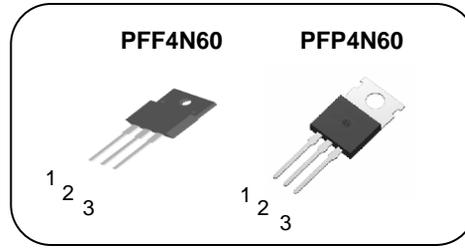


N-channel MOSFET

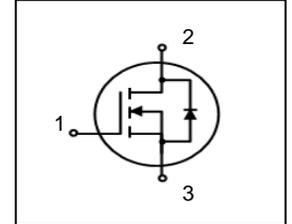
Features

- High ruggedness
- $R_{DS(ON)}$ (Max 2.3 Ω)@ $V_{GS}=10V$
- 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	± 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
Off characteristics						
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°C	-	0.68	-	$V/^\circ\text{C}$
I_{DSS}	Drain to source leakage current	$V_{DS}=600V, V_{GS}=0V$	-	-	50	μA
		$V_{DS}=480V, T_C=125^\circ\text{C}$	-	-	100	μA
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
On characteristics						
$V_{GS(TH)}$	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	Ω
Dynamic characteristics						
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	-	μC

※. 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

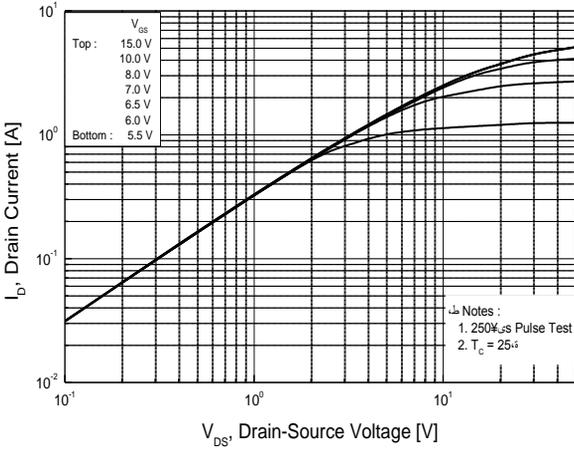


Fig. 2. Transfer characteristics

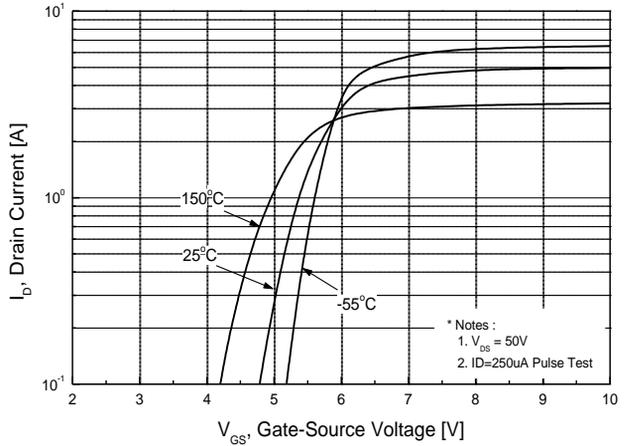


Fig. 3. On-resistance variation vs. drain current and gate voltage

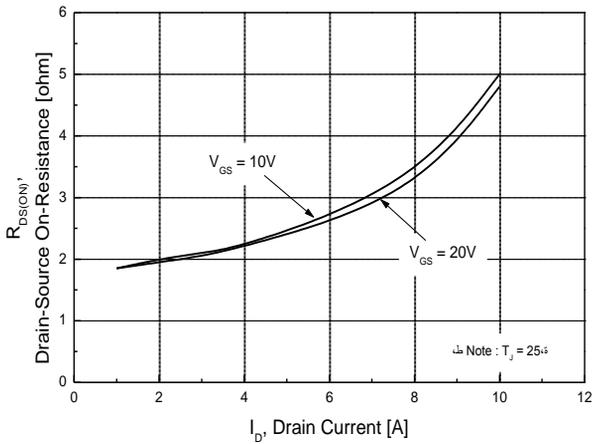


Fig. 4. On state current vs. diode forward voltage

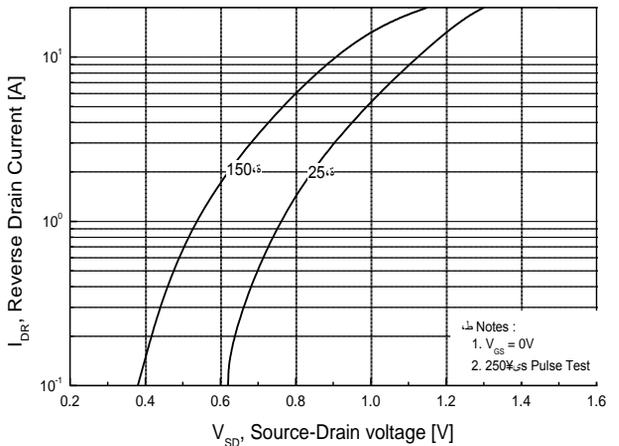


Fig. 5. Capacitance characteristics (Non-Repetitive)

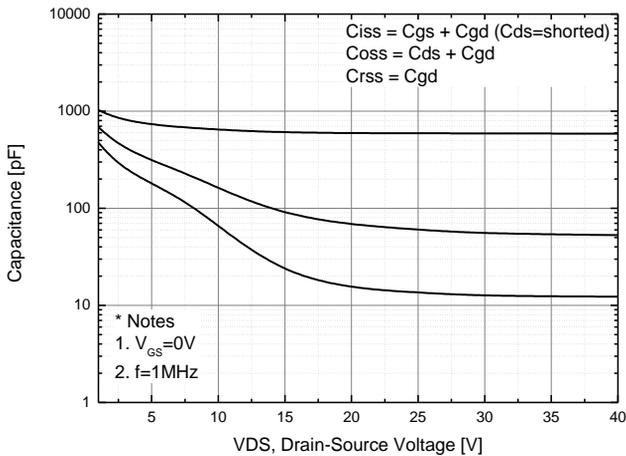


Fig. 6. Gate charge characteristics

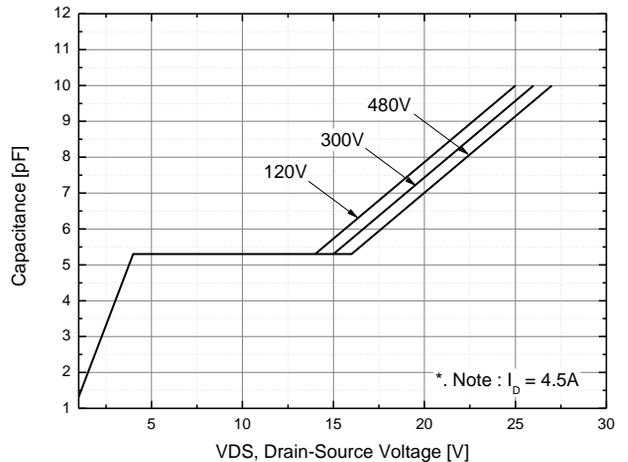


Fig 7. Breakdown Voltage Variation vs. Junction Temperature

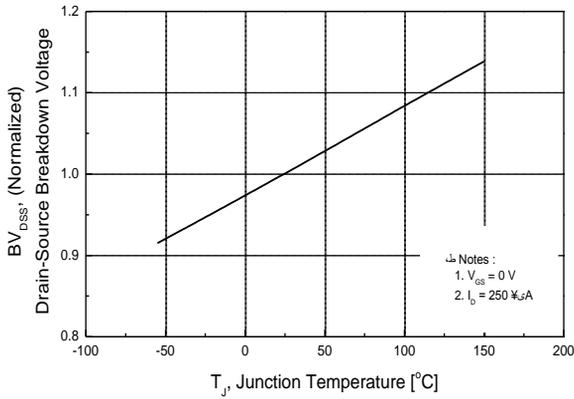


Fig. 8. On resistance variation vs. junction temperature

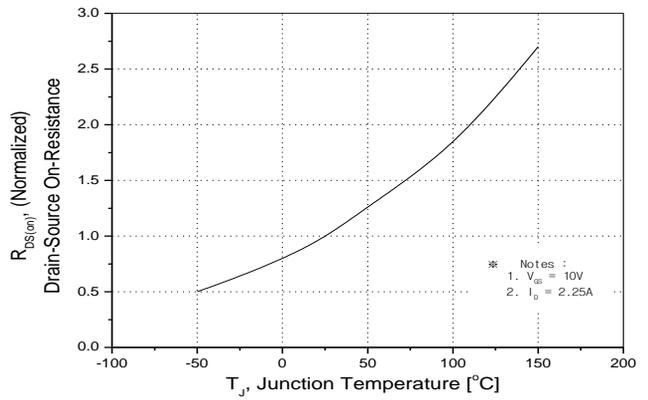


Fig. 9. Maximum drain current vs. case temperature.

