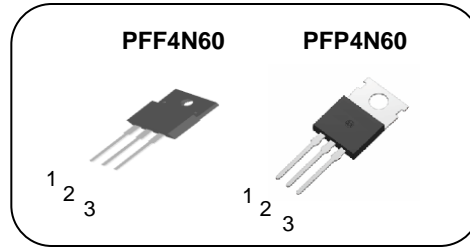


## N-channel MOSFET

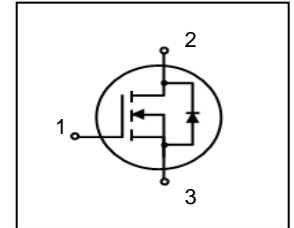
### Features

- High ruggedness
- $R_{DS(ON)}$  (Max 2.3  $\Omega$ ) @  $V_{GS}=10V$
- Gate Charge (Typ. 27nC)
- Improved dv/dt Capability
- 100% Avalanche Tested



1. Gate 2. Drain 3. Source

**$BV_{DSS}$  : 600V**  
 **$I_D$  : 4.5A**  
 **$R_{DS(ON)}$  : 2.3ohm**



### General Description

These N-channel enhancement mode field effect power transistor is using Powergate semiconductor's advanced planar stripe, DMOS technology intended for off line switch mode power supply. Also, especially designed to minimize  $R_{DS(ON)}$  and high rugged avalanche characteristics. These devices are well suited for high efficiency switching Mode power supplies and active power factor correction.

### Absolute maximum ratings

Symbol	Parameter	Value		Unit
		PFP4N60	PFF4N60	
$V_{DSS}$	Drain to Source Voltage	600		V
$I_D$	Continuous Drain Current (@ $T_C=25^\circ C$ )	4.5	4.5*	A
	Continuous Drain Current (@ $T_C=100^\circ C$ )	2.6	2.6*	A
$I_{DM}$	Drain current pulsed (note 1)	16		A
$V_{GS}$	Gate to Source Voltage	$\pm 30$		V
$E_{AS}$	Single pulsed Avalanche Energy (note 2)	262		mJ
$E_{AR}$	Repetitive Avalanche Energy (note 1)	3.9		mJ
dv/dt	Peak diode Recovery dv/dt (note 3)	4.5		V/ns
$P_D$	Total power dissipation (@ $T_C=25^\circ C$ )	98	33*	W
	Derating Factor above 25°C	0.78	0.31	W/°C
$T_{STG}, T_J$	Operating Junction Temperature & Storage Temperature	-55 ~ + 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.

### Thermal characteristics

Symbol	Parameter	Value		Unit
		PFP4N60	PFF4N60	
$R_{thJC}$	Thermal resistance, Junction to case	1.28	3.8	°C/W
$R_{thCS}$	Thermal resistance, Case to Sink	0.5		°C/W
$R_{thJA}$	Thermal resistance, Junction to ambient	62.5		°C/W

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
<b>Off characteristics</b>						
$BV_{DSS}$	Drain to source breakdown voltage	$V_{GS}=0V, I_D=250\mu A$	600	-	-	V
$\Delta BV_{DSS} / \Delta T_J$	Breakdown voltage temperature coefficient	$I_D=250\mu A$ , referenced to $25^\circ\text{C}$	-	0.68	-	$V/^\circ\text{C}$
$I_{DSS}$	Drain to source leakage current	$V_{DS}=600V, V_{GS}=0V$	-	-	50	$\mu A$
		$V_{DS}=480V, T_C=125^\circ\text{C}$	-	-	100	$\mu A$
$I_{GSS}$	Gate to source leakage current, forward	$V_{GS}=30V, V_{DS}=0V$	-	-	100	nA
	Gate to source leakage current, reverse	$V_{GS}=-30V, V_{DS}=0V$	-	-	-100	nA
<b>On characteristics</b>						
$V_{GS(TH)}$	Gate threshold voltage	$V_{DS}=V_{GS}, I_D=250\mu A$	3.0	-	5.0	V
$R_{DS(ON)}$	Drain to source on state resistance	$V_{GS}=10V, I_D = 2.0A$		2.05	2.3	$\Omega$
<b>Dynamic characteristics</b>						
$C_{iss}$	Input capacitance	$V_{GS}=0V, V_{DS}=25V, f=1\text{MHz}$		570	740	pF
$C_{oss}$	Output capacitance			64	83	
$C_{rss}$	Reverse transfer capacitance			14	18	
$t_{d(on)}$	Turn on delay time	$V_{DS}=300V, I_D=4.5A, R_G=25\Omega$		25	32	ns
$t_r$	Rising time			54	70	
$t_{d(off)}$	Turn off delay time			120	157	
$t_f$	Fall time			34	45	
$Q_g$	Total gate charge	$V_{DS}=480V, V_{GS}=10V, I_D=4.5A$		27	30	nC
$Q_{gs}$	Gate-source charge			2.8	-	
$Q_{gd}$	Gate-drain charge			8.7	-	

