

## SWITCHING REGULATOR APPLICATIONS

### Features

- High Voltage :  $V_{DSS}=650V(\text{Min.})$
- Low  $C_{RSS}$  :  $C_{RSS}=16pF(\text{Typ.})$
- Low gate charge :  $Q_g=35nC(\text{Typ.})$
- Low  $R_{DS(on)}$  :  $R_{DS(on)}=0.85\Omega(\text{Max.})$

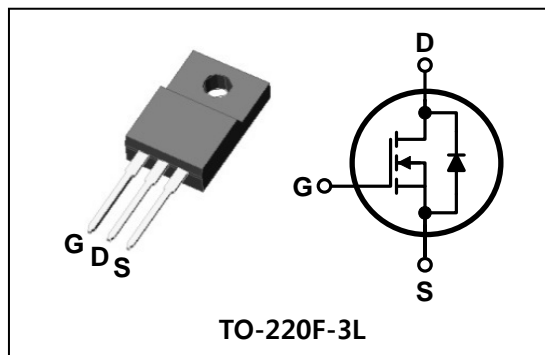
### Ordering Information

Type No.	Marking	Package Code
SMK0965F	SMK0965	TO-220F-3L
SMK0965F (HF)	SMK0965	TO-220F-3L

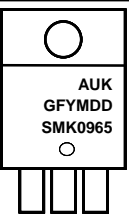
\* SMK0965F : Pb Free Product

\* SMK0965F (HF) : Halogen Free Product

### PIN Connection



### Marking Diagram

	Column 1 : Manufacturer
	Column 2 : Production Information e.g.) GFYMDD
	- . G : Option Code (H : Halogen Free) - . F : Factory Management Code - . YMDD : Date Code (Year, Month, Date)
	Column 3 : Device Code

### Absolute maximum ratings ( $T_C=25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Rating	Unit	
Drain-source voltage	$V_{DSS}$	650	V	
Gate-source voltage	$V_{GSS}$	$\pm 30$	V	
Drain current (DC) *	$I_D$	$T_C=25^\circ\text{C}$	9	A
		$T_C=100^\circ\text{C}$	5.5	A
Drain current (Pulsed) *	$I_{DM}$	36	A	
Power dissipation	$P_D$	40	W	
Avalanche current (Single) ②	$I_{AS}$	9	A	
Single pulsed avalanche energy ②	$E_{AS}$	250	mJ	
Avalanche current (Repetitive) ①	$I_{AR}$	9	A	
Repetitive avalanche energy ①	$E_{AR}$	11.6	mJ	
Junction temperature	$T_J$	150	$^\circ\text{C}$	
Storage temperature range	$T_{stg}$	-55~150		

\* Limited by maximum junction temperature

Characteristic	Symbol	Typ.	Max.	Unit	
Thermal resistance	Junction-case	$R_{th(J-C)}$	-	3.1	$^\circ\text{C/W}$
	Junction-ambient	$R_{th(J-A)}$	-	62.5	

