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SUPER-MOSFET

Super Junction Metal Oxide Semiconductor Field Effect Transistor

600V Super Junction Power MOSFET With Fast-Recovery
SS*47N60SFD

Rev. 1.5

Jun. 2019

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SSW47N60SFD/SSA47N60SFD

600V N-Channel MOSFET With Fast-Recovery

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.

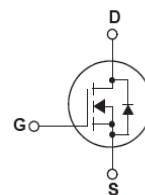
Features

- Multi-Epi process SJ-FET
- Fast-Recovery body diode
- Extremely Low Reverse Recovery Charge
- 650V @T_J = 150 °C
- Typ. RDS(on) = 65mΩ
- Ultra Low Gate Charge (typ. Q_g = 64nC)
- 100% avalanche tested

SSW47N60SFD



SSA47N60SFD



Absolute Maximum Ratings

Symbol	Parameter	SSW_A47N60SFD	Unit
V _{DSS}	Drain-Source Voltage	600	V
I _D	Drain Current -Continuous (TC = 25°C)	47*	A
	-Continuous (TC = 100°C)	29*	
I _{DM}	Drain Current - Pulsed (Note 1)	140	A
V _{GSS}	Gate-Source voltage	±30	V
E _{AS}	Single Pulsed Avalanche Energy (Note 2)	1135	mJ
I _{AR}	Repetitive Avalanche Current (Note 1)	9.3	A
E _{AR}	Repetitive Avalanche Energy (Note 1)	1.72	mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	40	V/ns
dV _{ds} /dt	Drain Source voltage slope (V _{ds} =480V)	80	V/ns
P _D	Power Dissipation (TC = 25°C)	391	W
T _J , T _{STG}	Operating and Storage Temperature Range	-55 to +150	°C
T _L	Maximum Lead Temperature for Soldering Purpose, 1/8" from Case for 5 Seconds	300	°C

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

Thermal Characteristics

Symbol	Parameter	SSW_A47N60SFD	Unit
R _{θJC}	Thermal Resistance, Junction-to-Case	0.32	°C/W
R _{θCS}	Thermal Resistance, Case-to-Sink Typ.	0.5	°C/W
R _{θJA}	Thermal Resistance, Junction-to-Ambient	62	°C/W



Electrical Characteristics TC = 25°C unless otherwise noted

SSW47N60SFD/SSA47N60SFD 600V N-Channel MOSFET With Fast-Recovery

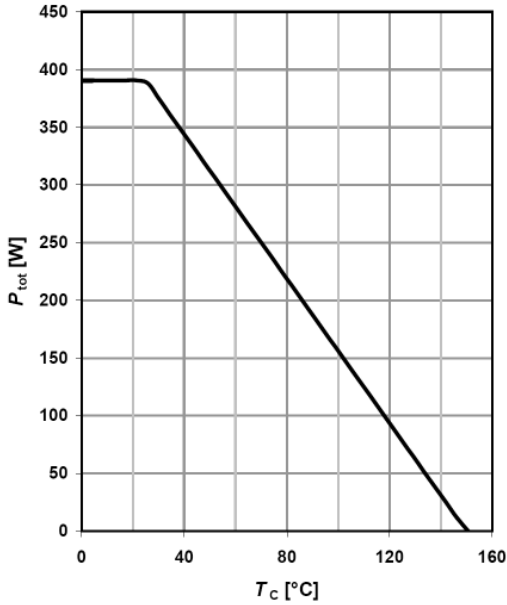
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Off Characteristics						
BV _{DSS}	Drain-Source Breakdown Voltage	V _{GS} = 0V, I _D = 250μA, T _J = 25°C	600	-	-	V
		V _{GS} = 0V, I _D = 250μA, T _J = 150°C	-	650	-	V
ΔBV _{DSS} /ΔT _J	Breakdown Voltage Temperature Coefficient	I _D = 250μA, Referenced to 25°C	-	0.6	-	V/°C
I _{DSS}	Zero Gate Voltage Drain Current	V _{DS} = 600V, V _{GS} = 0V -T _J = 150°C	-	1 300	5 -	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	3.0	-	5.0	V
R _{DS(on)}	Static Drain-Source On-Resistance	V _{GS} = 10V, I _D = 23A	-	65	75	mΩ
g _{FS}	Forward Transconductance	V _{DS} = 40V, I _D = 25A	-	35	-	S
Dynamic Characteristics						
C _{iss}	Input Capacitance	V _{DS} = 25V, V _{GS} = 0V, f = 1.0MHz	-	3250	-	pF
C _{oss}	Output Capacitance		-	910	-	pF
C _{rss}	Reverse Transfer Capacitance		-	27	-	pF
Switching Characteristics						
t _{d(on)}	Turn-On Delay Time	V _{DD} = 480V, I _D = 23A R _G = 20Ω (Note 4)	-	16	-	ns
t _r	Turn-On Rise Time		-	12	-	ns
t _{d(off)}	Turn-Off Delay Time		-	83	-	ns
t _f	Turn-Off Fall Time		-	5	-	ns
Q _g	Total Gate Charge	V _{DS} = 480V, I _D = 23A V _{GS} = 10V (Note 4)	-	64	-	nC
Q _{gs}	Gate-Source Charge		-	19	-	nC
Q _{gd}	Gate-Drain Charge		-	25.5	-	nC
Drain-Source Diode Characteristics and Maximum Ratings						
I _S	Maximum Continuous Drain-Source Diode Forward Current		-	-	47	A
I _{SM}	Maximum Pulsed Drain-Source Diode Forward Current		-	-	140	A
V _{SD}	Drain-Source Diode Forward Voltage	V _{GS} = 0V, I _S = 23A	-	0.9	1.5	V
t _{rr}	Reverse Recovery Time	V _{GS} = 0V, V _R = 480V, I _S = 23A, di/dt = 100A/μs	-	230	-	ns
Q _{rr}	Reverse Recovery Charge		-	3	-	μC
I _{rrm}	Peak Reverse Recovery Current		-	23	-	A

