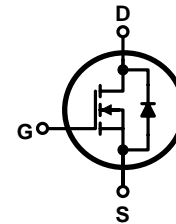
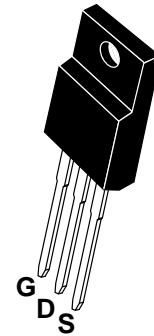


## PIN Connection TO-220F

$V_{DSS}$	600	V
$I_D$	12	A
$P_D(T_C=25^\circ C)$	140	W
$R_{DS(ON)}$	0.55	$\Omega$



### Marking Diagram



Y = Year  
 A = Assembly Location  
 WW = Work Week  
 FIR12N60AF = Specific Device Code

## Features

- **Fast Switching**
- **Low Gate Charge** (Typical Data:58nC)
- **Low Reverse transfer capacitances**(Typical:90pF)
- **100% Single Pulse avalanche energy Test**

## Applications

Power switch circuit of adaptor and charger.

## Absolute (Tc= 25°C unless otherwise specified)

Symbol	Parameter	Rating	Units
$V_{DSS}$	Drain-to-Source Voltage	600	V
$I_D$	Continuous Drain Current	12	A
	Continuous Drain Current $T_C = 100^\circ C$	7.4	A
$I_{DM}^{a1}$	Pulsed Drain Current	48	A
$V_{GS}$	Gate-to-Source Voltage	$\pm 20$	V
$E_{AS}^{a2}$	Single Pulse Avalanche Energy	865	mJ
$E_{AR}^{a1}$	Avalanche Energy ,Repetitive	23.5	mJ
$I_{AR}^{a1}$	Avalanche Current	8.0	A
$dv/dt^{a3}$	Peak Diode Recovery dv/dt	4.5	V/ns
$P_D$	Power Dissipation	140	W
	Derating Factor above 25°C	1.1	W/°C
$T_J, T_{stg}$	Operating Junction and Storage Temperature Range	150, -55 to 150	°C
$T_L$	Maximum Temperature for Soldering	300	°C

**Electrical Characteristics** (Tc= 25°C unless otherwise specified)

<b>OFF Characteristics</b>						
Symbol	Parameter	Test Conditions	Rating			Units
			Min.	Typ.	Max.	
V <sub>DSS</sub>	Drain to Source Breakdown Voltage	V <sub>GS</sub> =0V, I <sub>D</sub> =250μA	600	--	--	V
ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	Bvdss Temperature Coefficient	I <sub>D</sub> =250μA, Reference 25°C	--	0.70	--	V/°C
I <sub>DSS</sub>	Drain to Source Leakage Current	V <sub>DS</sub> = 600V, V <sub>GS</sub> = 0V, T <sub>a</sub> = 25°C	--	--	25	μA
		V <sub>DS</sub> = 480V, V <sub>GS</sub> = 0V, T <sub>a</sub> = 125°C	--	--	250	
V <sub>GSO</sub>	Gate Source Breakdown Voltage	I <sub>GS</sub> = ±1mA (Open Drain)	±20			V
I <sub>GSS(F)</sub>	Gate to Source Forward Leakage	V <sub>GS</sub> = +20V	--	--	10	μA
I <sub>GSS(R)</sub>	Gate to Source Reverse Leakage	V <sub>GS</sub> = -20V	--	--	-10	μA

<b>ON Characteristics</b>						
Symbol	Parameter	Test Conditions	Rating			Units
			Min.	Typ.	Max.	
R <sub>DS(ON)</sub>	Drain-to-Source On-Resistance	V <sub>GS</sub> =10V, I <sub>D</sub> =6A	--	0.55	0.65	Ω
V <sub>GS(TH)</sub>	Gate Threshold Voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA	2.0	3.0	4.0	V
Pulse width tp ≤ 380μs, δ ≤ 2%						

<b>Dynamic Characteristics</b>						
Symbol	Parameter	Test Conditions	Rating			Units
			Min.	Typ.	Max.	
g <sub>fs</sub>	Forward Transconductance	V <sub>DS</sub> =15V, I <sub>D</sub> = 6.0A	--	9.2	--	S
C <sub>iss</sub>	Input Capacitance	V <sub>GS</sub> = 0V V <sub>DS</sub> = 25V f = 1.0MHz	--	1850	--	pF
C <sub>oss</sub>	Output Capacitance		--	180	--	
C <sub>rss</sub>	Reverse Transfer Capacitance		--	20	--	