**Electrical Characteristics** ( $T_C=25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Drain-source breakdown voltage	$BV_{DSS}$	$I_D=250\mu\text{A}$ , $V_{GS}=0\text{V}$	650	-	-	V
Gate threshold voltage	$V_{GS(th)}$	$I_D=250\mu\text{A}$ , $V_{DS}=V_{GS}$	2.0	-	4.0	V
Drain-source cut-off current	$I_{DSS}$	$V_{DS}=650\text{V}$ , $V_{GS}=0\text{V}$	-	-	1	$\mu\text{A}$
Gate leakage current	$I_{GSS}$	$V_{DS}=0\text{V}$ , $V_{GS}=\pm 30\text{V}$	-	-	$\pm 100$	nA
Drain-source on-resistance ④	$R_{DS(on)}$	$V_{GS}=10\text{V}$ , $I_D=4.5\text{A}$	-	0.72	0.85	$\Omega$
Forward transfer conductance ④	$g_{fs}$	$V_{DS}=10\text{V}$ , $I_D=4.5\text{A}$	-	11	-	S
Input capacitance	$C_{iss}$	$V_{GS}=0\text{V}$ , $V_{DS}=25\text{V}$ $f=1\text{MHz}$	-	2040	2550	pF
Output capacitance	$C_{oss}$		-	153	192	
Reverse transfer capacitance	$C_{rss}$		-	16	20	
Turn-on delay time	$t_{d(on)}$	$V_{DD}=300\text{V}$ , $I_D=9\text{A}$ $R_G=25\Omega$	-	23	-	ns
Rise time	$t_r$		-	69	-	
Turn-off delay time	$t_{d(off)}$		-	144	-	
Fall time	$t_f$		-	77	-	
Total gate charge	$Q_g$	$V_{DS}=520\text{V}$ , $V_{GS}=10\text{V}$ $I_D=9\text{A}$	-	35	57	nC
Gate-source charge	$Q_{gs}$		-	10	-	
Gate-drain charge	$Q_{gd}$		-	9	-	

**Source-Drain Diode Ratings and Characteristics** ( $T_C=25^\circ\text{C}$  unless otherwise noted)

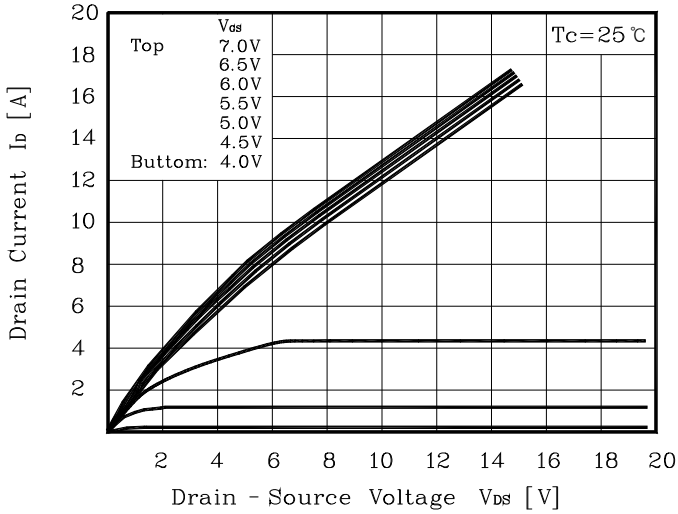
Characteristic	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Source current (DC)	$I_S$	Integral reverse diode in the MOSFET	-	-	9	A
Source current (Pulsed) ①	$I_{SM}$		-	-	36	
Forward voltage ④	$V_{SD}$	$V_{GS}=0\text{V}$ , $I_S=9\text{A}$	-	-	1.4	V
Reverse recovery time	$t_{rr}$	$I_S=9\text{A}$ , $V_{GS}=0\text{V}$ $dI_F/dt=100\text{A}/\mu\text{s}$	-	420	-	ns
Reverse recovery charge	$Q_{rr}$		-	4.2	-	$\mu\text{C}$

Note ;

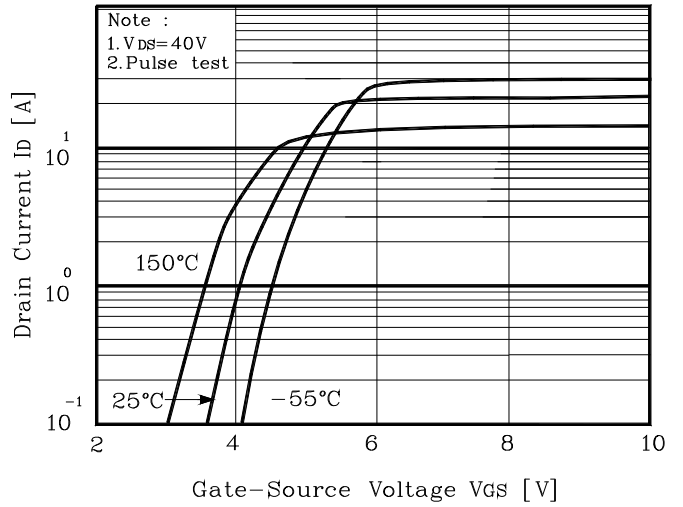
- ① Repetitive rating : Pulse width limited by maximum junction temperature
- ②  $L=5.7\text{mH}$ ,  $I_{AS}=9\text{A}$ ,  $V_{DD}=50\text{V}$ ,  $R_G=25\Omega$ , Starting  $T_J=25^\circ\text{C}$
- ③ Pulse Test : Pulse width $\leq 300\mu\text{s}$ , Duty cycle $\leq 2\%$
- ④ Essentially independent of operating temperature