NOTES:

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. I_{AS} = 9.3A, V_{DD} = 50V, Starting T_J = 25 °C
3. I_{SD} ≤ I_D, di/dt ≤ 200A/μs, V_{DD} ≤ BV_{DSS}, Starting T_J = 25 °C
4. Essentially Independent of Operating Temperature Typical Characteristics

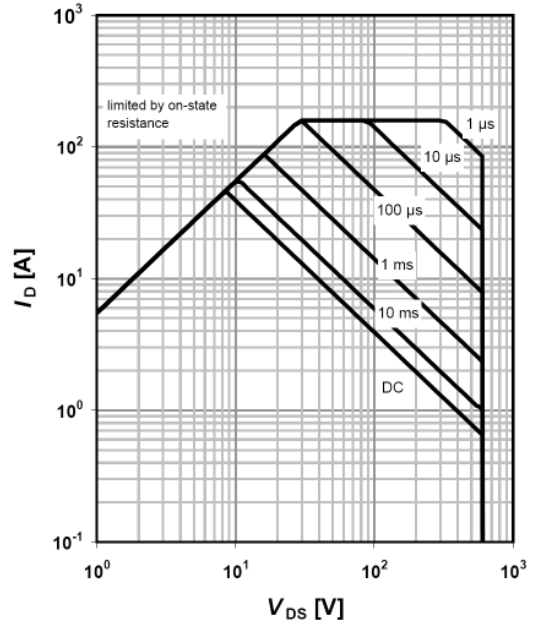
Typical Performance Characteristics

Power dissipation



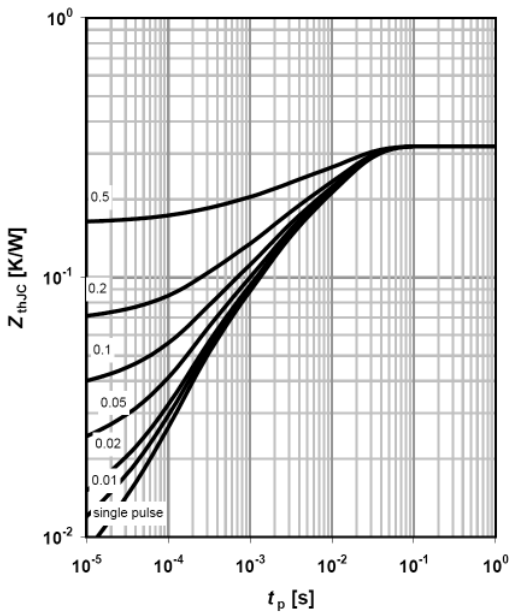
$$P_{tot}=f(T_c)$$

Safe operating area TC=25 °C



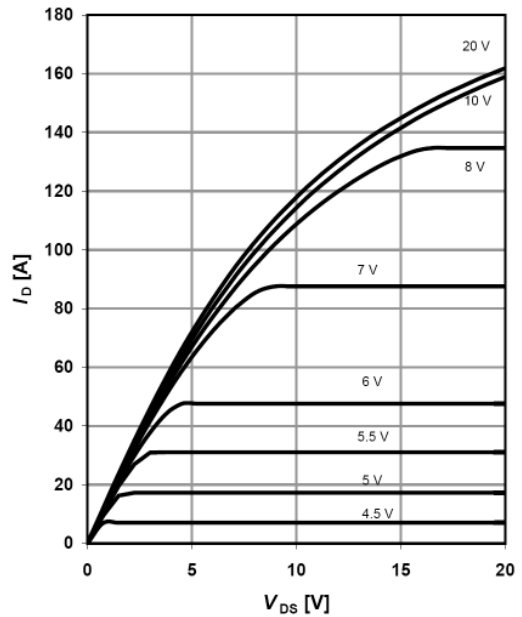
$$I_D=f(V_{DS}); T_C=25\text{ }^\circ\text{C}; D=0; \text{parameter } t_p$$

