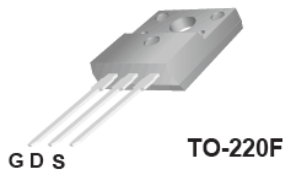


TSF65R950S1

650V 4.5A N-Channel SJ-MOSFET

General Description

Truesemi 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

- 700V @ $T_J = 150^\circ\text{C}$
- Typ. $R_{DS(on)} = 0.85\Omega$
- Ultra Low gate charge (typ. $Q_g = 15\text{nC}$)
- 100% avalanche tested



Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
V_{DSS}	Drain-Source Voltage	650	V
I_D	Drain Current -Continuous ($TC = 25^\circ\text{C}$)	4.5*	A
	-Continuous ($TC = 100^\circ\text{C}$)	2.9*	
I_{DM}	Drain Current – Pulsed (Note 1)	12*	A
V_{GSS}	Gate-Source voltage	± 30	V
E_{AS}	Single Pulsed Avalanche Energy (Note 2)	46	mJ
I_{AR}	Avalanche Current (Note 1)	1	A
E_{AR}	Repetitive Avalanche Energy (Note 1)	0.2	mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	15	V/ns
P_D	Power Dissipation ($TC = 25^\circ\text{C}$)	26	W
	-Derate above 25°C	0.3	
T_J, T_{STG}	Operating and Storage Temperature Range	-55 to +150	$^\circ\text{C}$
T_L	Maximum Lead Temperature for Soldering Purpose, 1/8" from Case for 5 Seconds	300	$^\circ\text{C}$

* Drain current limited by maximum junction temperature.

Thermal Characteristics

Symbol	Parameter	Value	Unit
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	4.9	$^\circ\text{C/W}$
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink Typ.	--	$^\circ\text{C/W}$
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	80	$^\circ\text{C/W}$

Electrical Characteristics TC = 25 °C unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Off Characteristics						
BV_{DSS}	Drain-Source Breakdown Voltage	$V_{GS} = 0V, I_D = 250\mu A, T_J = 25^\circ C$	650	--	--	V
		$V_{GS} = 0V, I_D = 250\mu A, T_J = 150^\circ C$	--	700	--	V
$\Delta BV_{DSS} / \Delta T_J$	Breakdown Voltage Temperature Coefficient	$I_D = 250\mu A$, Referenced to 25 °C	--	0.6	--	V/°C
I_{DSS}	Zero Gate Voltage Drain Current	$V_{DS} = 650V, V_{GS} = 0V, -T_J = 125^\circ C$	--	-- 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	$V_{DS} = V_{GS}, I_D = 250\mu A$	2.5	3.5	4.5	V
$R_{DS(on)}$	Static Drain-Source On-Resistance	$V_{GS} = 10V, I_D = 2.5A$	--	0.85	0.95	Ω
g_{FS}	Forward Trans conductance	$V_{DS} = 40V, I_D = 2.5A$ (Note 4)	--	8	--	S
R_g	Gate resistance	f=1MHz, open drain	--	3.5	--	Ω
Dynamic Characteristics						
C_{iss}	Input Capacitance	$V_{DS} = 25V, V_{GS} = 0V, f = 1.0MHz$	--	320	--	pF
C_{oss}	Output Capacitance		--	75	--	pF
C_{rss}	Reverse Transfer Capacitance		--	5	--	pF
Switching Characteristics						
$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 400V, I_D = 2.5A, R_G = 20\Omega$ (Note 4, 5)	--	10	--	ns
t_r	Turn-On Rise Time		--	8	--	ns
$t_{d(off)}$	Turn-Off Delay Time		--	60	--	ns
t_f	Turn-Off Fall Time		--	13	--	ns
Q_g	Total Gate Charge	$V_{DS} = 480V, I_D = 2.5A, V_{GS} = 10V$ (Note 4, 5)	--	15	--	nC
Q_{gs}	Gate-Source Charge		--	3	--	nC
Q_{gd}	Gate-Drain Charge		--	6	--	nC
Drain-Source Diode Characteristics and Maximum Ratings						
I_S	Maximum Continuous Drain-Source Diode Forward Current		--	--	4.5	A
I_{SM}	Maximum Pulsed Drain-Source Diode Forward Current		--	--	16	A
V_{SD}	Drain-Source Diode Forward Voltage	$V_{GS} = 0V, I_F = 2.5A$	--	0.9	1.5	V
t_{rr}	Reverse Recovery Time	$V_{GS} = 0V, I_F = 2.5A, di_F/dt = 100A/\mu s$ (Note 4)	--	180	--	ns
Q_{rr}	Reverse Recovery Charge		--	1.5	--	μC