## Electrical Characteristic Curves

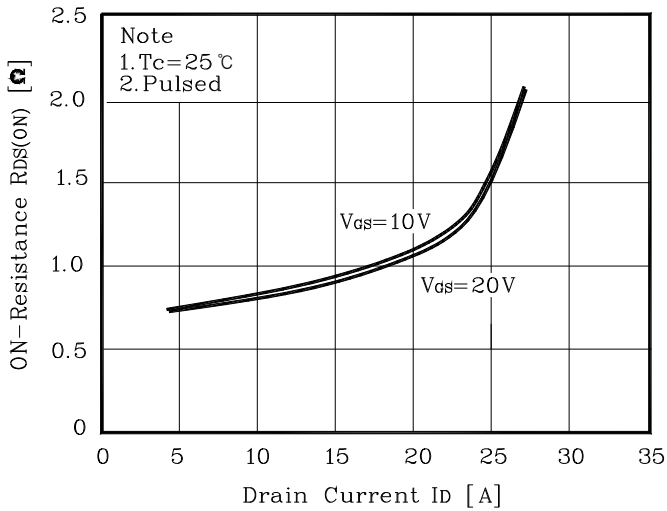
**Fig. 1  $I_D - V_{DS}$**



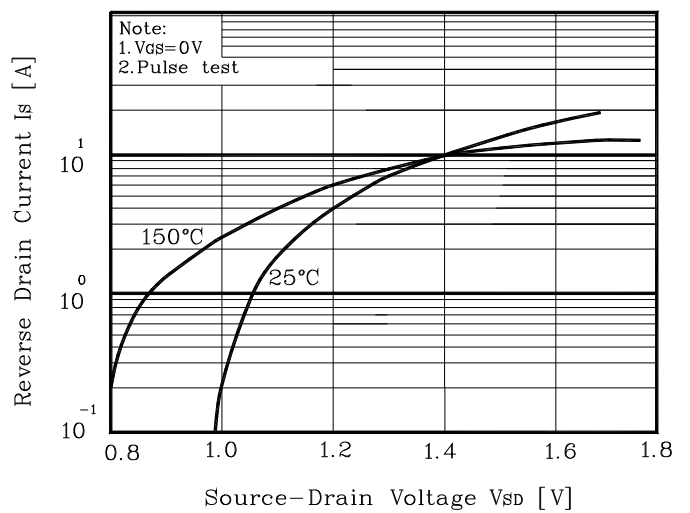
**Fig. 2  $I_D - V_{GS}$**



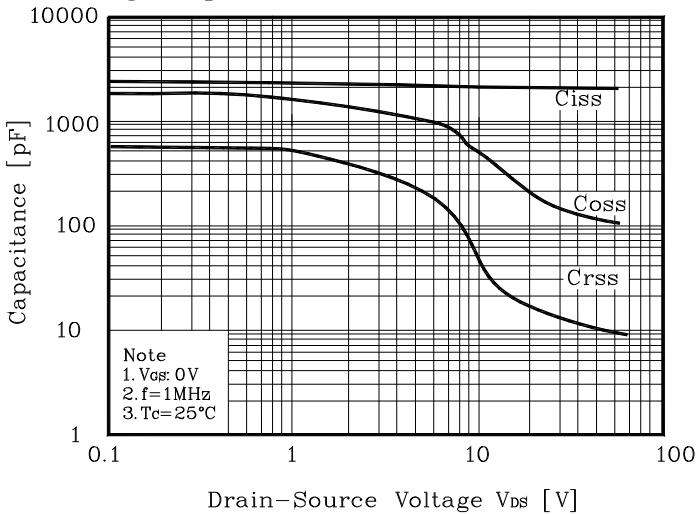
**Fig. 3  $R_{DS(on)} - I_D$**



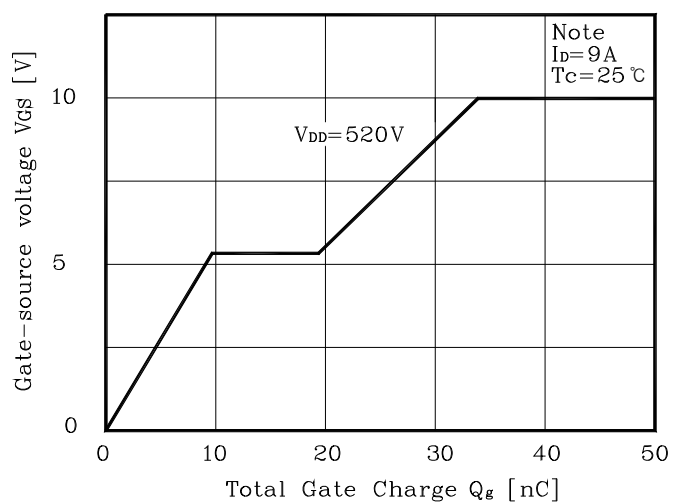
