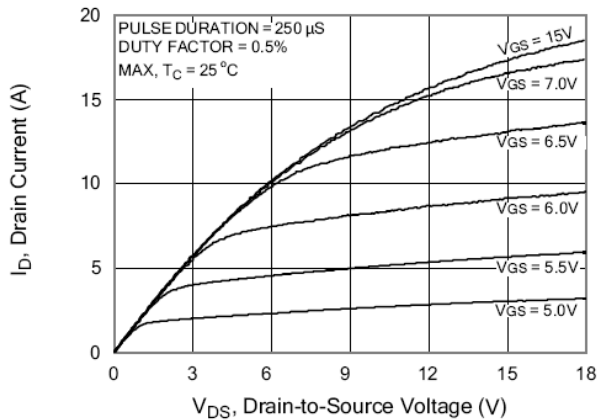
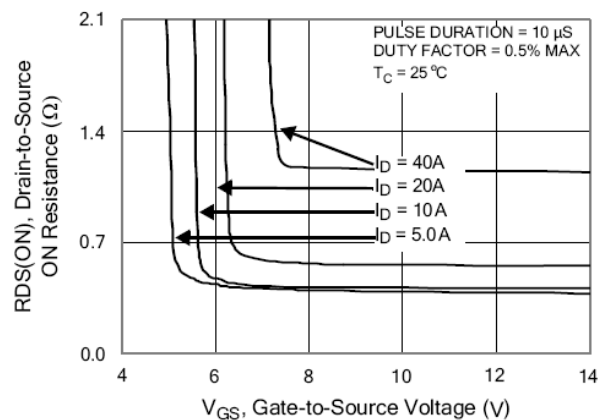


Figure 5. Typical Drain-to-Source ON Resistance vs Gate Voltage and Drain Current



Typical Characteristics(Cont.)