<b>Resistive Switching Characteristics</b>						
Symbol	Parameter	Test Conditions	Rating			Units
			Min.	Typ.	Max.	
t <sub>d(ON)</sub>	Turn-on Delay Time	I <sub>D</sub> = 12.0A V <sub>DD</sub> = 300V V <sub>GS</sub> = 10V R <sub>G</sub> = 4.7Ω	--	30	--	ns
t <sub>r</sub>	Rise Time		--	90	--	
t <sub>d(OFF)</sub>	Turn-Off Delay Time		--	140	--	
t <sub>f</sub>	Fall Time		--	90	--	
Q <sub>g</sub>	Total Gate Charge	I <sub>D</sub> = 12.0A V <sub>DD</sub> = 480V V <sub>GS</sub> = 10V	--	52	--	nC
Q <sub>gs</sub>	Gate to Source Charge		--	8.5	--	
Q <sub>gd</sub>	Gate to Drain ("Miller") Charge		--	20	--	

Source-Drain Diode Characteristics						
Symbol	Parameter	Test Conditions	Rating			Units
			Min.	Typ.	Max.	
$I_S$	Continuous Source Current (Body Diode)		--	--	12	A
$I_{SM}$	Maximum Pulsed Current (Body Diode)		--	--	48	A
$V_{SD}$	Diode Forward Voltage	$I_S=12.0A, V_{GS}=0V$	--	--	1.4	V
$t_{rr}$	Reverse Recovery Time	$I_S=12.0A, T_j = 25^\circ C$ $dI_f/dt=100A/us,$ $V_{GS}=0V$	--	430	--	ns
$Q_{rr}$	Reverse Recovery Charge		--	5.0	--	nC
$I_{RRM}$	Reverse Recovery Current		--	15	--	A
Pulse width $t_p \leq 380\mu s, \delta \leq 2\%$						

Symbol	Parameter	Typ.	Units
$R_{\theta JC}$	Junction-to-Case	0.89	$^\circ C/W$
$R_{\theta JA}$	Junction-to-Ambient	100	$^\circ C/W$

<sup>a1</sup>: Repetitive rating; pulse width limited by maximum junction temperature

<sup>a2</sup>:  $L=10.0mH, I_D=12A, Start T_j=25^\circ C$

<sup>a3</sup>:  $I_{SD}=12A, di/dt \leq 100A/us, V_{DD} \leq BV_{DS}, Start T_j=25^\circ C$