Max. transient thermal impedance



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

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

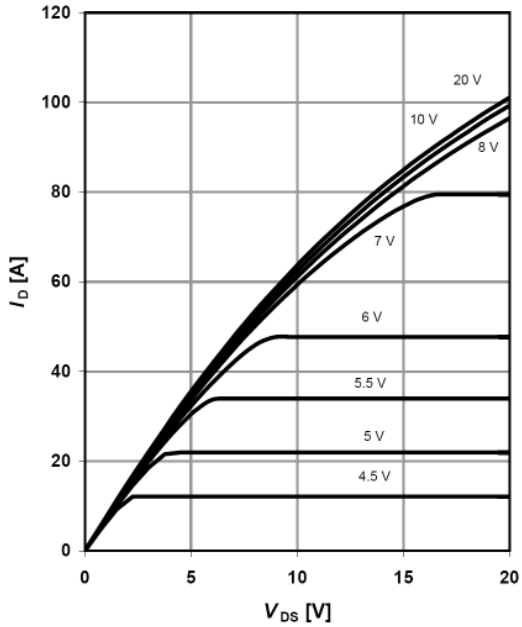


$$I_D=f(V_{DS}); T_j=25\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$$



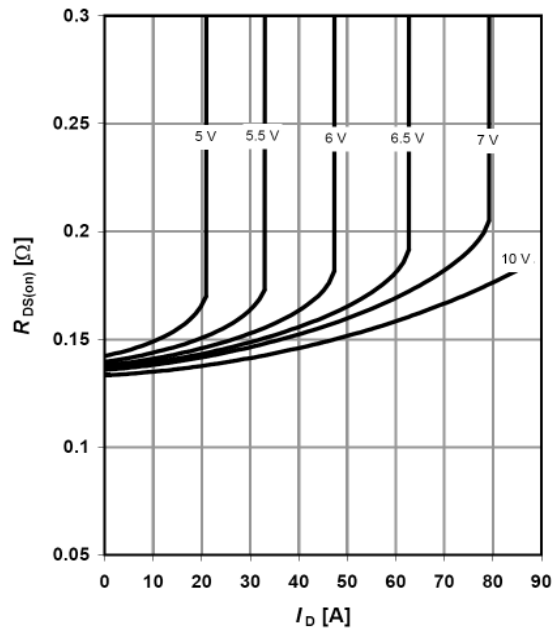
Typical Performance Characteristics

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



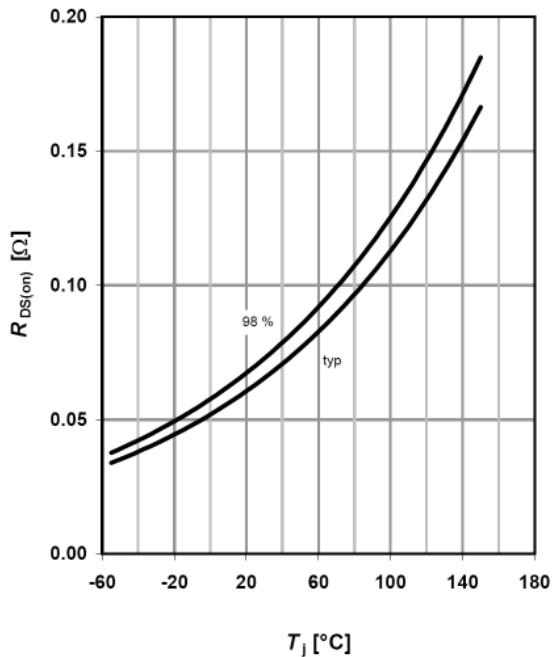
$I_D=f(V_{DS}); T_j=125\text{ }^\circ\text{C}$; parameter: V_{GS}

Typ. drain-source on-state resistance



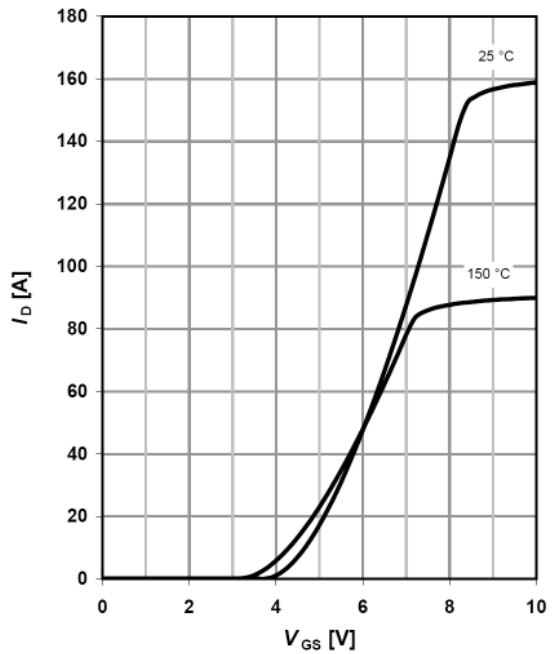
$R_{DS(on)}=f(I_D); T_j=125\text{ }^\circ\text{C}$; parameter: V_{GS}