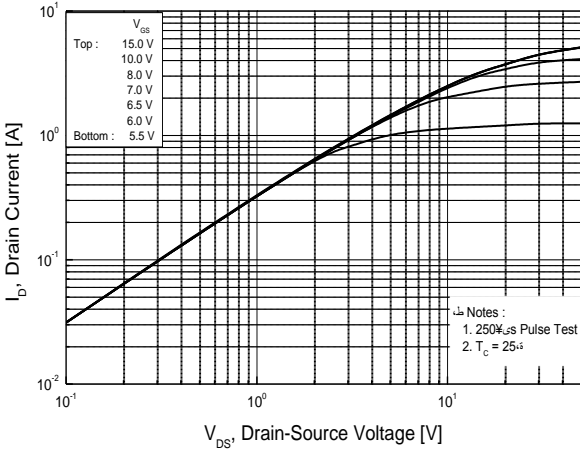
**Source to drain diode ratings characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_S$	Continuous source current	Integral reverse p-n Junction diode in the MOSFET	-	-	4.5	A
$I_{SM}$	Pulsed source current		-	-	16	A
$V_{SD}$	Diode forward voltage drop.	$I_S=4.5A, V_{GS}=0V$	-	-	1.4	V
$T_{rr}$	Reverse recovery time	$I_S=4.5A, V_{GS}=0V,$	-	560	-	ns
$Q_{rr}$	Breakdown voltage temperature	$dI_F/dt=100A/\mu s$	-	1.8	-	$\mu C$

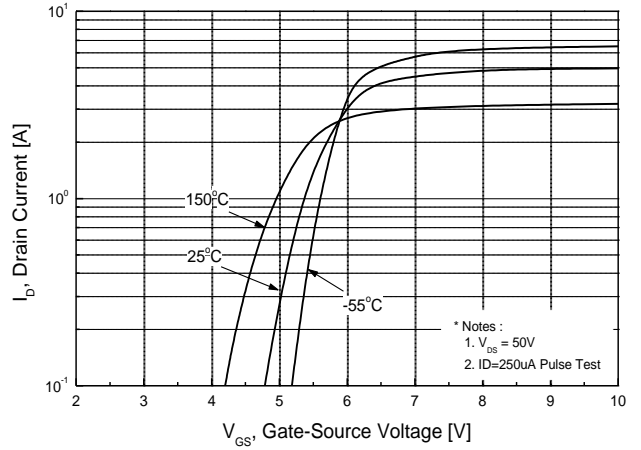
**\*. Notes**

1. Repetitive rating : pulse width limited by junction temperature.
2.  $L = 26\text{mH}, I_{AS} = 4.5A, V_{DD} = 50V, R_G=50\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 4.0A, di/dt = 300A/\mu s, V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$
4. Pulse Test : Pulse Width  $\leq 300\mu s$ , duty cycle  $\leq 2\%$
5. Essentially independent of operating temperature.