Electrical Characteristics Curves

Fig. 1  $I_D - V_{DS}$

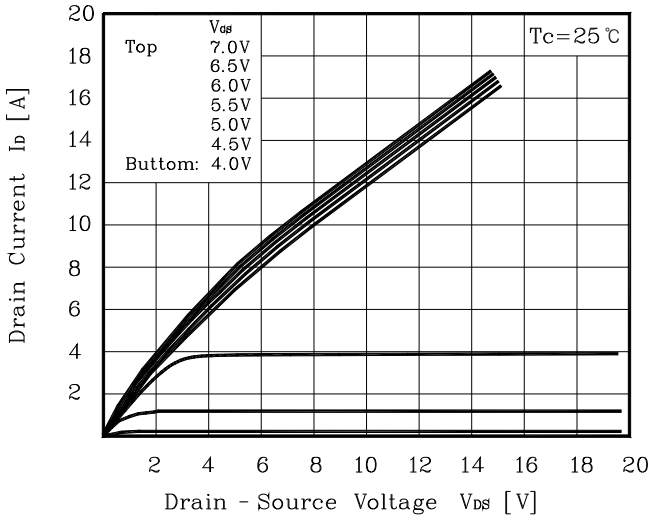


Fig. 2  $I_D - V_{GS}$

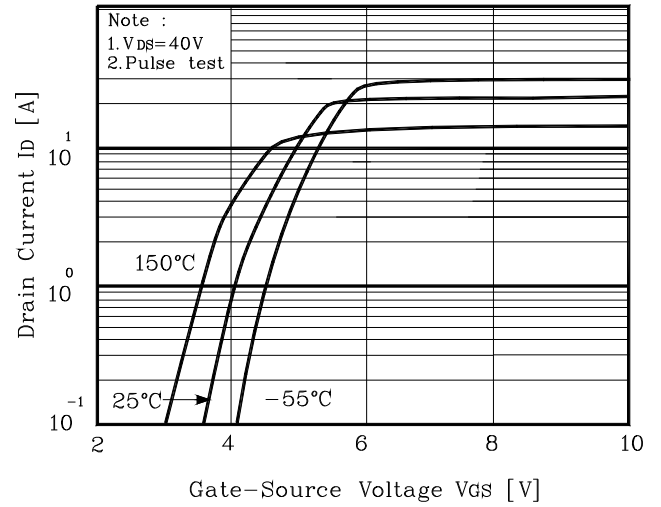


Fig. 3  $R_{DS(ON)} - I_D$

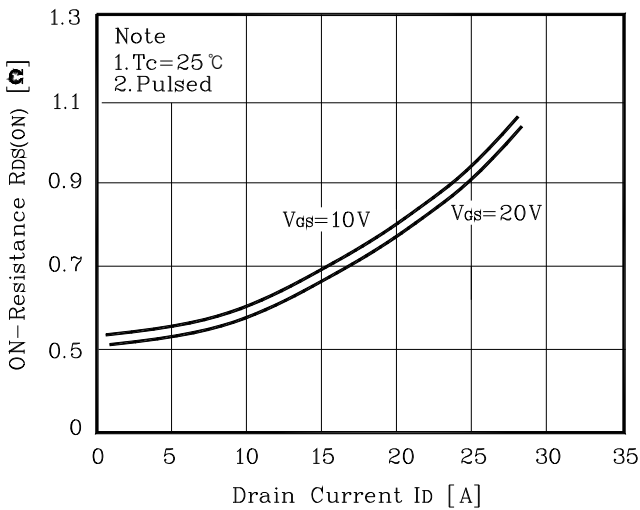