Typ. drain-source on-state resistance



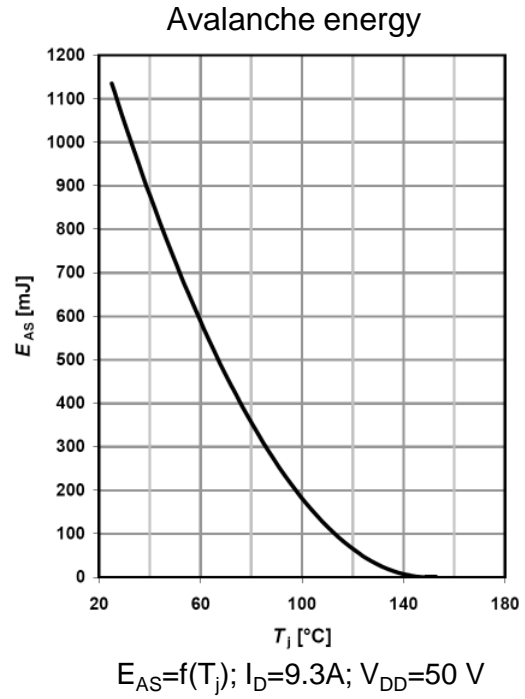
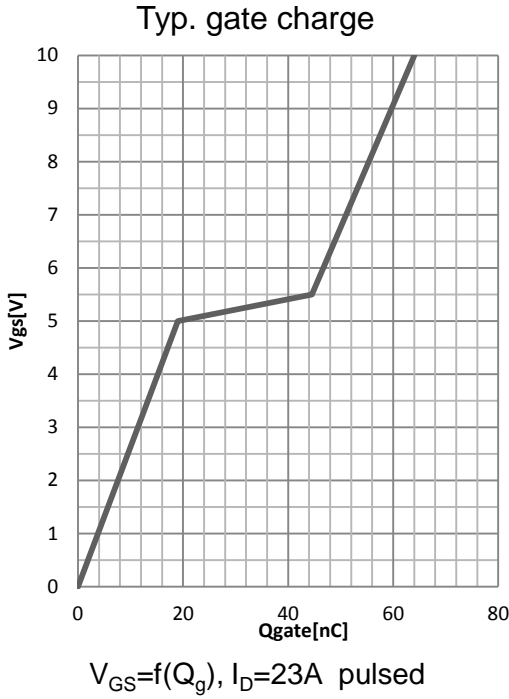
$R_{DS(on)}=f(T_j); I_D=23\text{ A}; V_{GS}=10\text{ V}$