NOTES:

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. $I_{AS}=1A, V_{DD}=50V$, Starting $T_J=25^\circ C$
3. $I_{SD}\leq 4.5A, di/dt \leq 200A/\mu s, V_{DD} \leq BV_{DSS}$, Starting $T_J = 25^\circ C$
4. Pulse Test: Pulse width $\leq 300\mu s$, Duty Cycle $\leq 2\%$
5. Essentially Independent of Operating Temperature Typical Characteristics

Typical Performance Characteristics

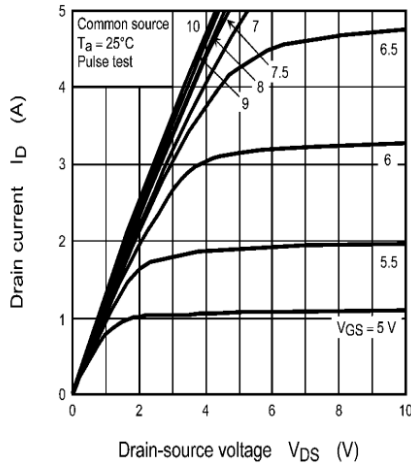


Figure 1: On-Region Characteristics@25°C

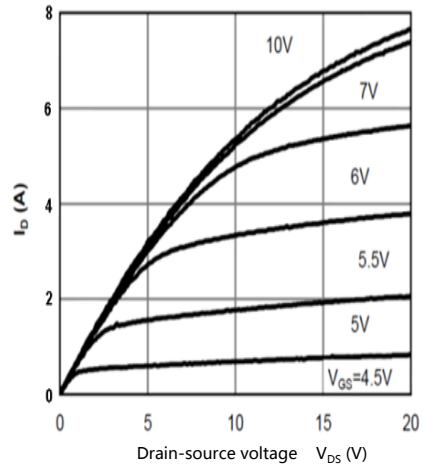


Figure 2: On-Region Characteristics@125°C

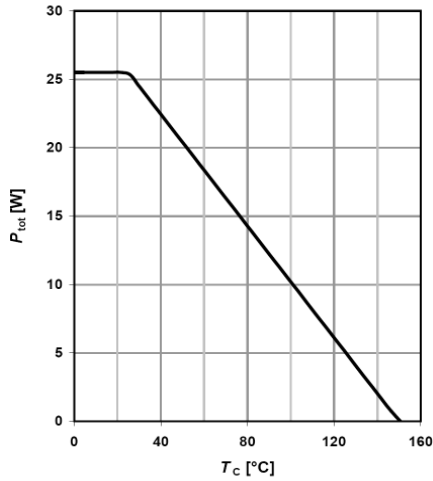


Figure 3: Power Dissipation