Fig. 4  $I_S - V_{SD}$

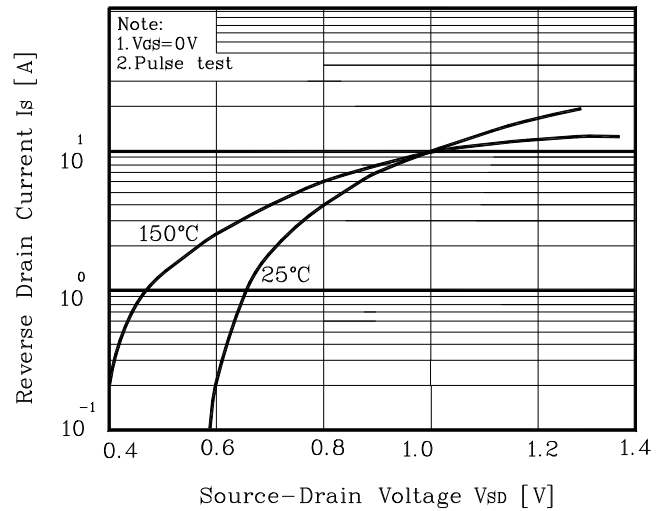


Fig. 5 Capacitance -  $V_{DS}$

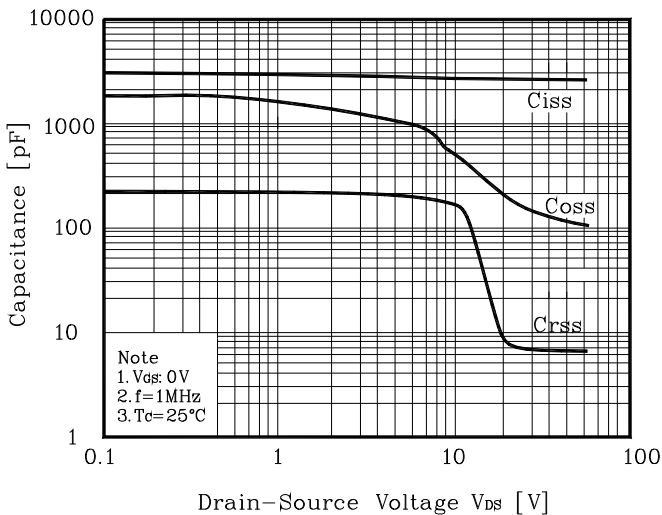
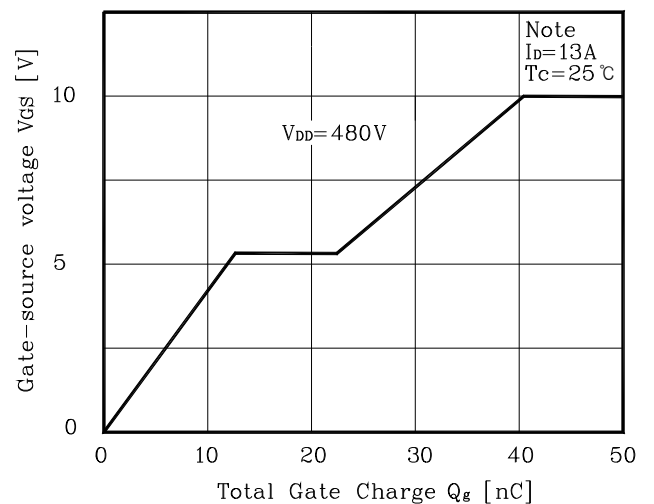
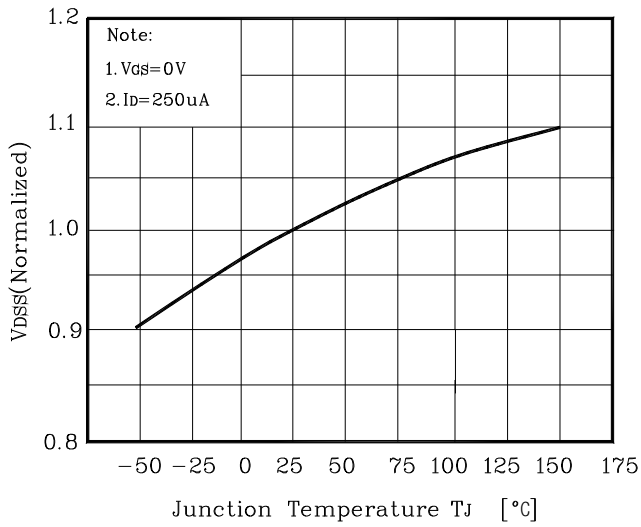