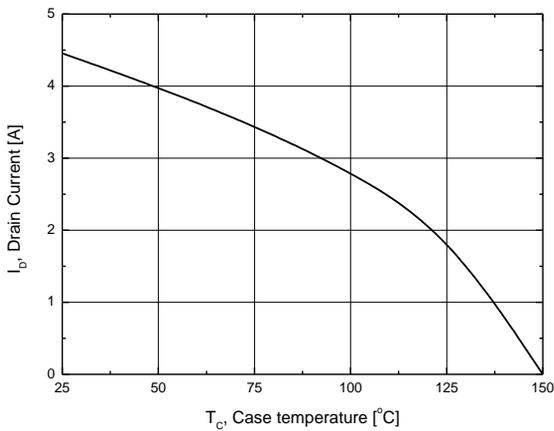


Fig. 10. Maximum safe operating area (TFP4N60)

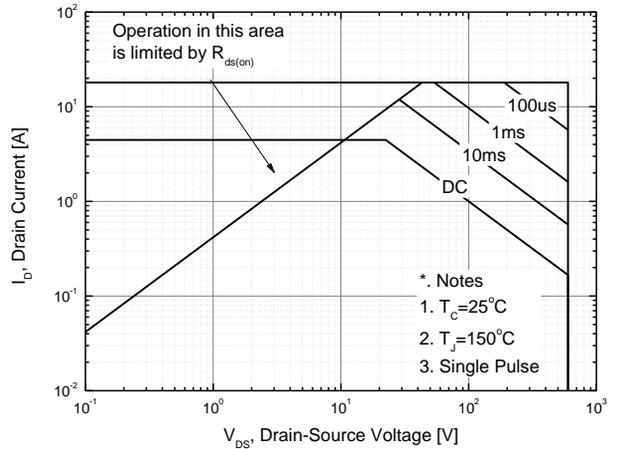


Fig. 11. Transient thermal response curve

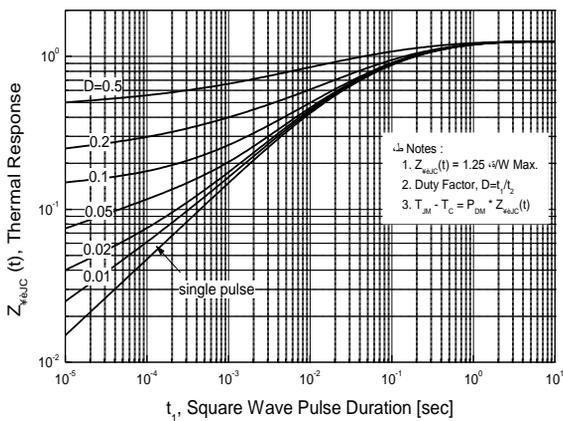


Fig. 12. Maximum safe operating area(TFF4N60)