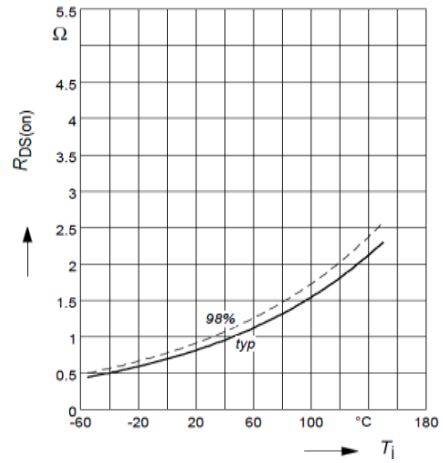


Figure 4: On-Resistance vs. Junction Temperature

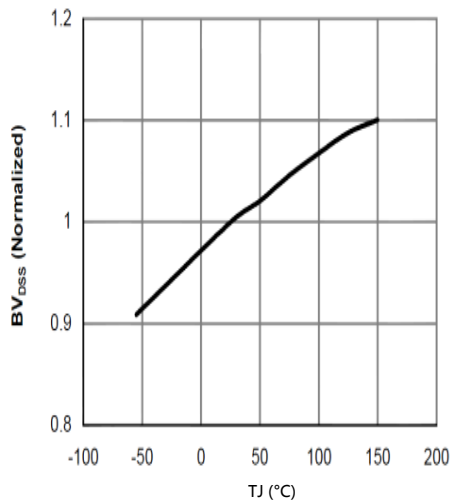


Figure 5: Break Down vs. Junction Temperature

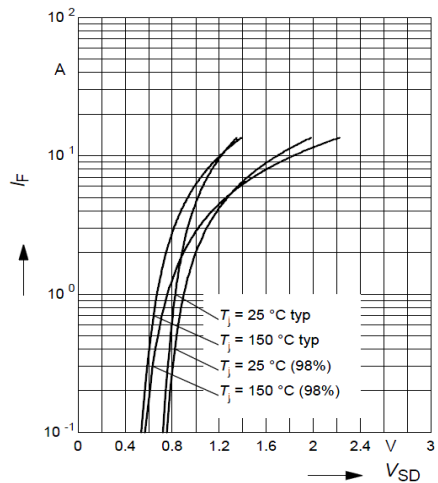


Figure 6: Body-Diode Characteristics

Typical Performance Characteristics

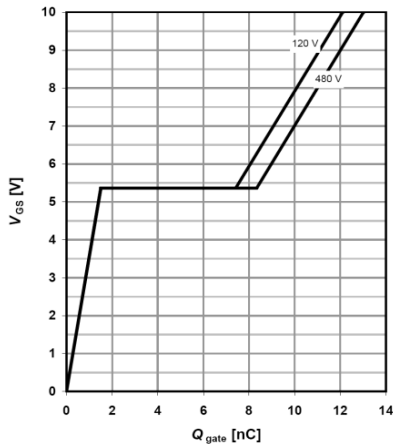


Figure 7: Gate-Charge Characteristics

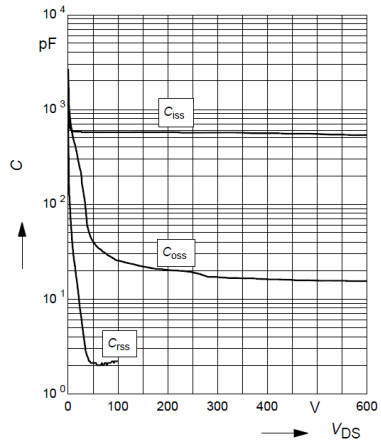


Figure 8: Capacitance Characteristics

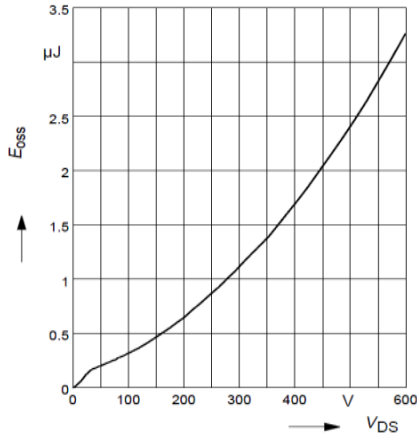


Figure 9: C_{oss} stored Energy

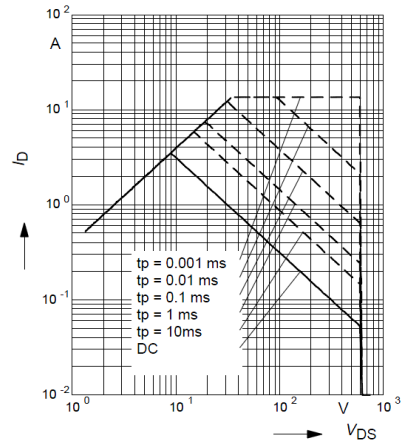


Figure 10: Maximum Forward Biased Safe Operating Area $T_c=25\text{ }^\circ\text{C}$,