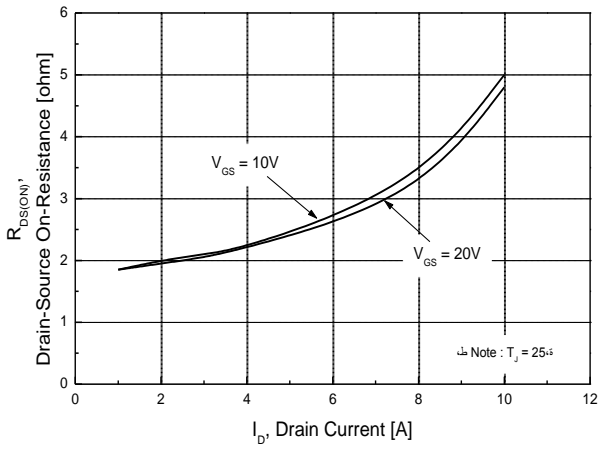
**Fig. 1. On-state characteristics**



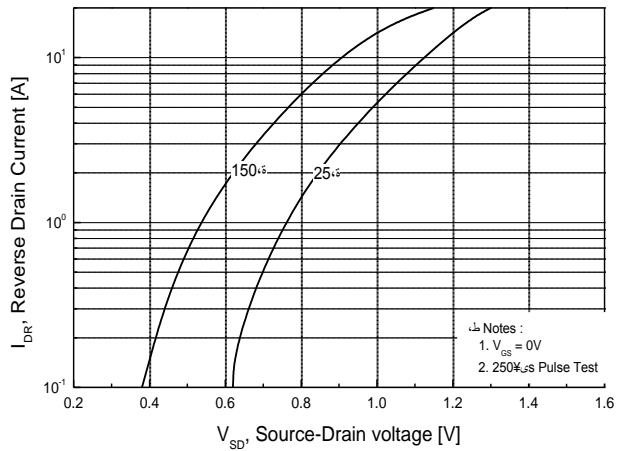
**Fig. 2. Transfer characteristics**



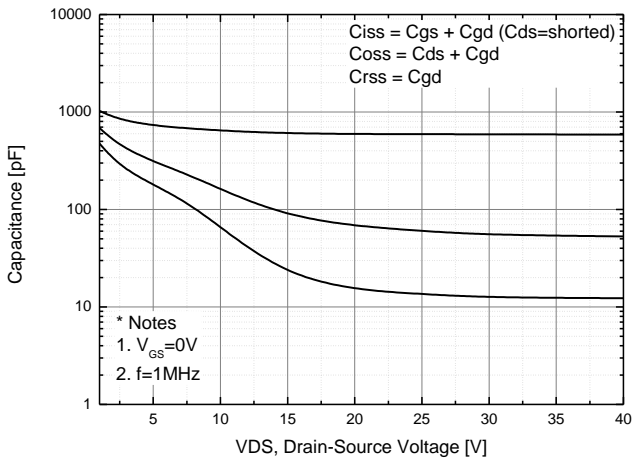
**Fig. 3. On-resistance variation vs. drain current and gate voltage**



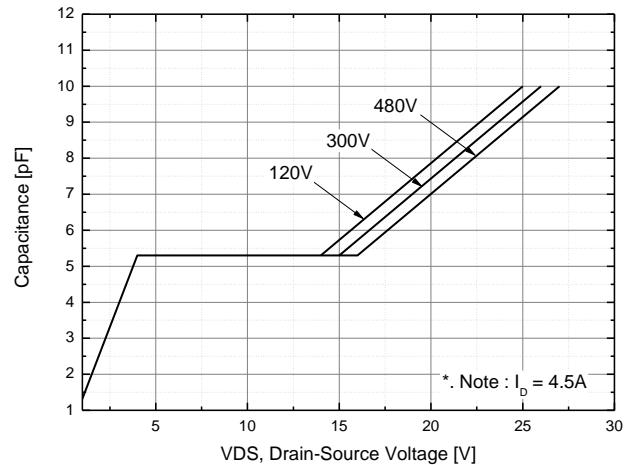
**Fig. 4. On state current vs. diode forward voltage**