Fig. 6  $V_{GS} - Q_G$

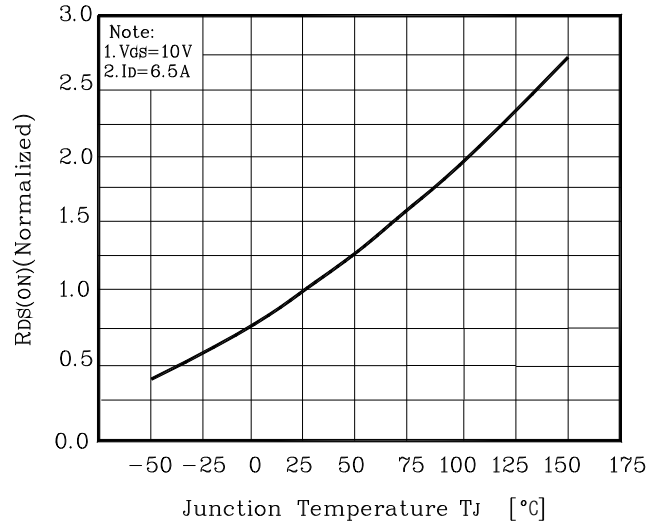


## Electrical Characteristics Curves (Continue)

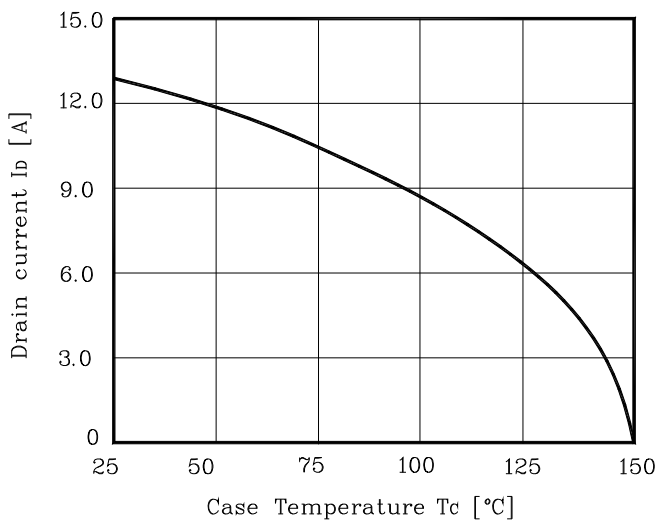
**Fig. 7  $BV_{DSS} - T_J$**



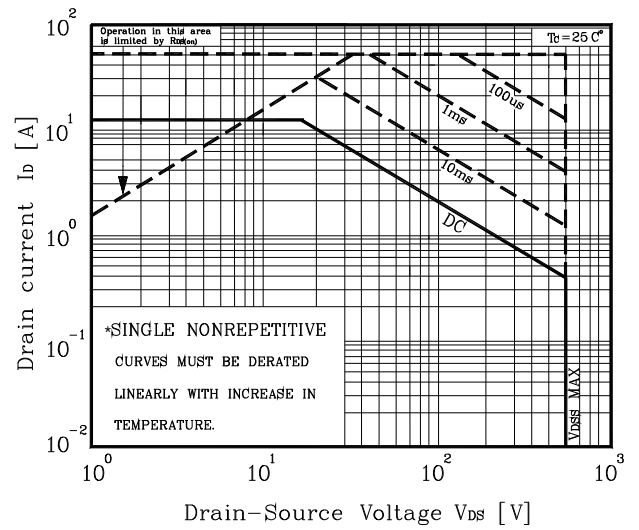
**Fig. 8  $R_{DS(ON)} - T_J$**



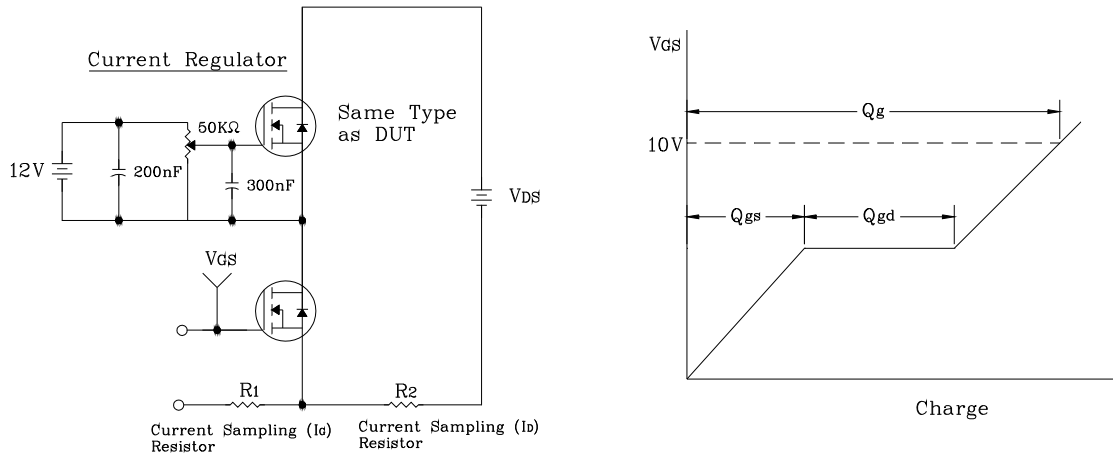