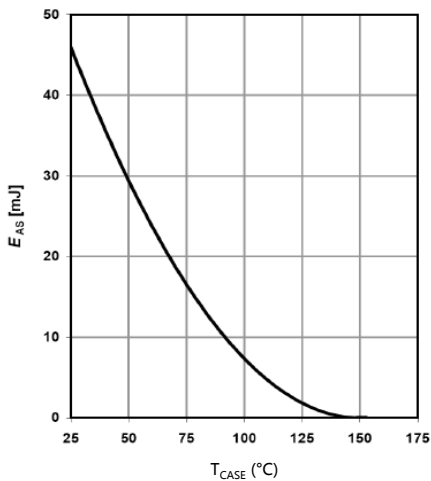


Figure 11: Avalanche energy

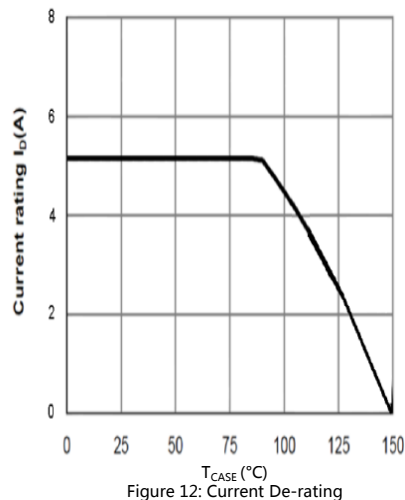


Figure 12: Current De-rating

Typical Performance Characteristics

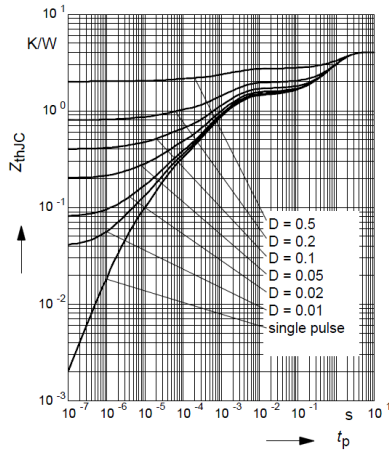


Figure 13: Single Pulse Power Rating Junction-to-Case

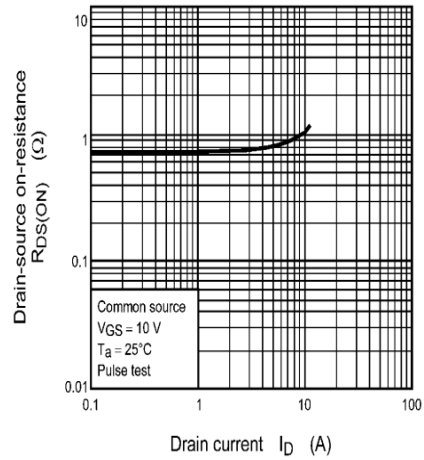