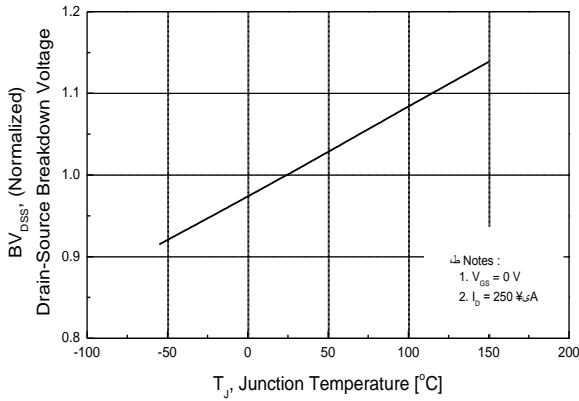
**Fig. 5. Capacitance characteristics (Non-Repetitive)**



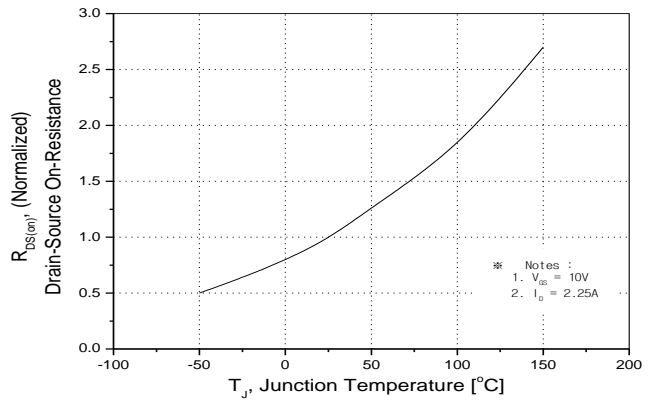
**Fig. 6. Gate charge characteristics**



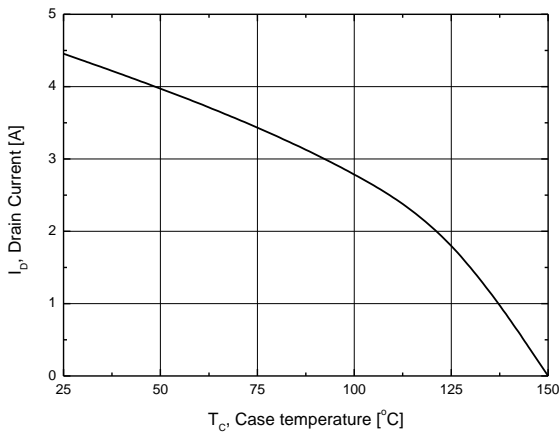
**Fig 7. Breakdown Voltage Variation vs. Junction Temperature**



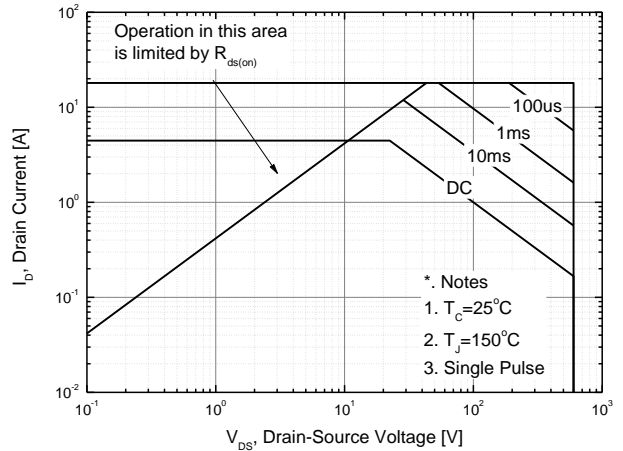
**Fig. 8. On resistance variation vs. junction temperature**