**Fig. 4  $I_S - V_{SD}$**



**Fig. 5 Capacitance -  $V_{DS}$**

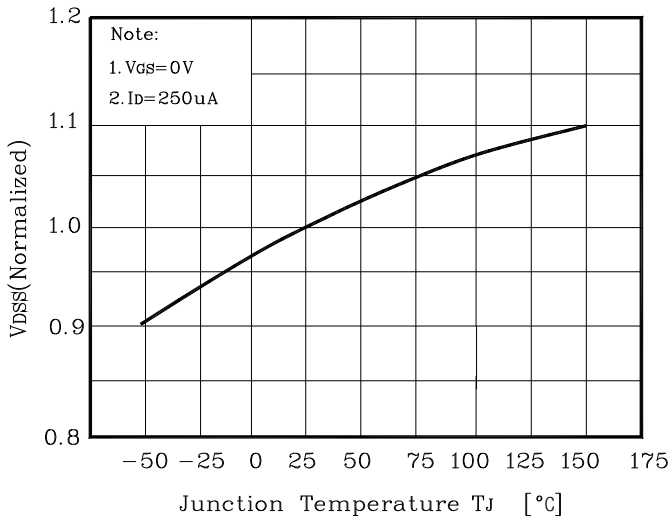


**Fig. 6  $V_{GS} - Q_G$**

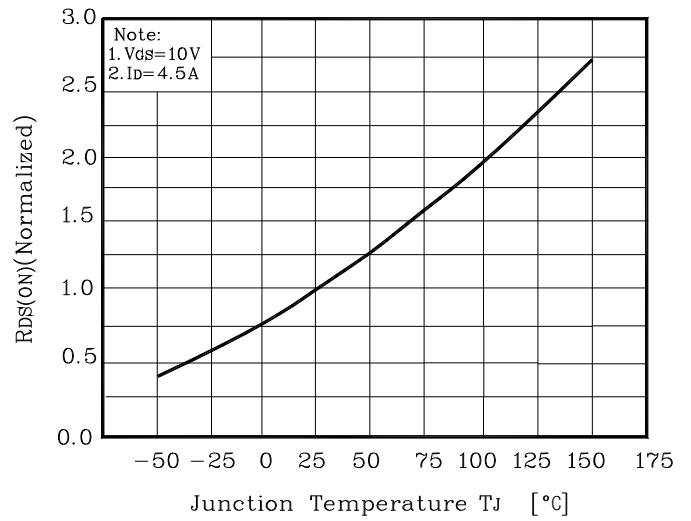


## Electrical Characteristic Curves

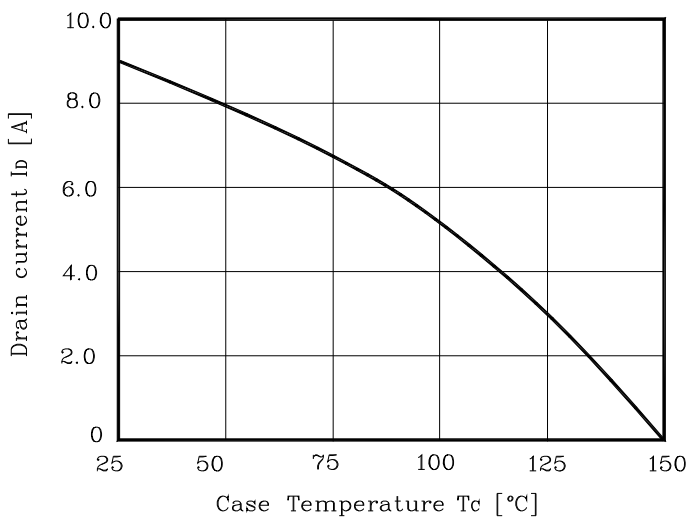