Figure 6. Maximum Peak Current Capability

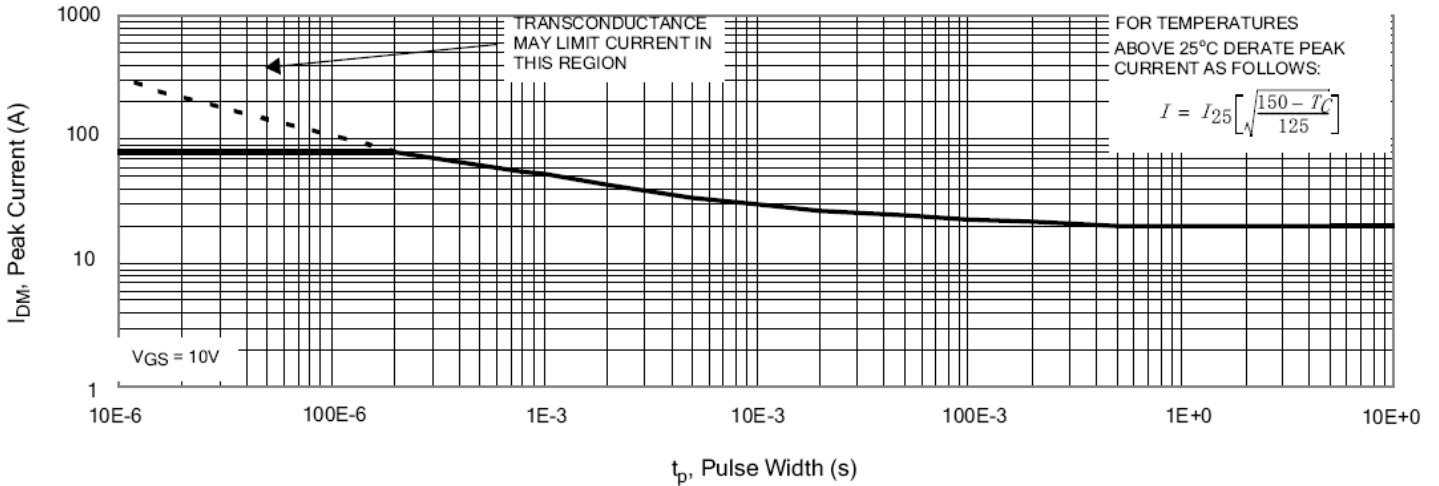


Figure 7. Typical Transfer Characteristics

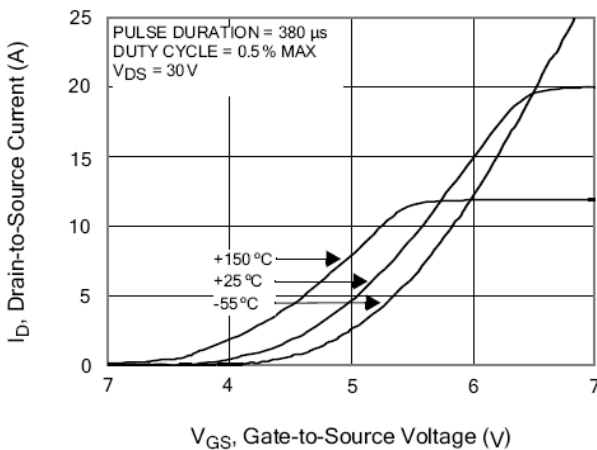


Figure 8. Unclamped Inductive Switching Capability

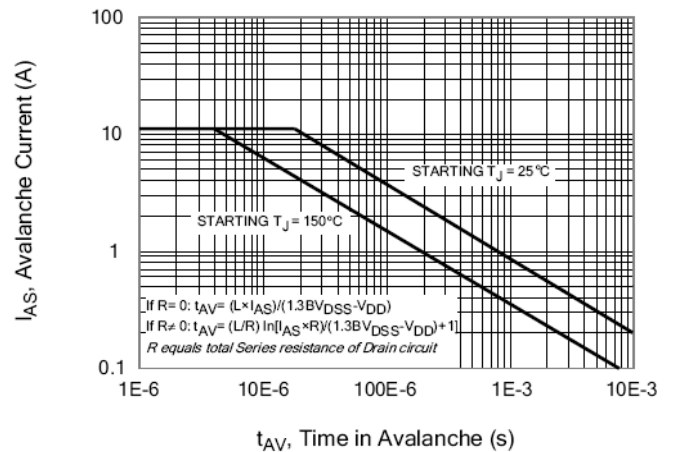