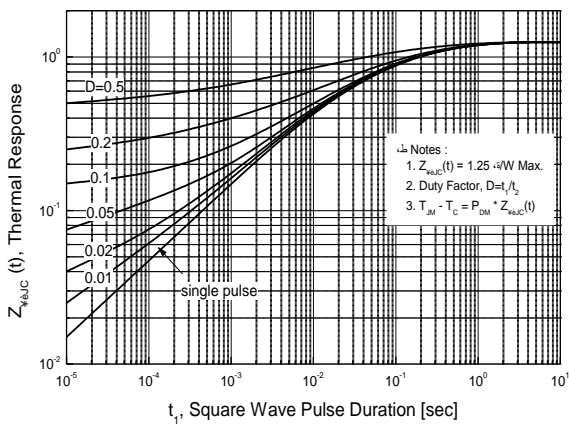
**Fig. 9. Maximum drain current vs. case temperature.**



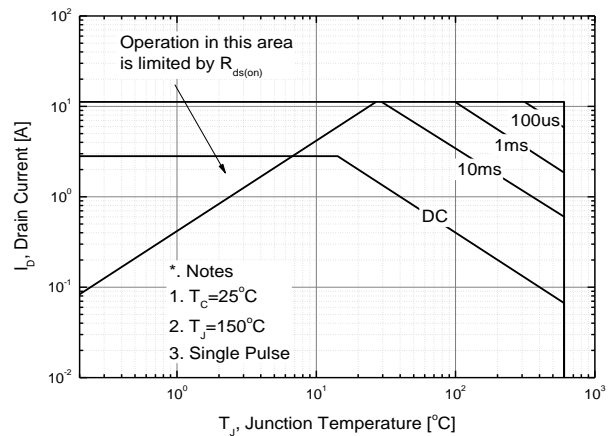
**Fig. 10. Maximum safe operating area (TFP4N60)**



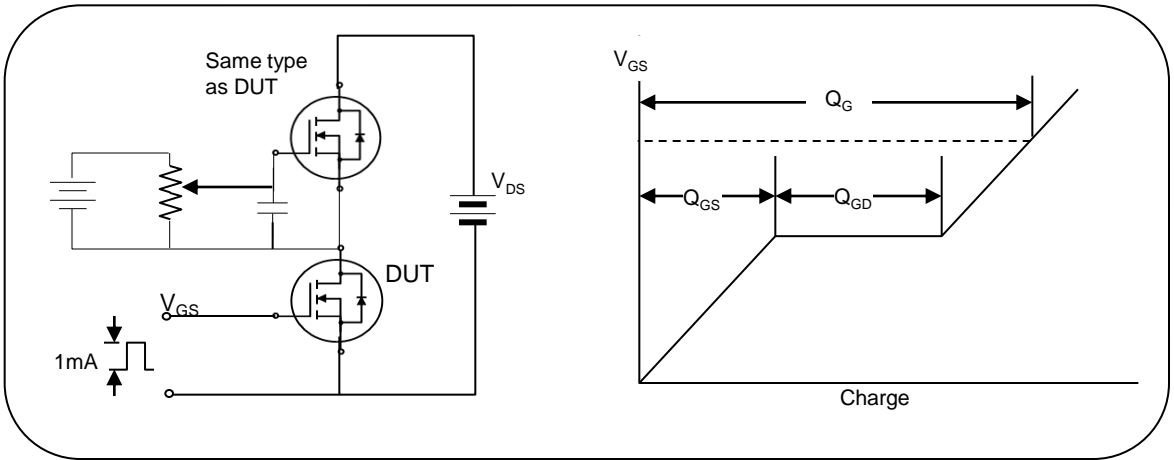
**Fig. 11. Transient thermal response curve**