**Fig. 7  $V_{DS}$  -  $T_J$**



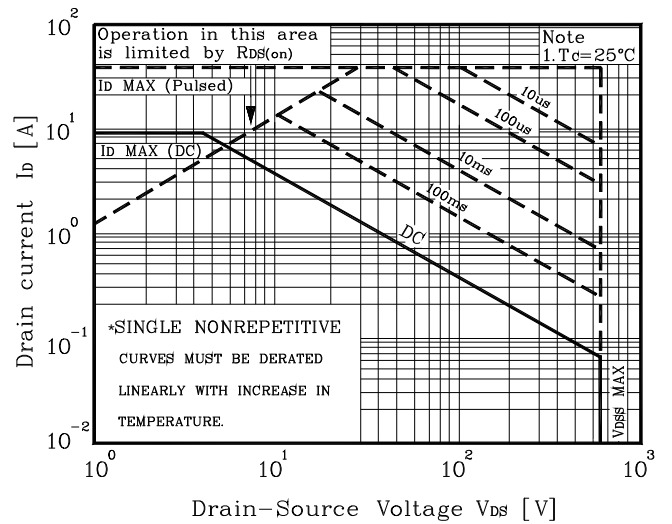
**Fig.8  $R_{DS(on)}$  -  $T_J$**



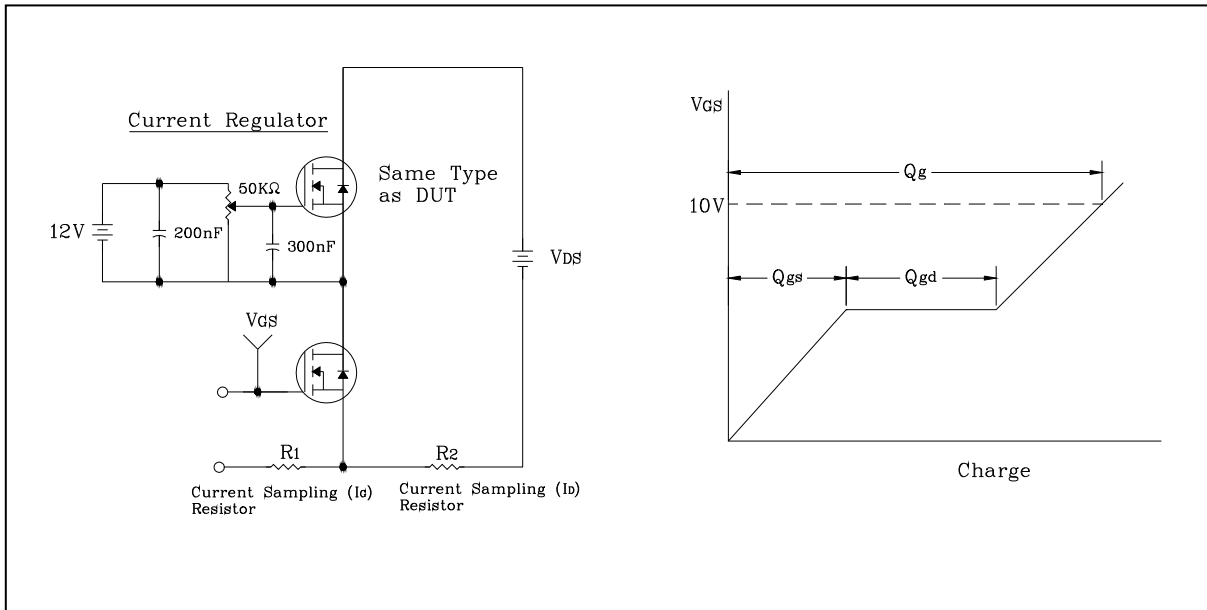
**Fig. 9  $I_D$  -  $T_C$**



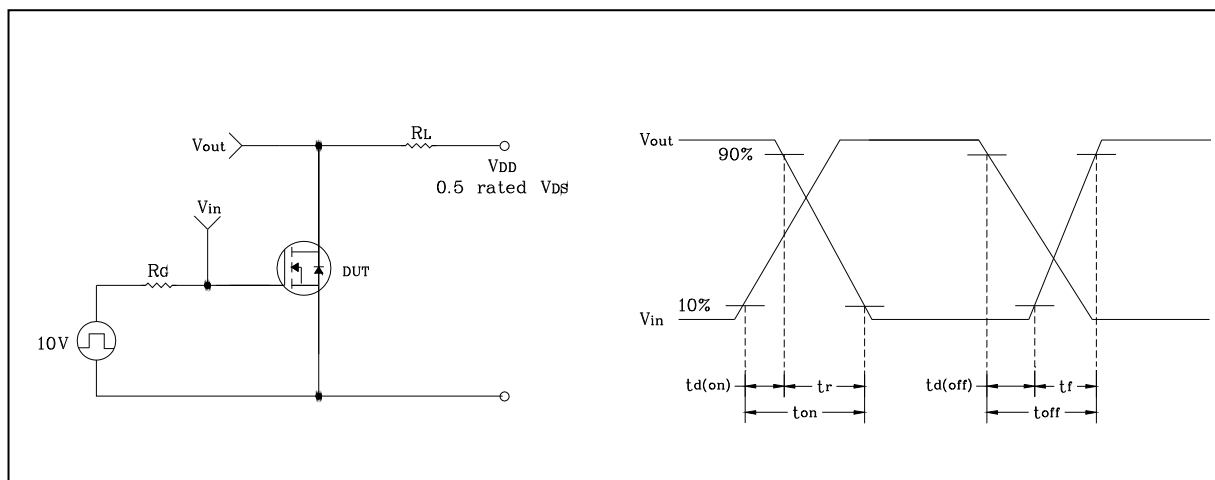
**Fig. 10 Safe Operating Area**



**Fig. 11 Gate Charge Test Circuit & Waveform**