Figure 9. Typical Drain-to-Source ON Resistance vs Drain Current

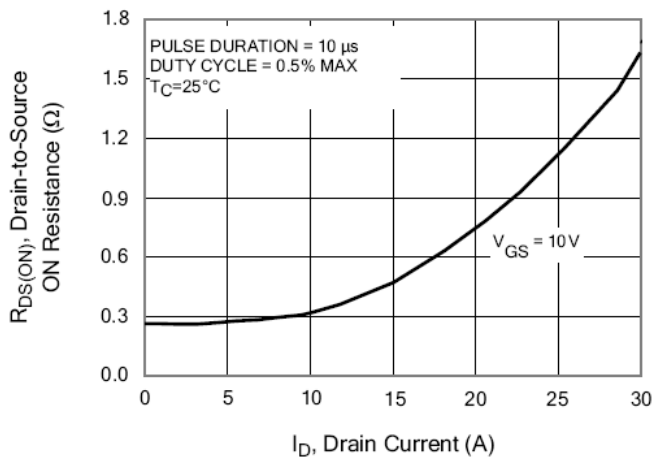
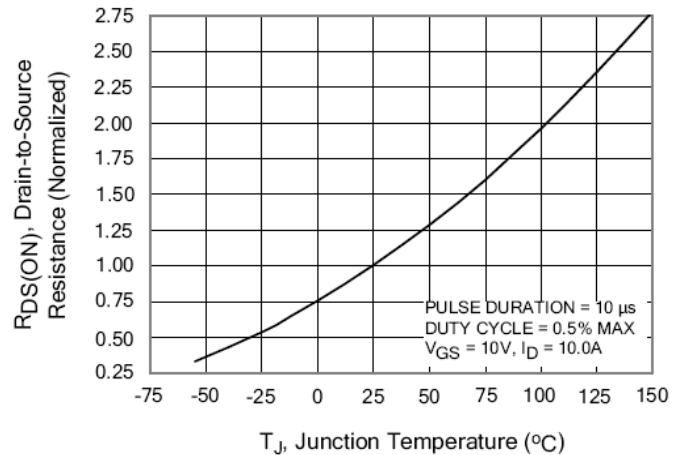


Figure 10. Typical Drain-to-Source ON Resistance vs Junction Temperature



Typical Characteristics(Cont.)