**Fig. 9  $I_D - T_C$**



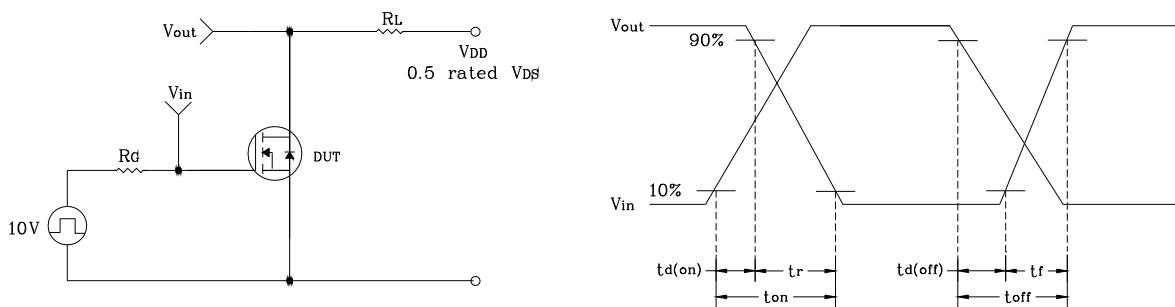
**Fig. 10 Safe Operating Area**



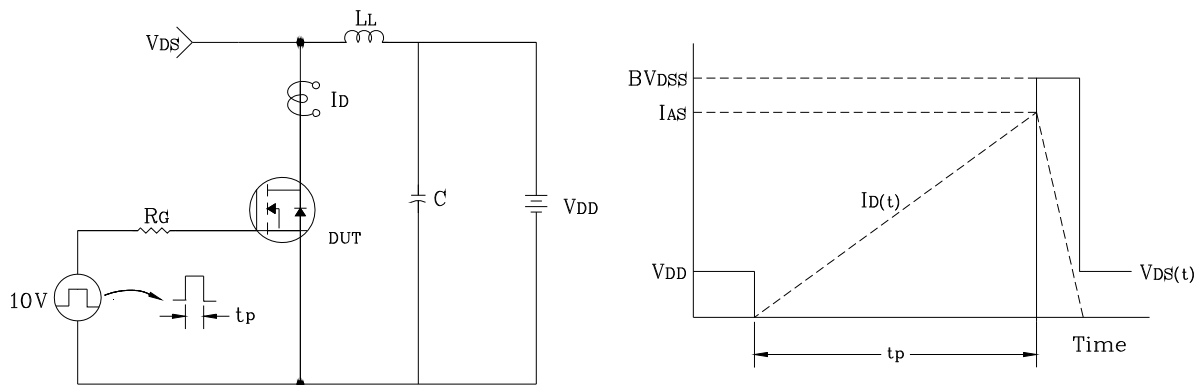
**Fig. 11 Gate Charge Test Circuit & Waveform**



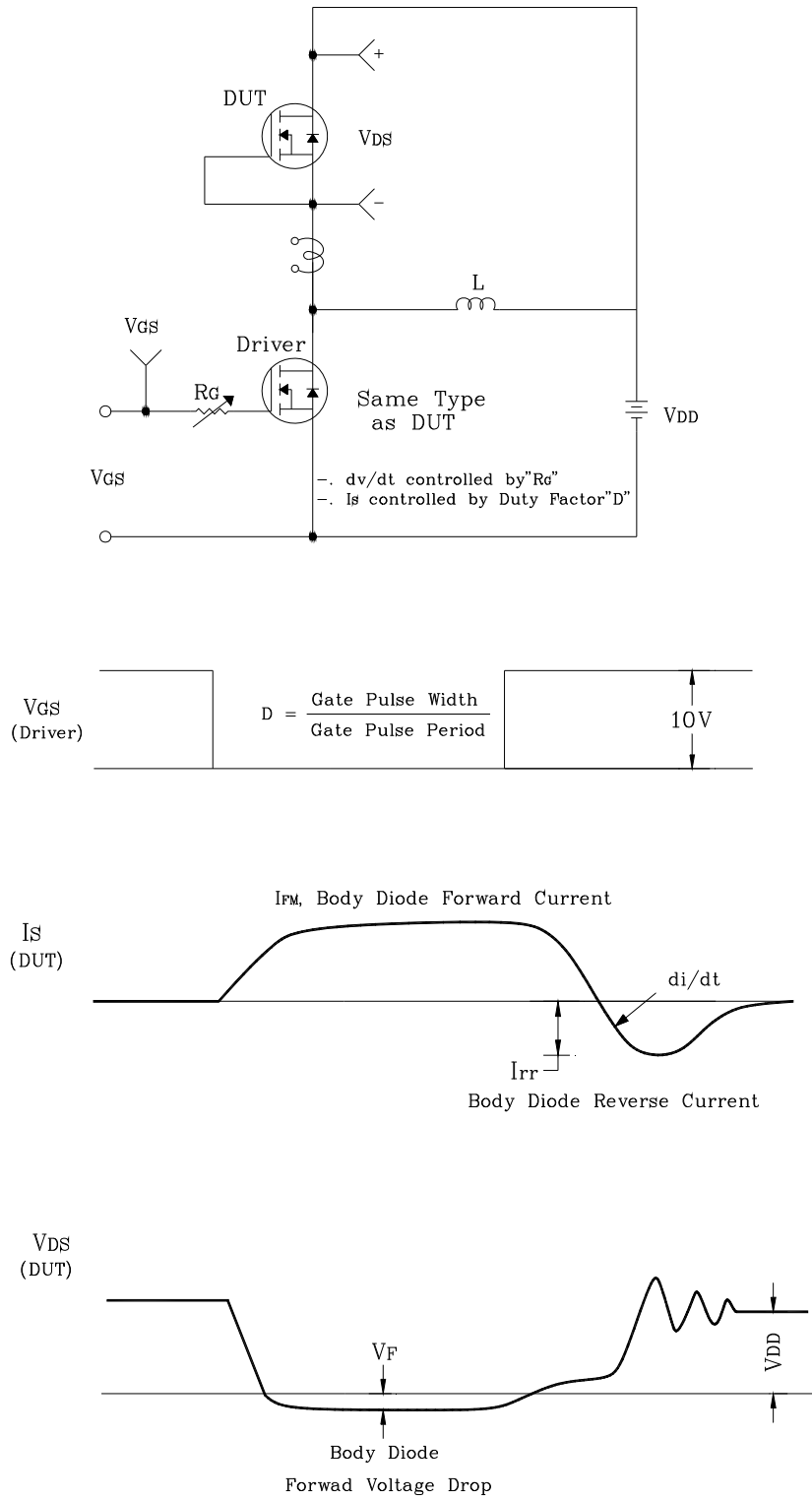
**Fig. 12 Resistive Switching Test Circuit & Waveform**