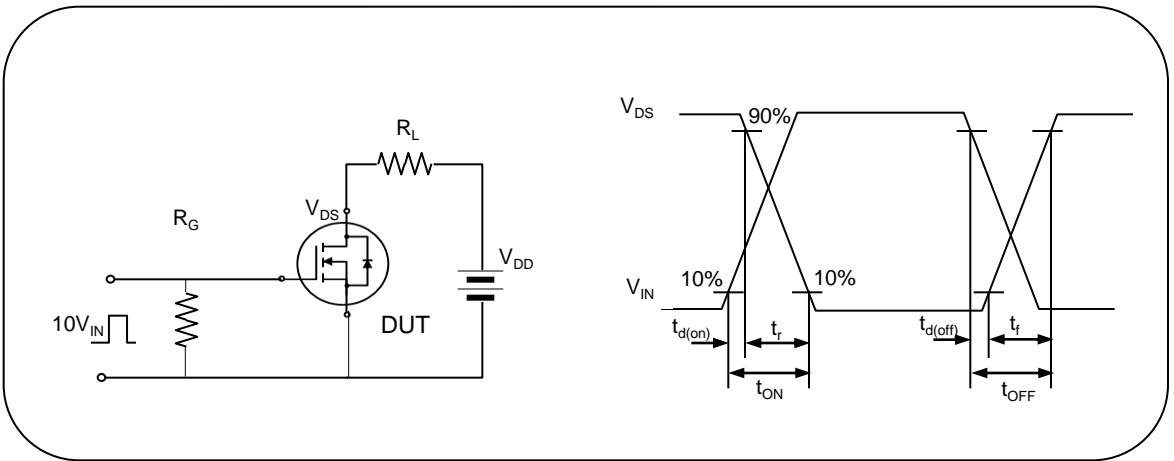
**Fig. 12. Maximum safe operating area(TFF4N60)**