Figure 11. Typical Breakdown Voltage vs Junction Temperature

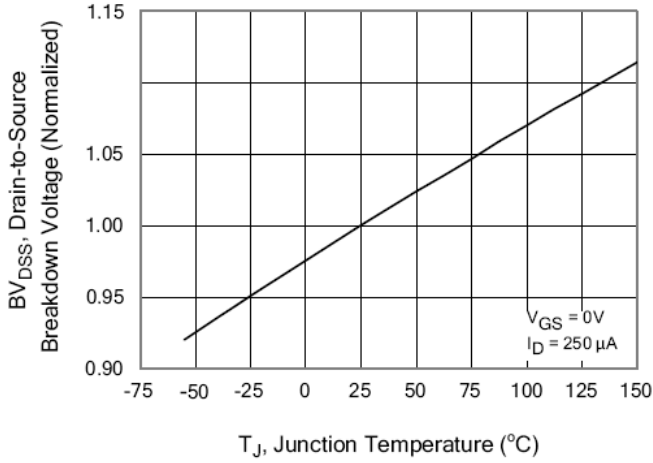


Figure 12. Typical Threshold Voltage vs Junction Temperature

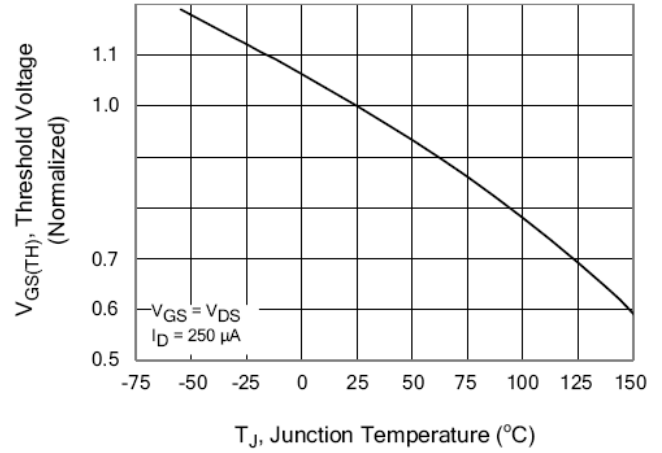


Figure 13. Maximum Forward Bias Safe Operating Area

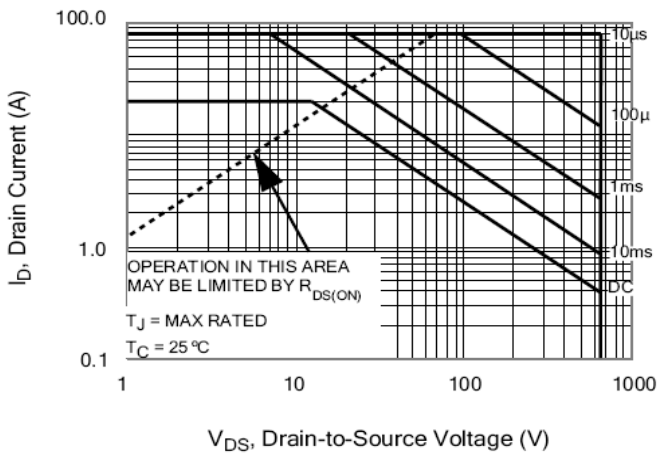


Figure 14. Capacitance vs Vds

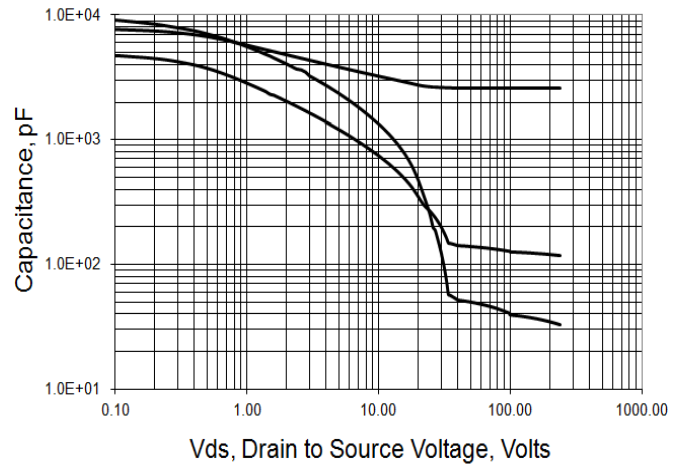


Figure 15. Typical Gate Charge

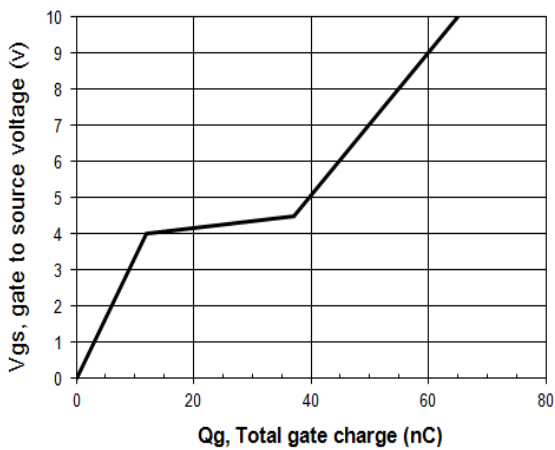
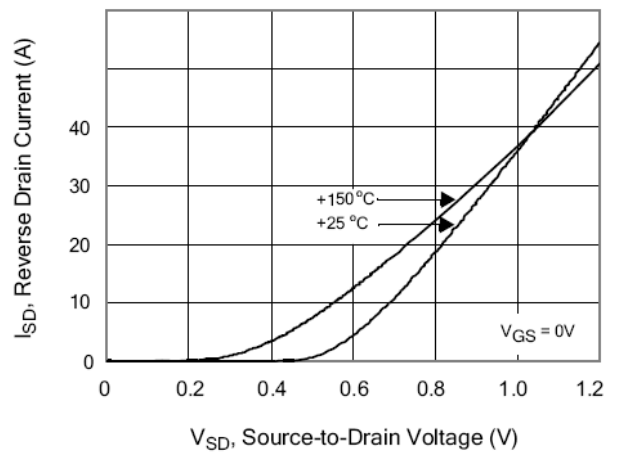