Typ. transfer characteristics

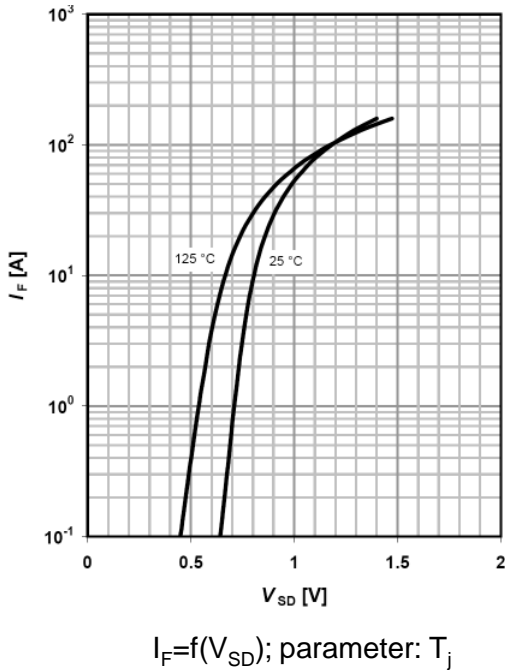


$I_D=f(V_{GS}); V_{DS}=40\text{ V}$

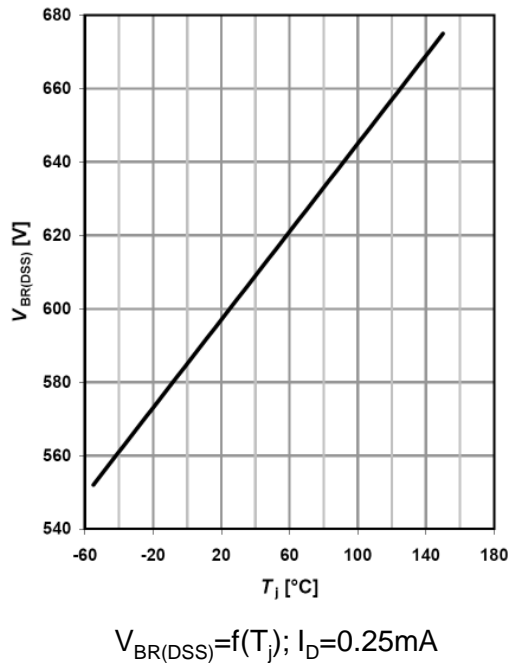
Typical Performance Characteristics



Forward characteristics of reverse diode



Drain-source breakdown voltage

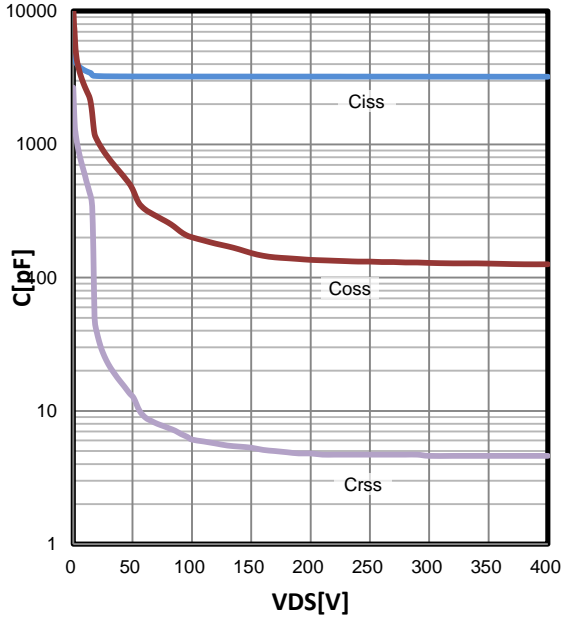




Typical Performance Characteristics

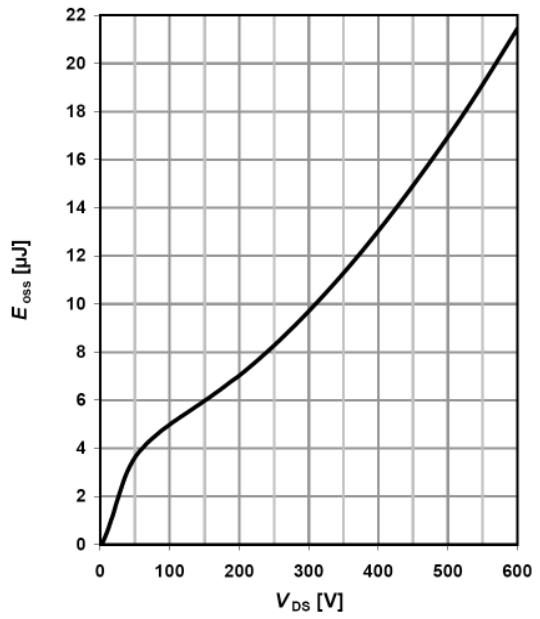
SSW47N60SFD/SSA47N60SFD 600V N-Channel MOSFET With Fast-Recovery

Typ. capacitances



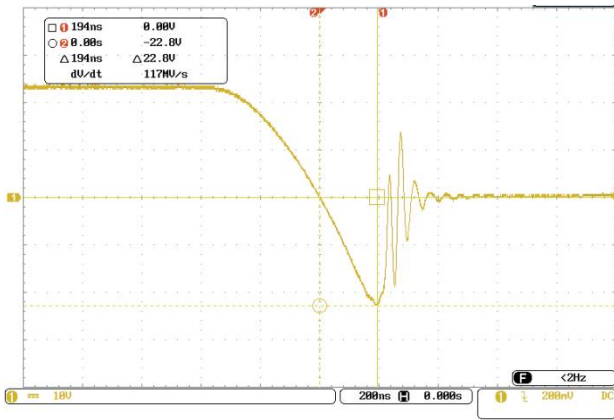
$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$