Figure 14 On-Resistance vs. Drain Current and Gate Voltage

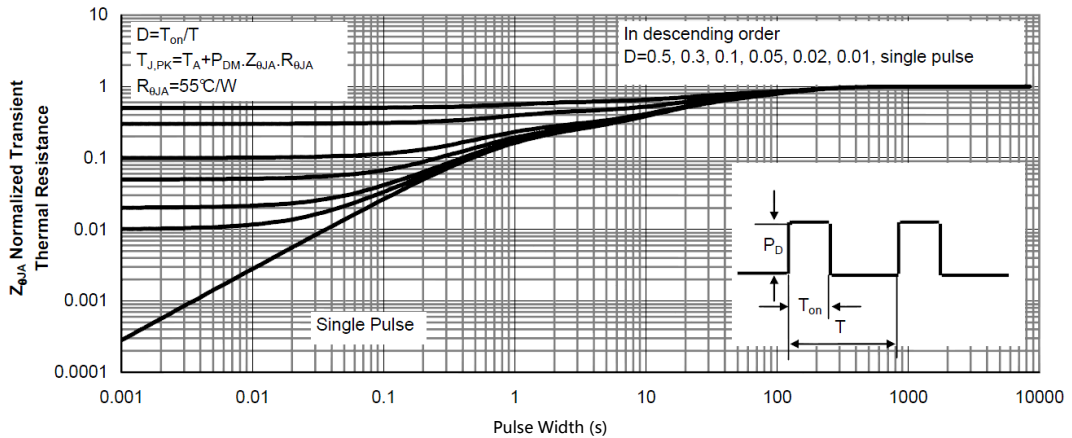


Figure 15: Normalized Maximum Transient Thermal Impedance

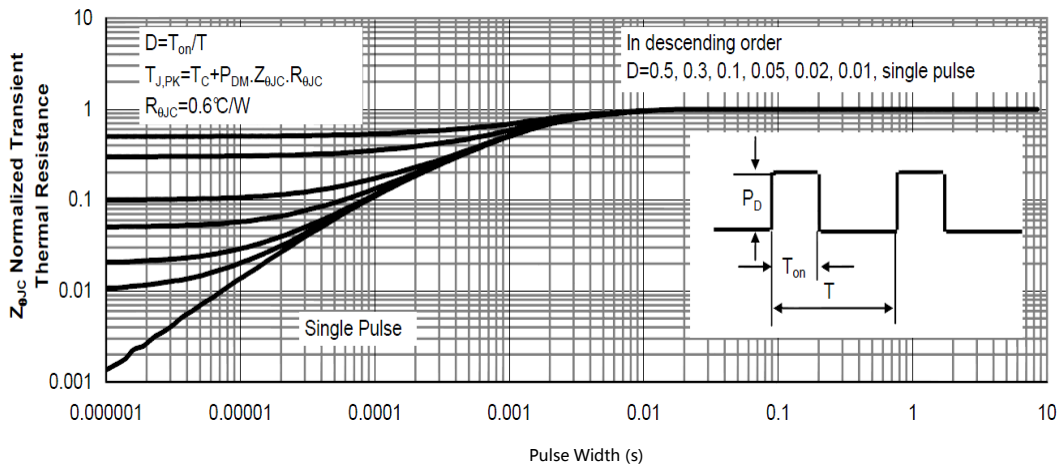
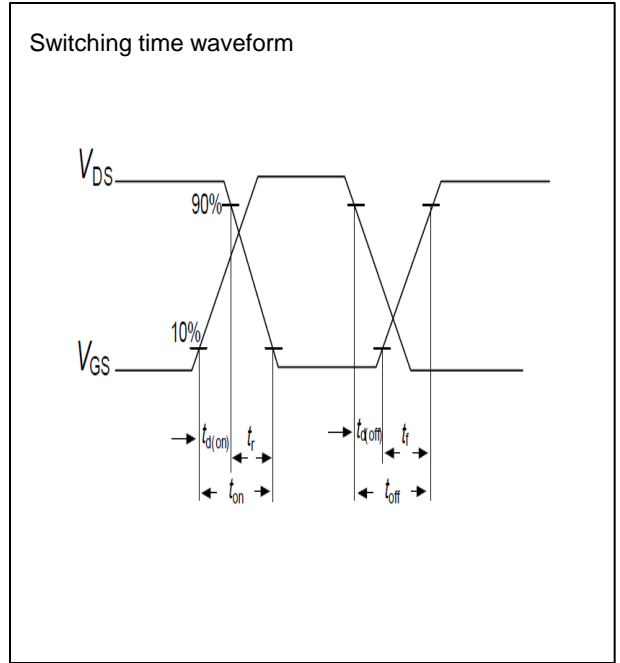
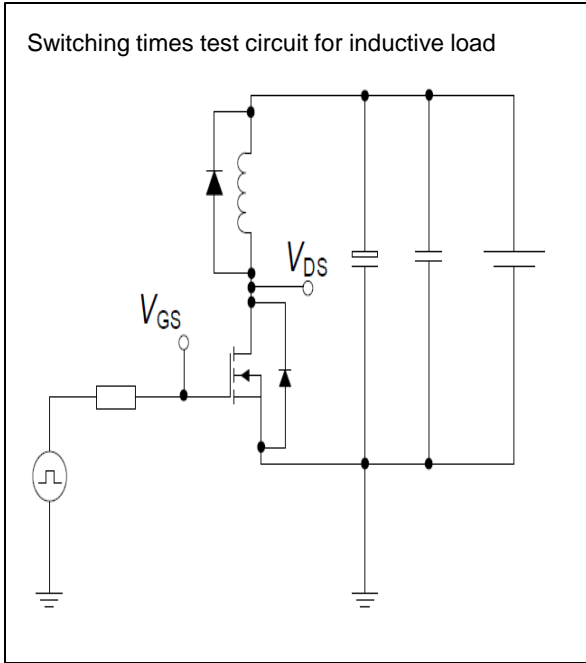