Figure 16. Typical Body Diode Transfer Characteristics



Test Circuits and Waveforms

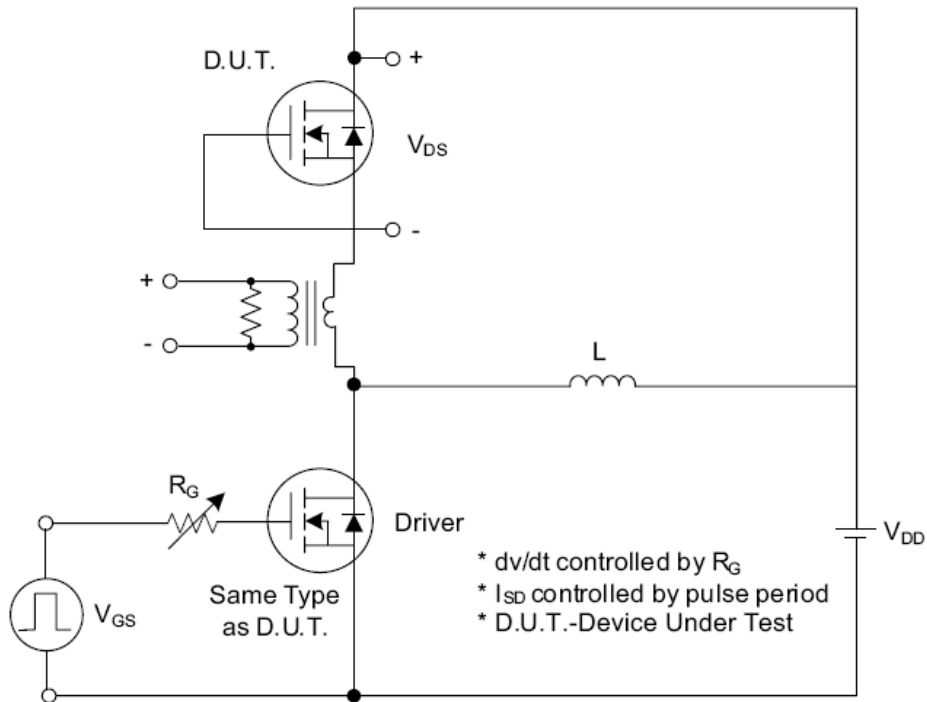


Fig. 1.1 Peak Diode Recovery dv/dt Test Circuit

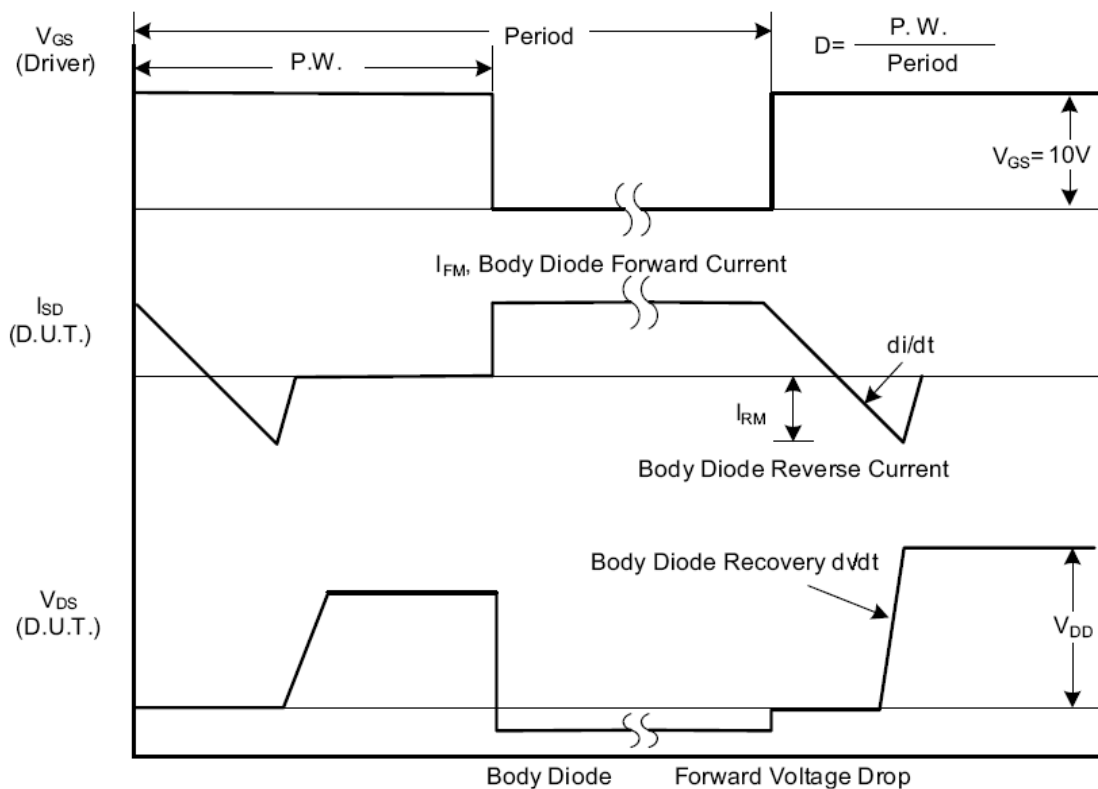


Fig. 1.2 Peak Diode Recovery dv/dt Waveforms

Test Circuits and Waveforms (Cont.)