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

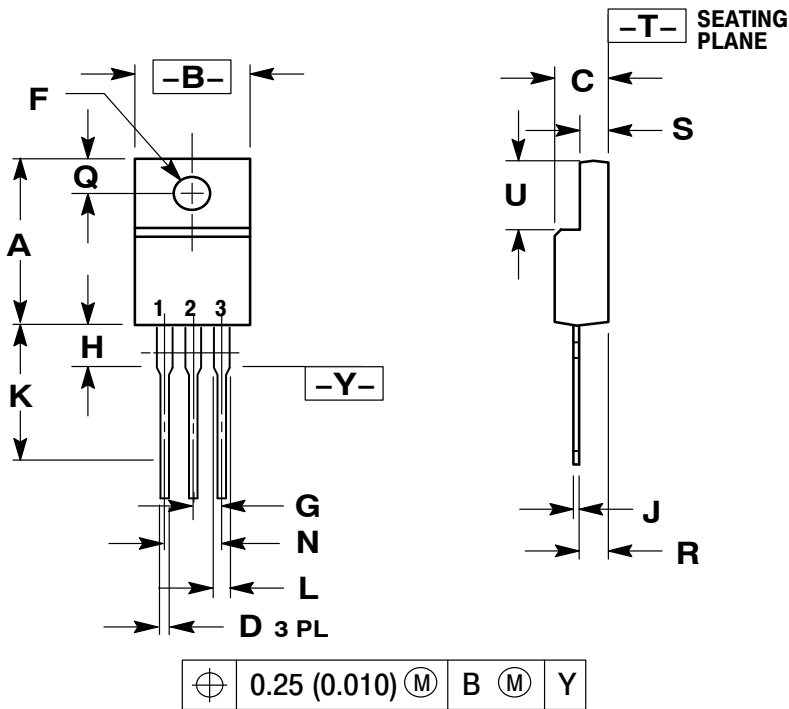


**Fig. 14 Diode Reverse Recovery Time Test Circuit & Waveform**



## Package Dimensions

### TO-220F



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH
3. 221D-01 THRU 221D-02 OBSOLETE, NEW STANDARD 221D-03.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.617	0.635	15.67	16.12
B	0.392	0.419	9.96	10.63
C	0.177	0.193	4.50	4.90
D	0.024	0.039	0.60	1.00
F	0.116	0.129	2.95	3.28
G	0.100 BSC		2.54 BSC	
H	0.118	0.135	3.00	3.43
J	0.018	0.025	0.45	0.63
K	0.503	0.541	12.78	13.73
L	0.048	0.058	1.23	1.47
N	0.200 BSC		5.08 BSC	
Q	0.122	0.138	3.10	3.50
R	0.099	0.117	2.51	2.96
S	0.092	0.113	2.34	2.87
U	0.239	0.271	6.06	6.88