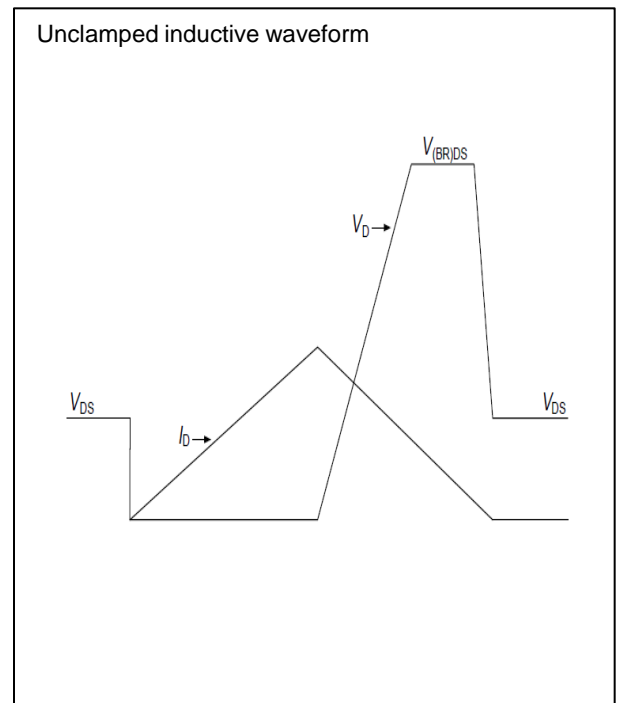
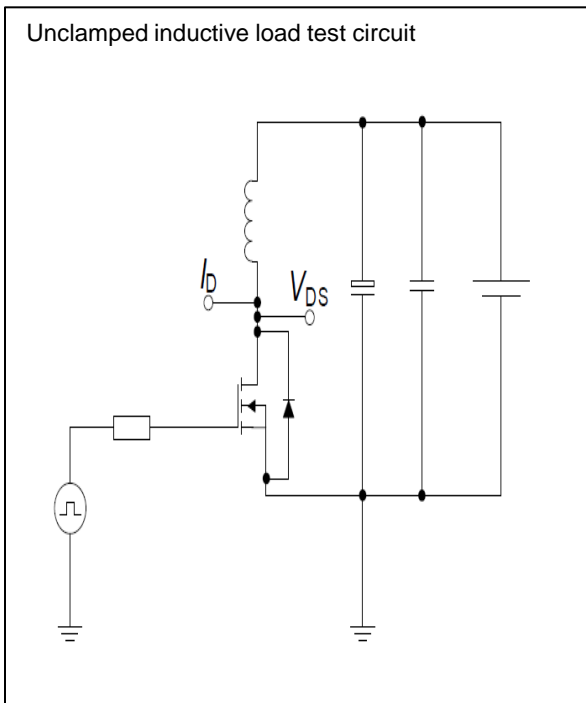
Figure 16: Normalized Maximum Transient Thermal Impedance