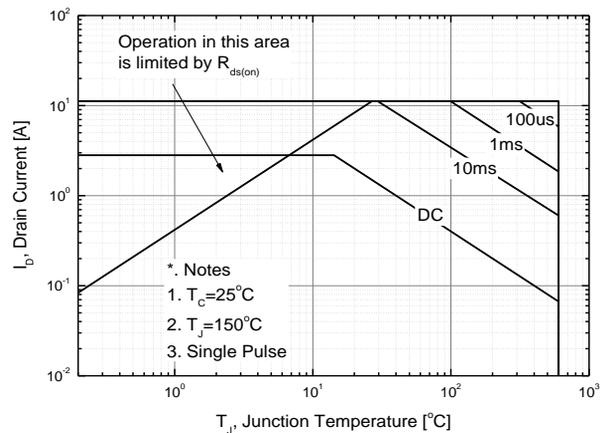


Fig. 12. Gate charge test circuit & waveform

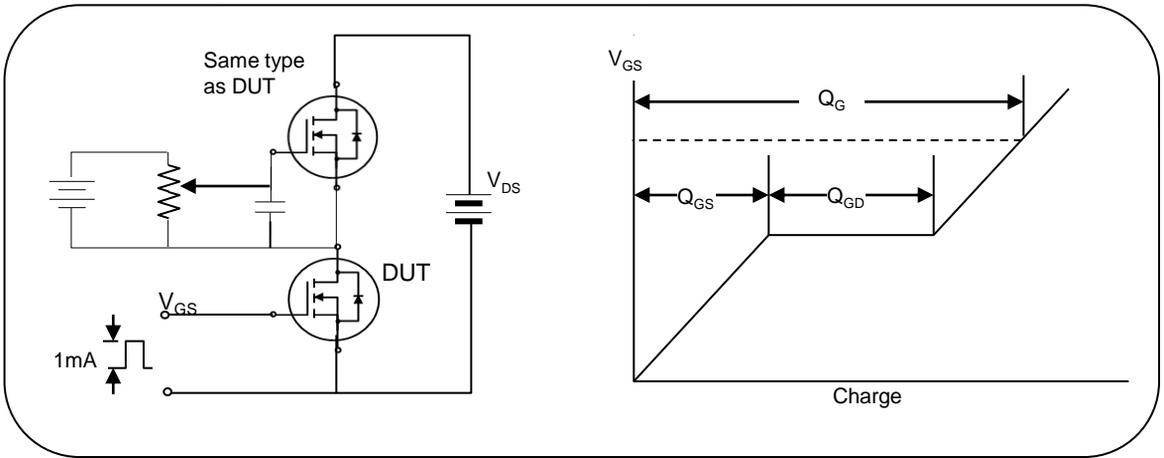


Fig. 13. Switching time test circuit & waveform

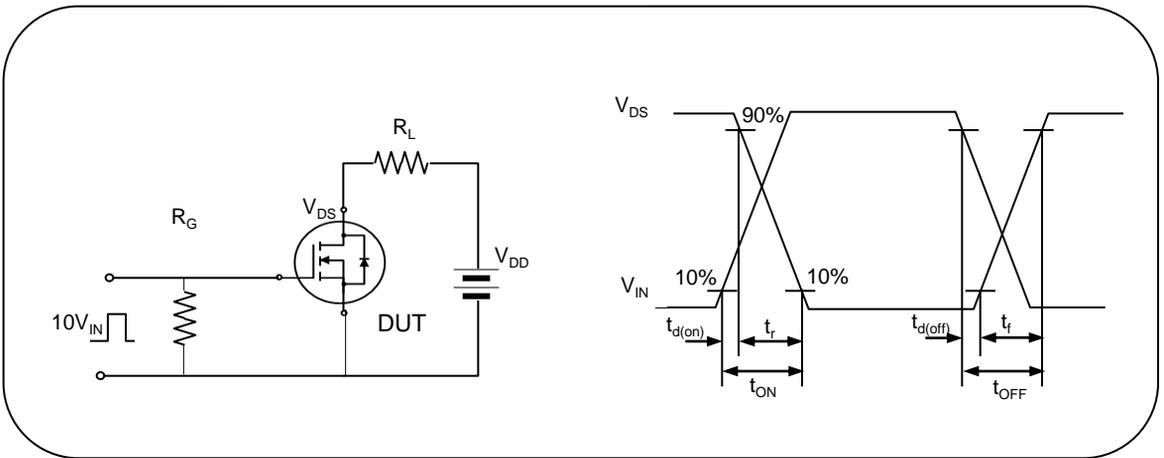