Typ. Coss stored energy



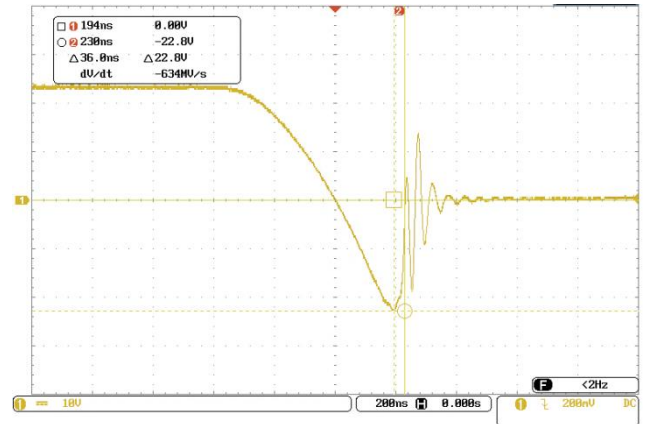
$E_{OSS}=f(V_{DS})$

Typ. Recovery Time(Ts)



$VR=480V, I_s = 23A, dI_F/dt = 100A/\mu s$

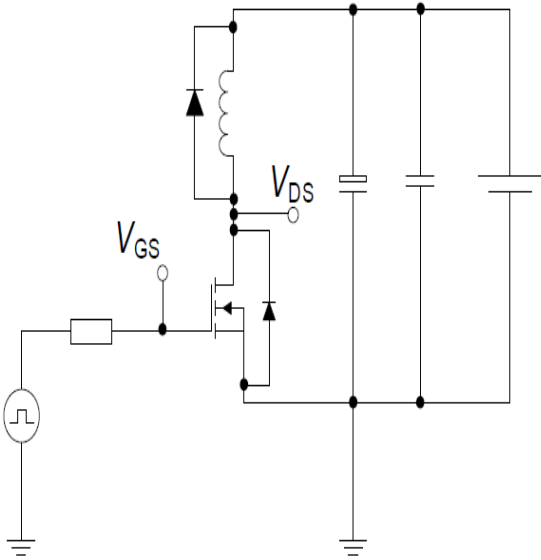
Typ. Recovery Time(Tf)



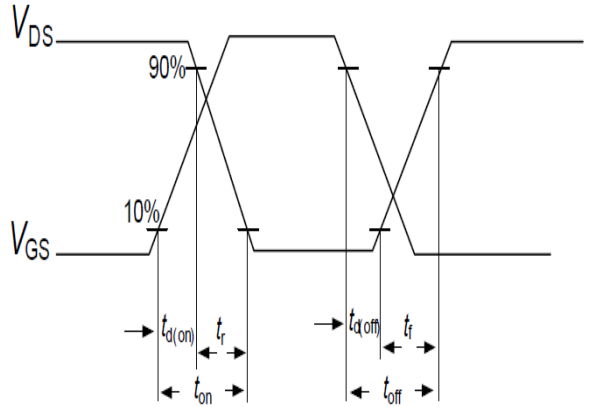
$VR=480V, I_s = 23A, dI_F/dt = 100A/\mu s$

Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load

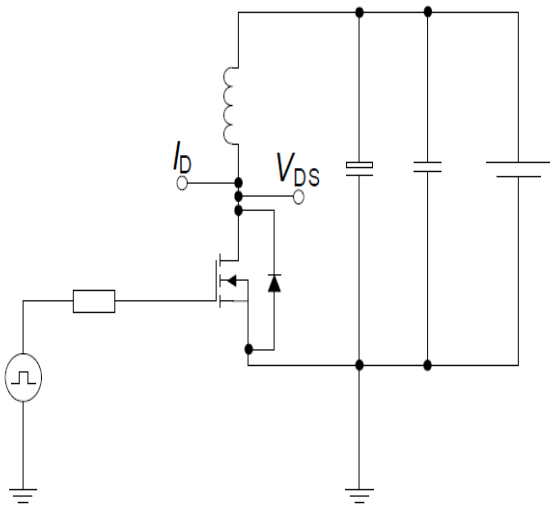


Switching time waveform

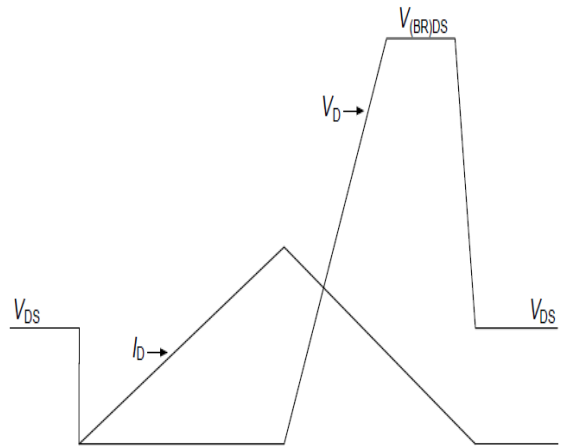


Unclamped inductive load test circuit and waveform

Unclamped inductive load test circuit

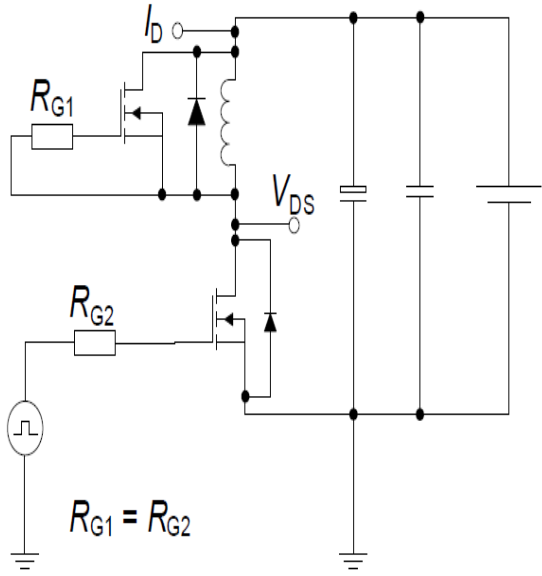


Unclamped inductive waveform

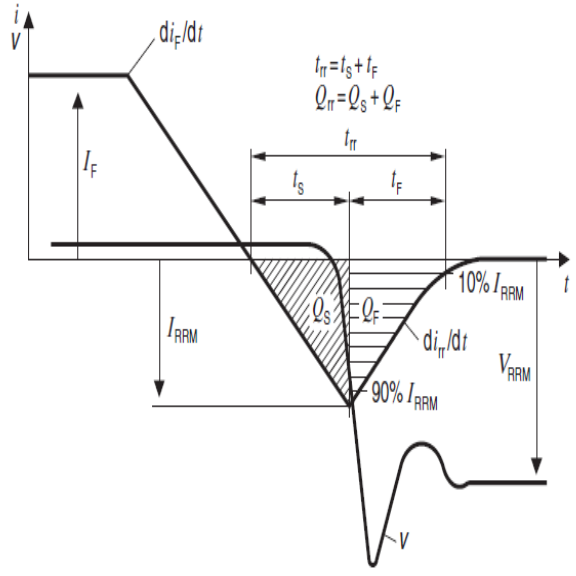


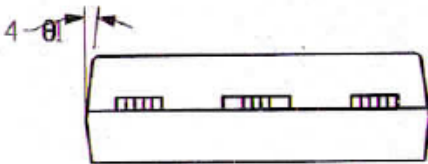
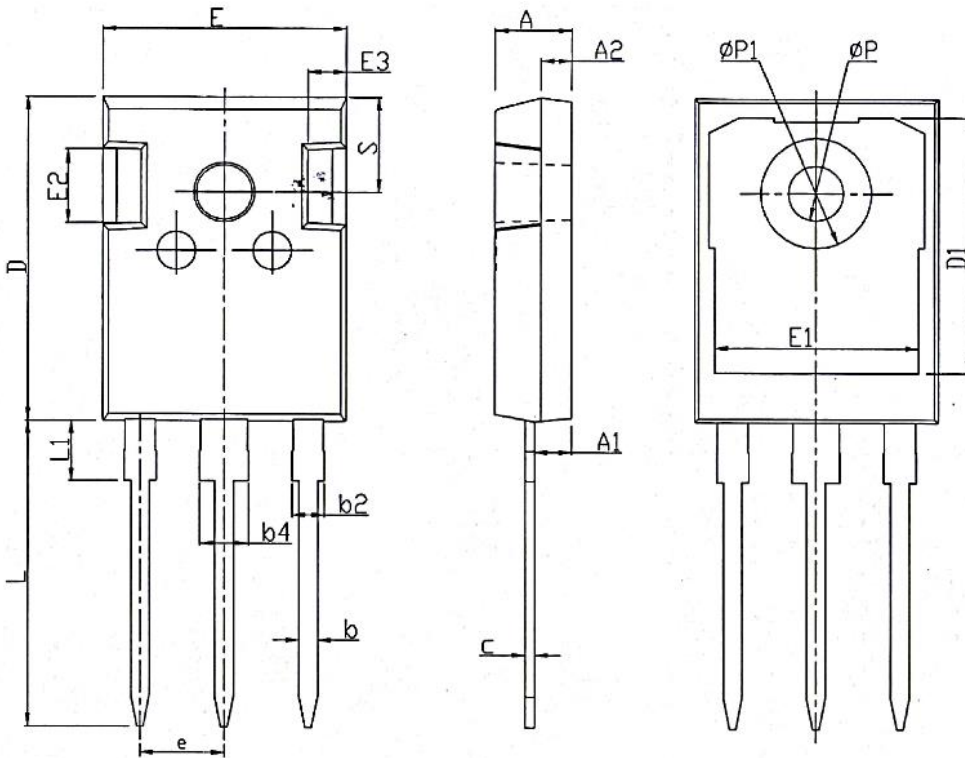
Test circuit and waveform for diode characteristics