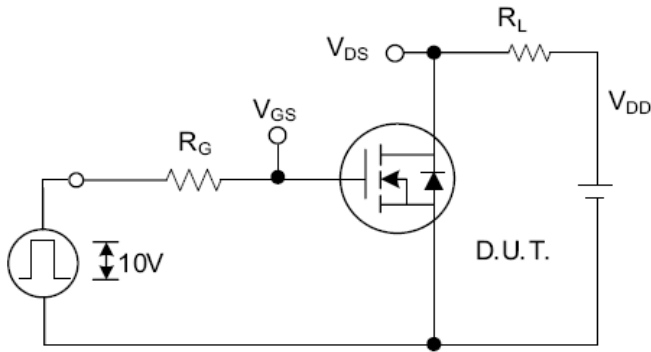


Fig. 2.1 Switching Test Circuit

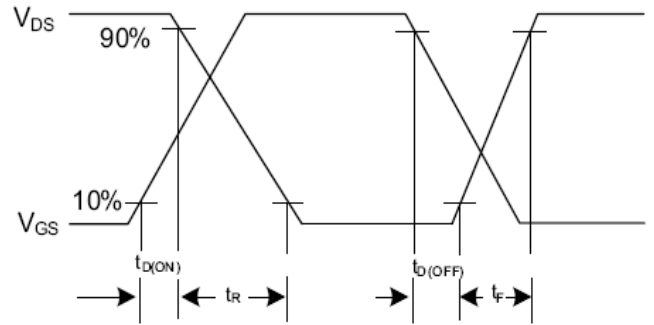


Fig. 2.2 Switching Waveforms

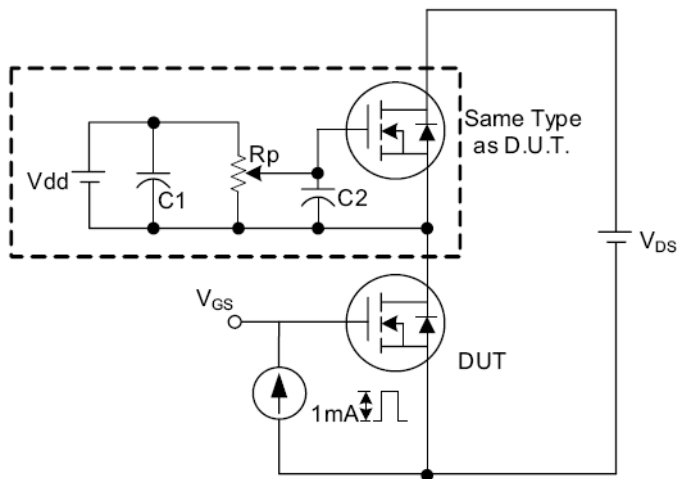


Fig. 3.1 Gate Charge Test Circuit

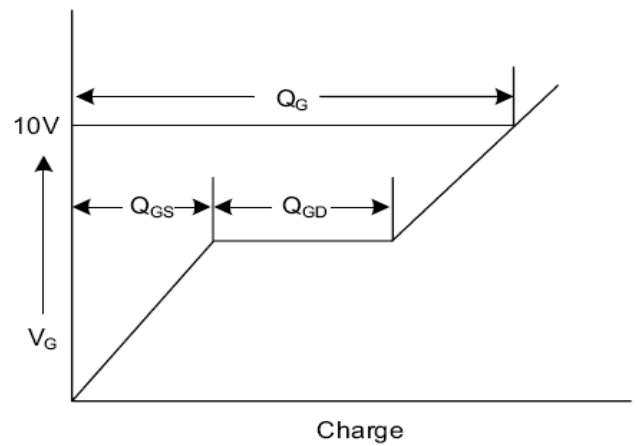


Fig. 3.2 Gate Charge Waveform

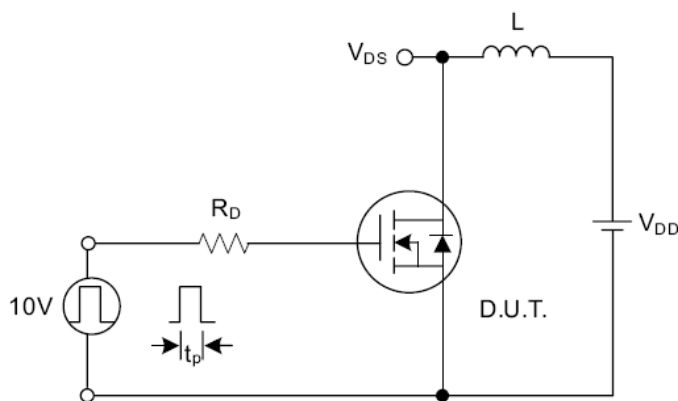


Fig. 4.1 Unclamped Inductive Switching Test Circuit

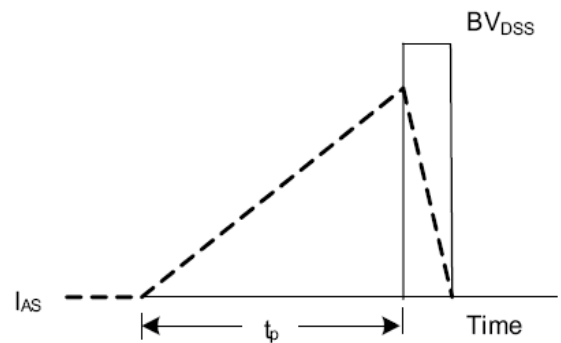


Fig. 4.2 Unclamped Inductive Switching Waveforms

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