**Fig. 12. Gate charge test circuit & waveform**



**Fig. 13. Switching time test circuit & waveform**



**Fig. 14. Unclamped Inductive switching test circuit & waveform**

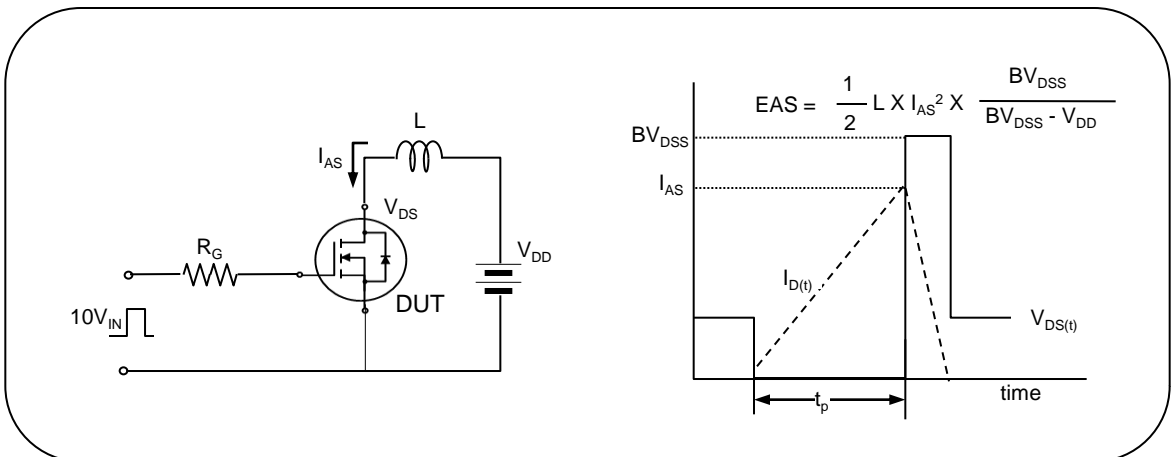
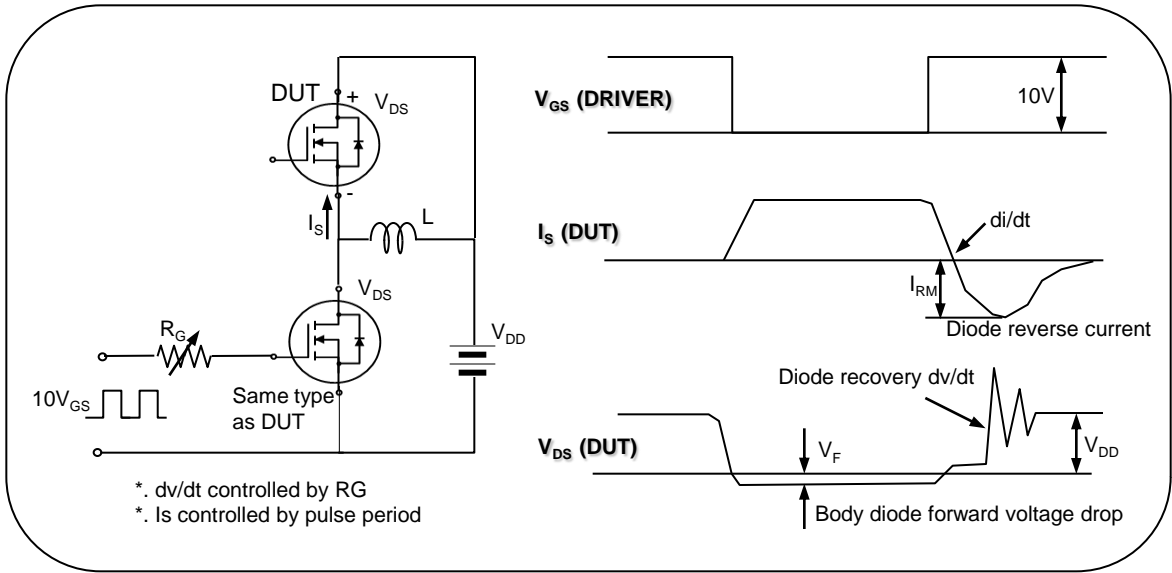
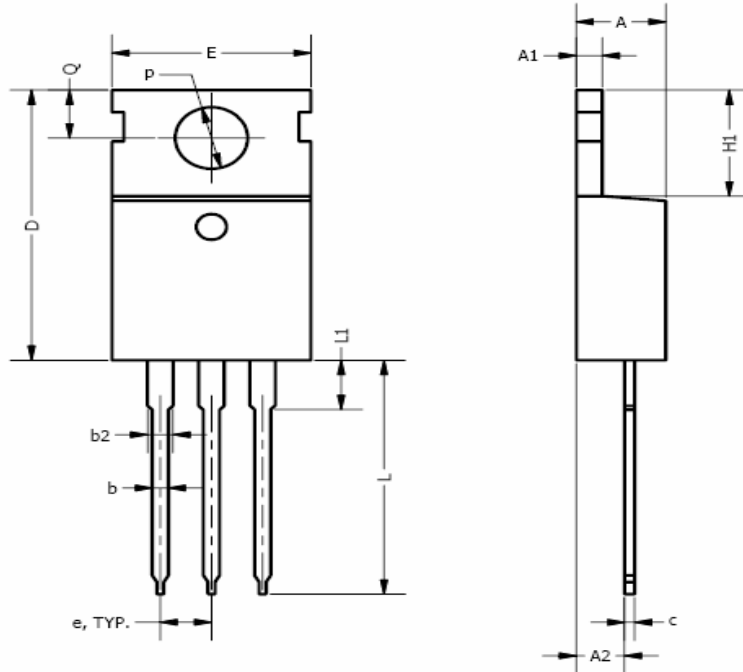