Test circuit for diode characteristics



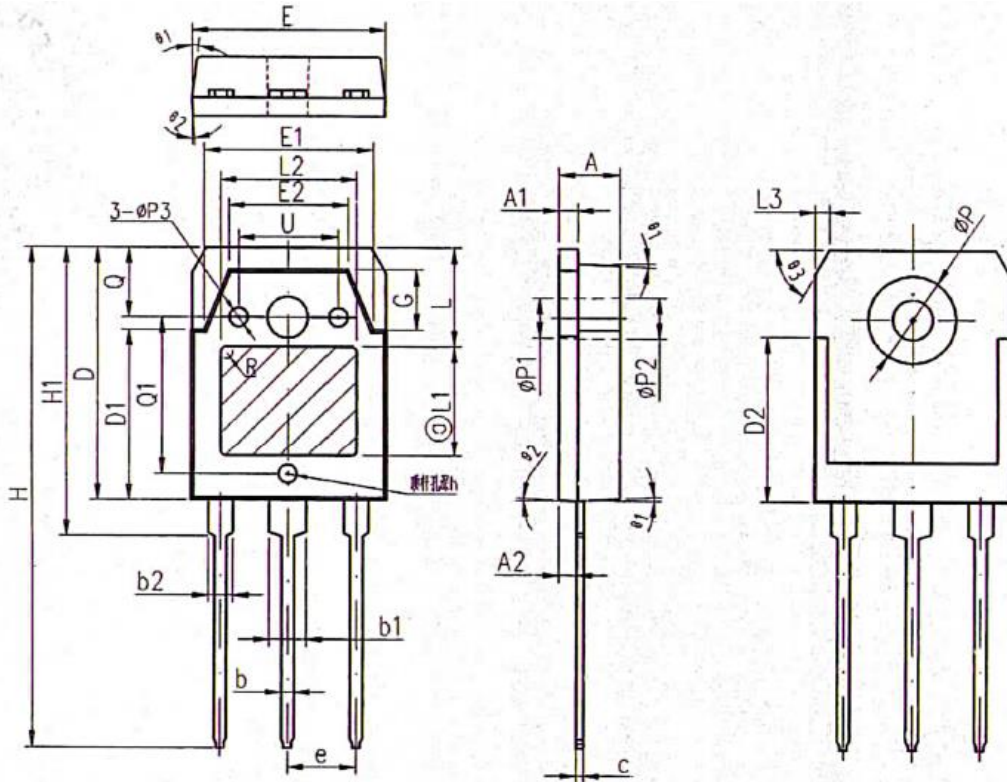
Diode recovery waveform





COMMON DIMENSIONS

SYMBOL	MM		
	MIN	NOM	MAX
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16	1.21	1.26
b2	1.96	2.01	2.06
b4	2.96	3.01	3.06
c	0.59	0.61	0.66
D	20.90	21.00	21.10
D1	16.25	16.55	16.85
D2	1.05	1.20	1.35
E	15.70	15.80	15.90
E1	13.10	13.30	13.50
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	5.44BSC		
h	0.05	0.10	0.15
L	19.80	19.92	20.10
L1	-	-	4.30
ΦP	3.50	3.60	3.70
$\Phi P1$	-	-	7.30
$\Phi P2$	2.40	2.50	2.60
Q	5.60	5.80	6.00
S	6.15BSC		
R	0.50REF		
T	9.80	-	10.20
T1	1.65REF		
T2	8.00REF		
T3	12.80REF		
U	6.00	-	6.40
$\theta 1$	6°	7°	8°
$\theta 2$	4°	5°	6°
$\theta 3$	1°	-	1.5°
$\theta 4$	14°	15°	16°



COMMON DIMENSIONS

SYMBOL	MM		
	MIN	NOM	MAX
A	4.60	4.80	5.00
A1	1.40	1.50	1.60
A2	1.33	1.38	1.43
b	0.80	1.00	1.20
b1	2.80	3.00	3.20
b2	1.80	2.00	2.20
c	0.50	0.60	0.70
D	19.75	19.90	20.05
D1	13.70	13.90	14.10
D2	12.90 REF		
E	15.40	15.60	15.80
E1	13.40	13.60	13.80
E2	9.40	9.60	9.80
e	5.45 TYP		
G	4.60	4.80	5.00
H	40.30	40.50	40.70
H1	23.20	23.40	23.60
h	0.05	0.10	0.15
L	7.40 TYP		
L1	9.00 TYP		
L2	11.00 TYP		
L3	1.00 REF		
ϕP	6.90	7.00	7.10
$\phi P1$	3.20 REF		
$\phi P2$	3.50 REF		
$\phi P3$	1.40	1.50	1.60
R	0.50 REF		
Q	5.00 REF		
Q1	12.56	12.76	12.96
U	7.8	8	8.2
$\theta 1$	5°	7°	9°
$\theta 2$	1°	3°	5°
$\theta 3$	60° REF		



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