Test circuits

Switching times test circuit and waveform for inductive load

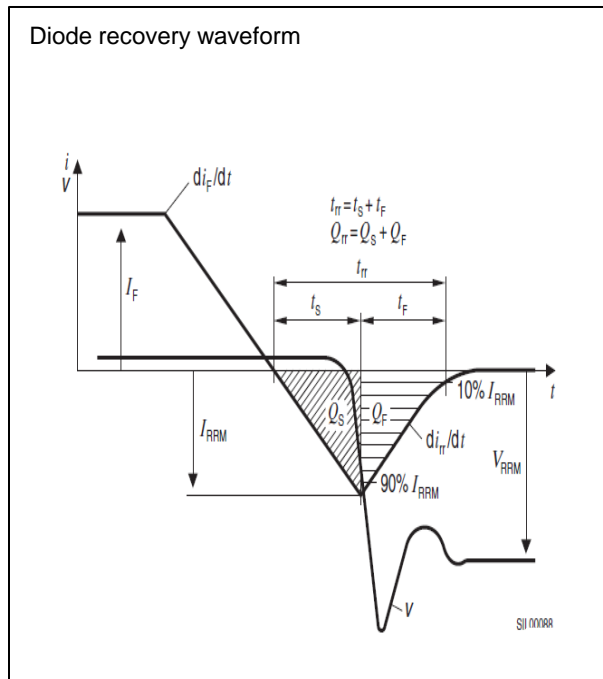
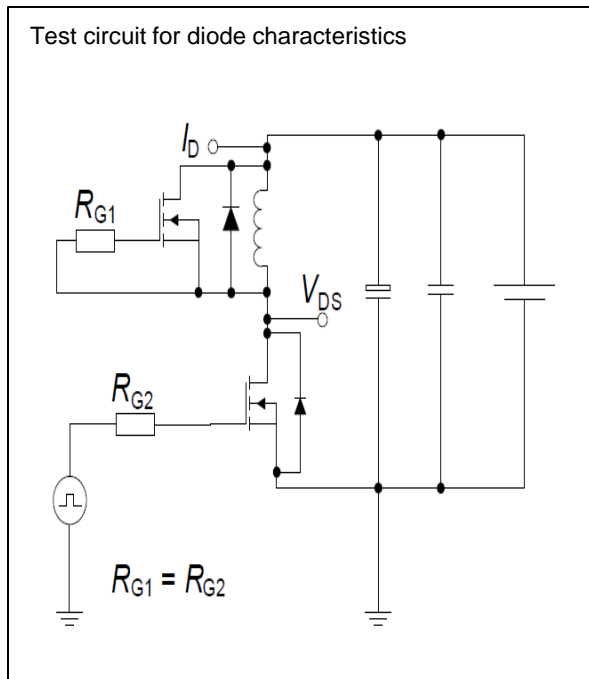