Fig. 14. Unclamped Inductive switching test circuit & waveform

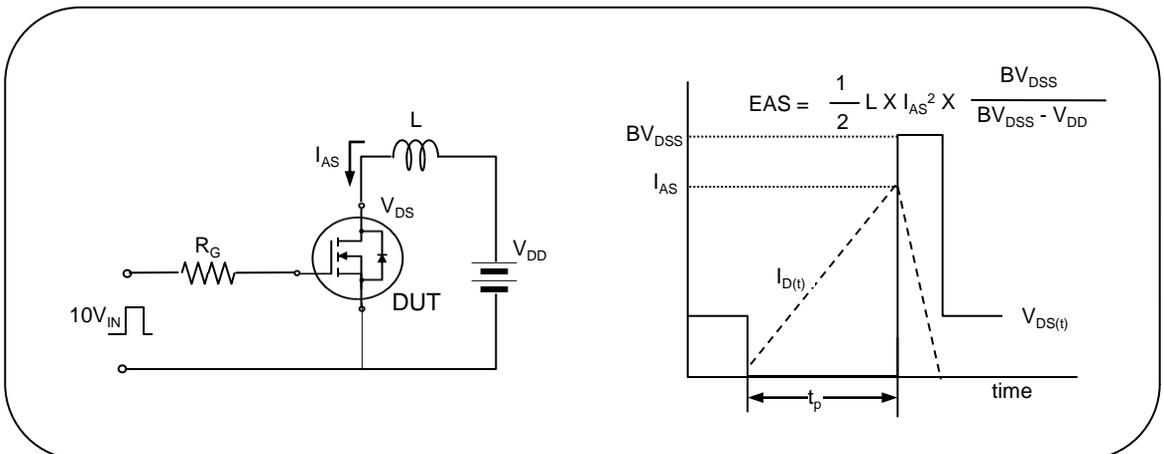
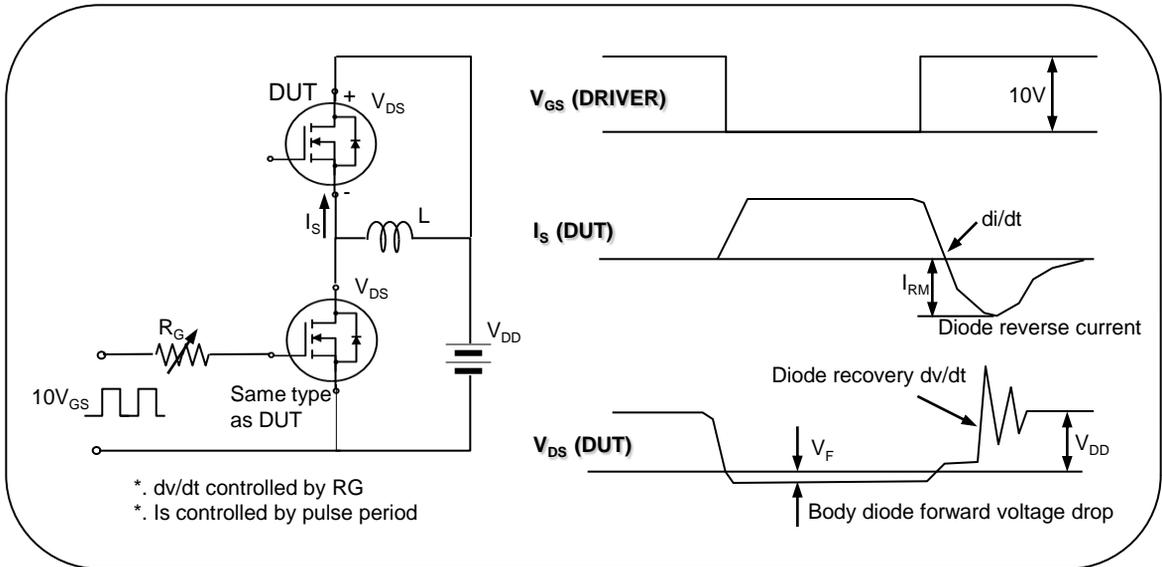
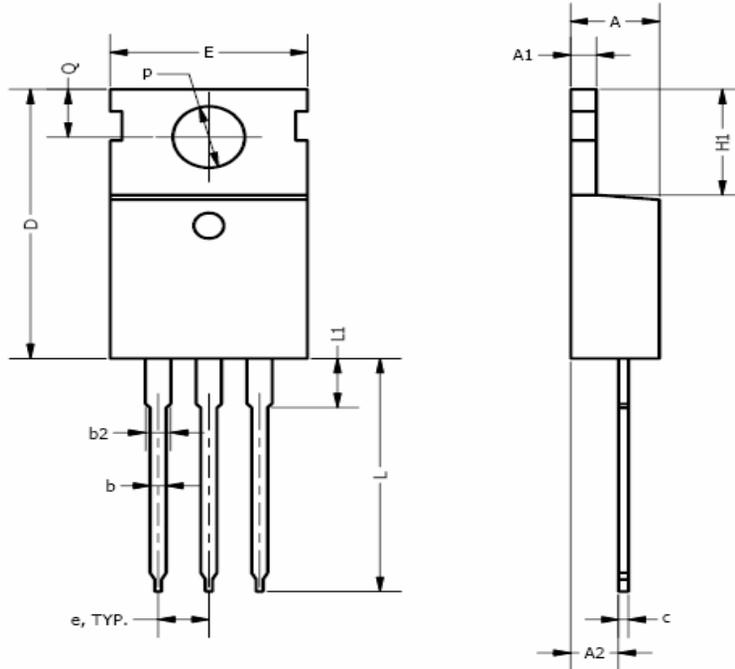