**Fig. 12 Resistive Switching Test Circuit & Waveform**



**Fig. 13 E<sub>AS</sub> Test Circuit & Waveform**

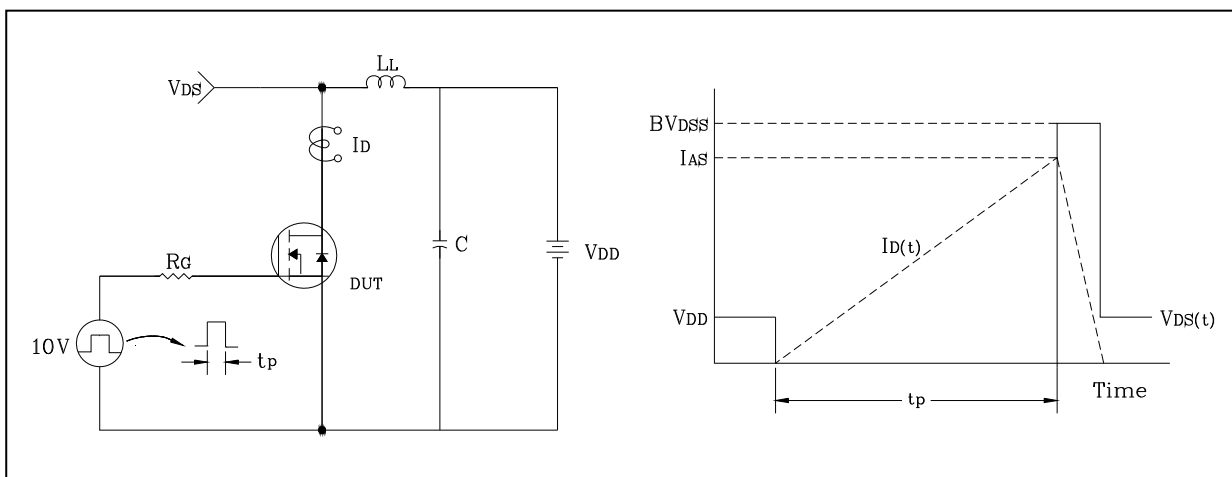
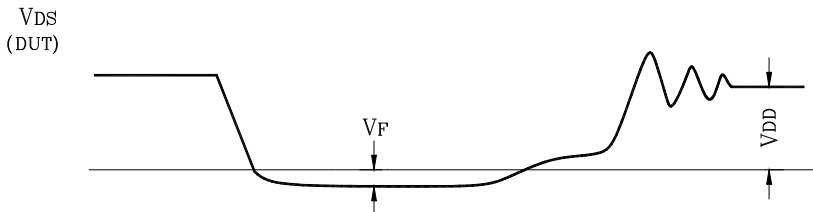
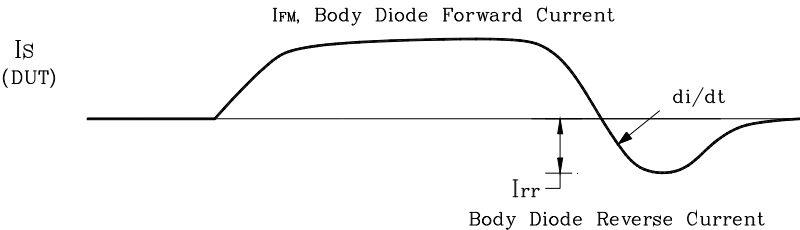
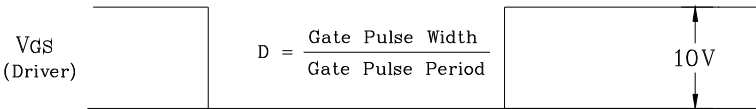