Fig. 15. Peak diode recovery dv/dt test circuit & waveform

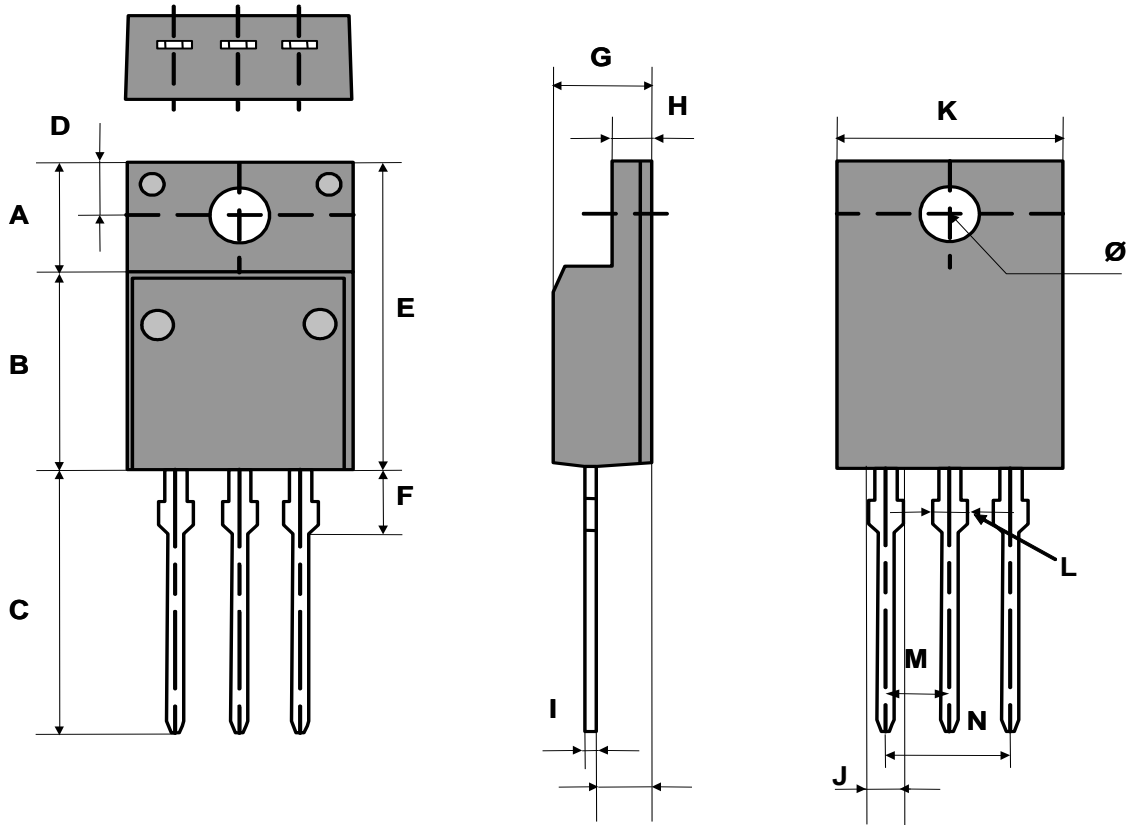


## TO-220 Package Dimension



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.14	0.19	3.56	4.83
A1	0.02	0.055	0.51	1.4
A2	0.08	0.115	2.03	2.92
b	0.015	0.04	0.38	1.02
b2	0.045	0.07	1.14	1.78
c	0.014	0.024	0.36	0.61
D	0.56	0.65	14.22	16.51
e	0.096	0.104	2.44	2.64
E	0.38	0.42	9.65	10.67
H1	0.23	0.27	5.84	6.86
L	0.5	0.58	12.7	14.73
L1	-	0.25	-	6.35
$\varnothing P$	0.139	0.161	3.53	4.09
Q	0.1	0.135	2.54	3.43

## TO-220F Package Dimension



DIMENSION		A	B	C	D	E	F	G	H
mm	Min	6.00	7.85	12.88	3.00	15.0	3.15	4.45	3.05
	Typ.	6.05	7.90	13.08	3.02	15.2	3.25	4.50	3.10
	Max	6.10	7.95	13.28	3.04	15.4	3.35	4.55	3.15

DIMENSION		I	J	K	L	M	N	Ø	
mm	Min	0.585	1.245	9.95	1.65	2.00	4.58	2.90	
	Typ.	0.595	1.250	10.00	1.66	2.05	4.60	2.95	
	Max	0.605	1.255	10.05	1.67	2.10	4.62	3.00	