Fig. 15. Peak diode recovery dv/dt test circuit & waveform

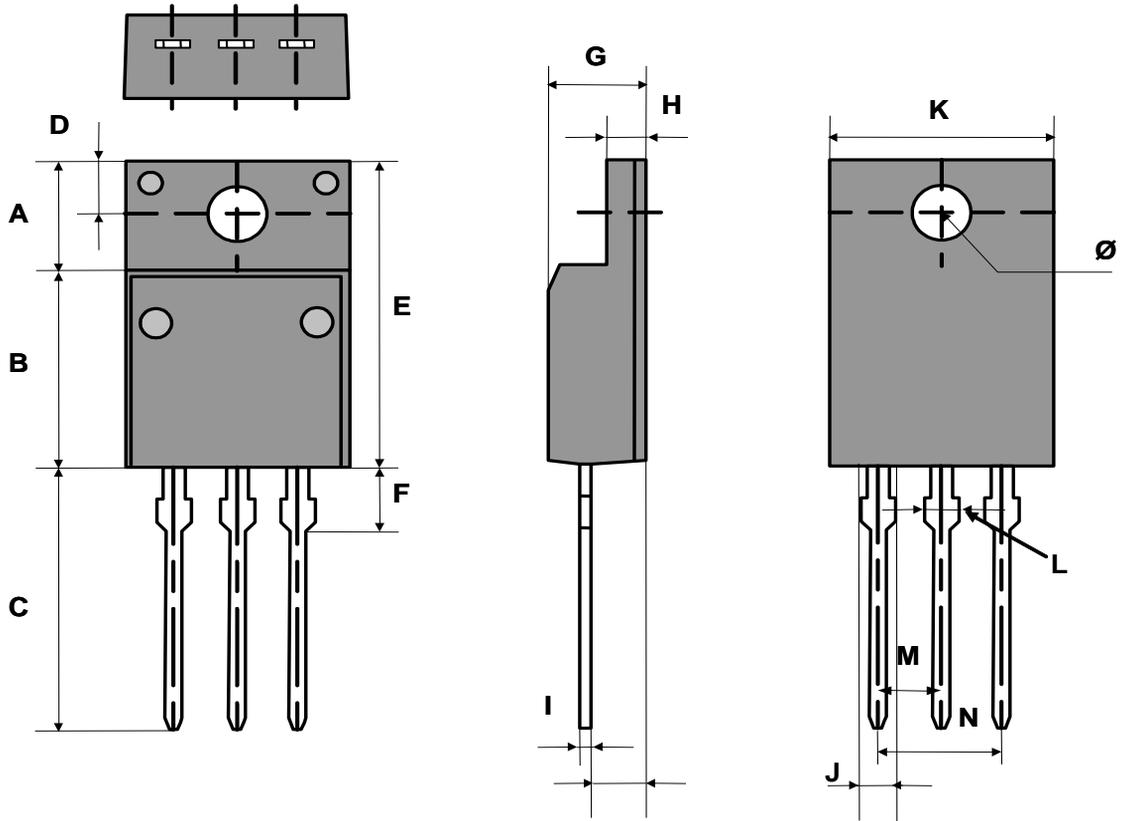


TO-220 Package Dimension



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	