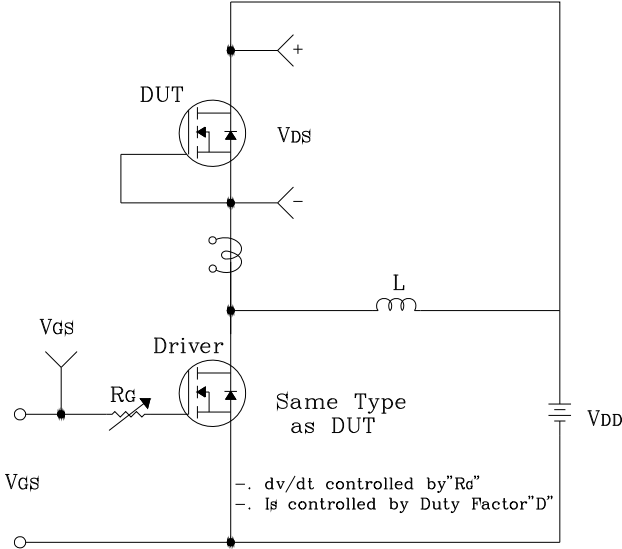
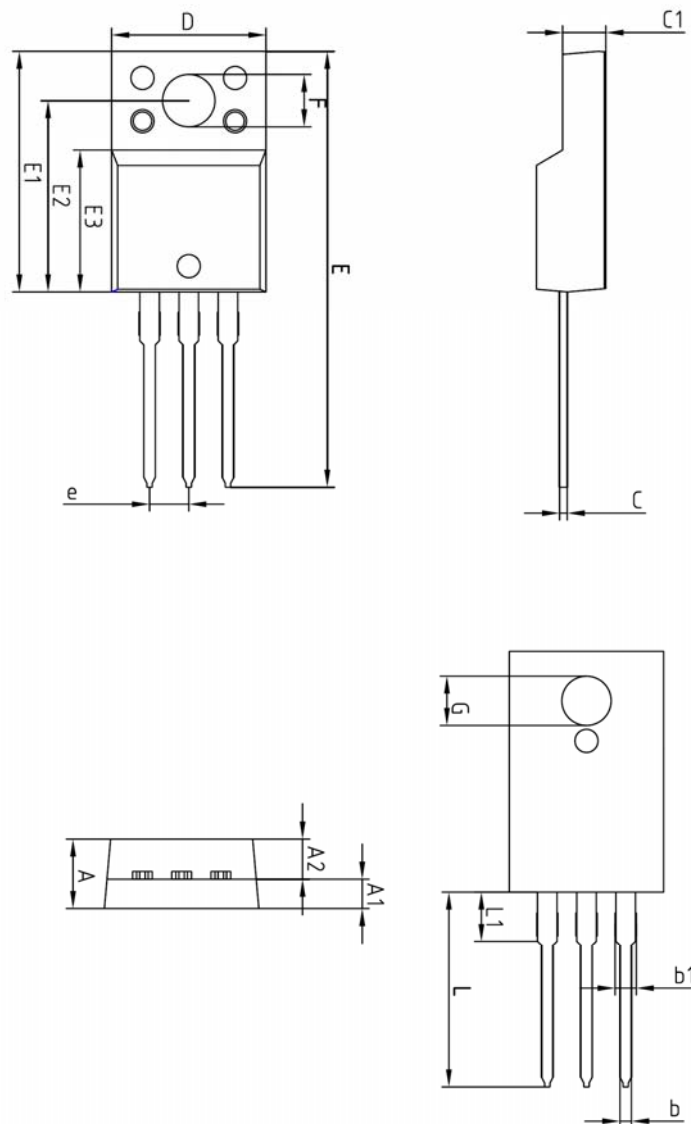


Fig. 14 Diode Reverse Recovery Time Test Circuit & Waveform



## Outline Dimension

unit: mm



SYMBOL	MILLIMETERS			NOTE
	MINIMUM	NOMINAL	MAXIMUM	
A	-	-	4.60	
A1	2.45	2.50	2.55	
A2	1.95	2.00	2.05	
b	0.65	0.75	0.85	
b1	1.07	1.27	1.47	
C	0.40	0.50	0.60	
C1	2.70	2.80	2.90	
D	9.90	10.00	10.10	
E	28.00	-	28.60	
E1	15.50	15.60	15.70	
E2	12.30	12.40	12.50	
E3	9.15	9.20	9.25	
F	3.30	3.40	3.50	
G	3.10	3.20	3.30	
e	2.54 BSC			
L	12.40	-	13.00	
L1	3.46 BSC			

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