Unclamped inductive load test circuit and waveform

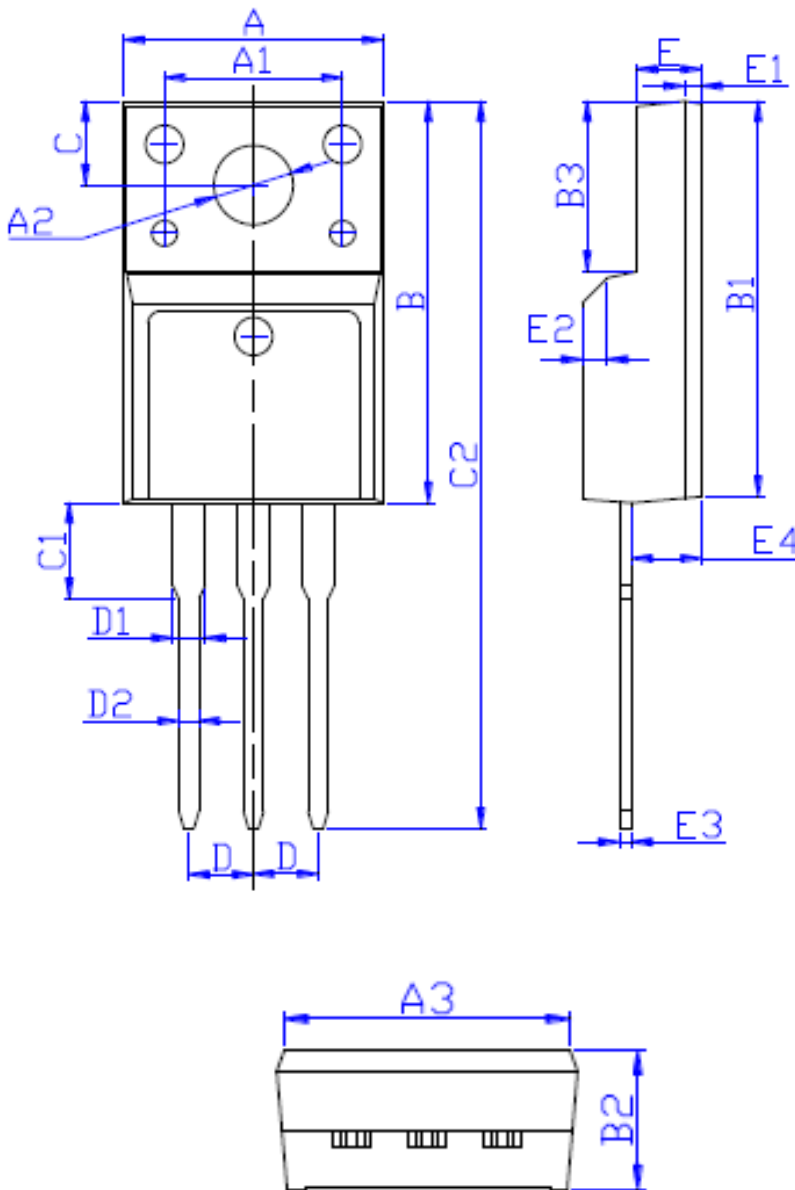


Test circuits

Test circuit and waveform for diode characteristics



Package Outline TO-220F



DIM	MILLIMETERS
A	10.16 ± 0.30
A1	7.00 ± 0.20
A2	3.12 ± 0.20
A3	9.70 ± 0.30
B	15.90 ± 0.50
B1	15.60 ± 0.50
B2	4.70 ± 0.30
B3	6.70 ± 0.30
C	3.30 ± 0.25
C1	3.25 ± 0.30
C2	28.70 ± 0.50
D	Typical 2.54
D1	1.47 (MAX)
D2	0.80 ± 0.20
E	2.55 ± 0.25
E1	0.70 ± 0.25
E2	1.0 × 45°
E3	0.50 ± 0.20
E4	2.75 ± 0.30