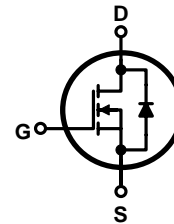
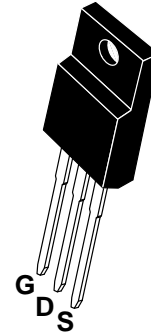


PIN Connection TO-220F

Marking Diagram


Y = Year
 A = Assembly Location
 WW = Work Week
 FIR10N65F = Specific Device Code

Switchng Regulator Application
Features

- High Voltage : $BV_{DSS}=650V(\text{Min.})$
- Low C_{rSS} : $C_{rSS}=16pF(\text{Typ.})$
- Low gate charge : $Qg=35nC(\text{Typ.})$
- Low $R_{DS(on)}$: $R_{DS(on)}=0.8\Omega$

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}	± 30	V
Drain current (DC) *	I_D	$T_C=25^\circ\text{C}$	10
		$T_C=100^\circ\text{C}$	5.5
Drain current (Pulsed) *	I_{DM}	40	A
Power dissipation	P_D	50	W
Avalanche current (Single) ②	I_{AS}	10	A
Single pulsed avalanche energy ②	E_{AS}	608	mJ
Avalanche current (Repetitive) ①	I_{AR}	10	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	$R_{th(J-C)}$	-	2.5
	Junction-ambient	$R_{th(J-A)}$	-	120

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

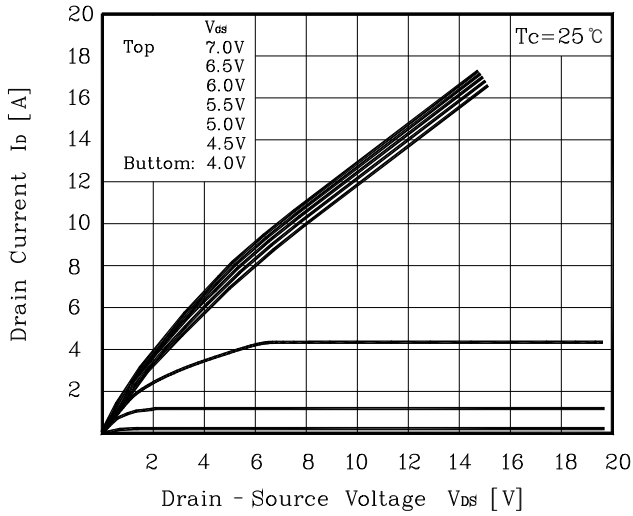
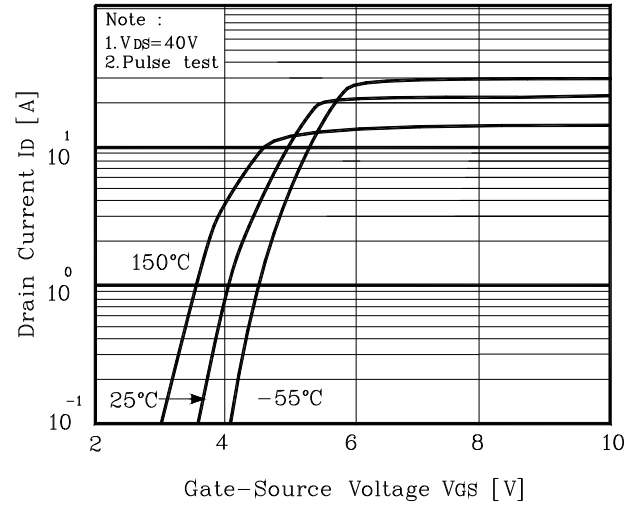
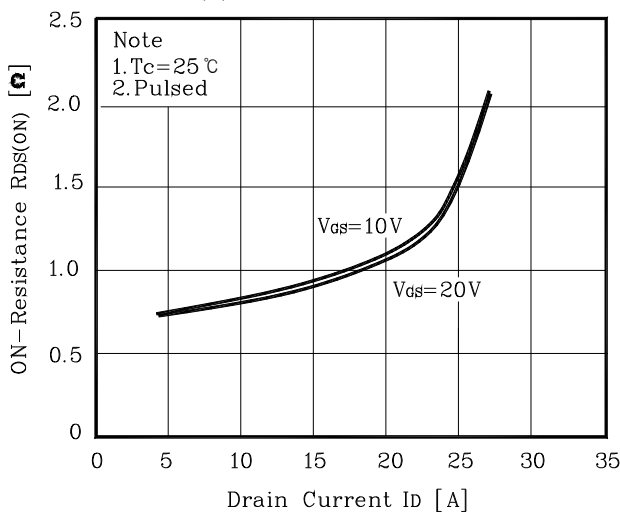
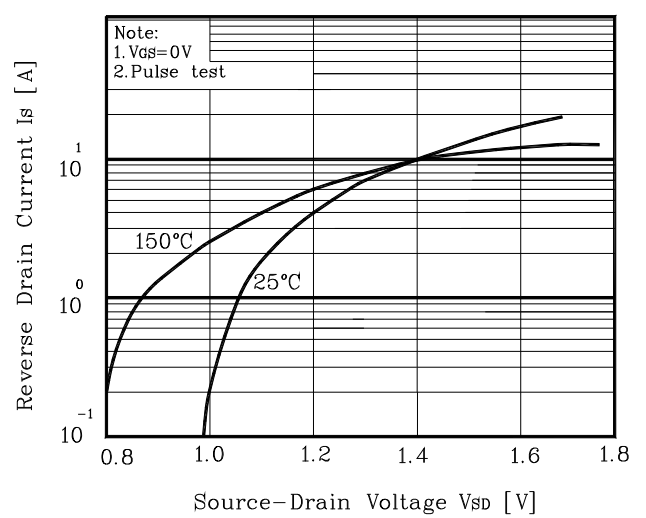
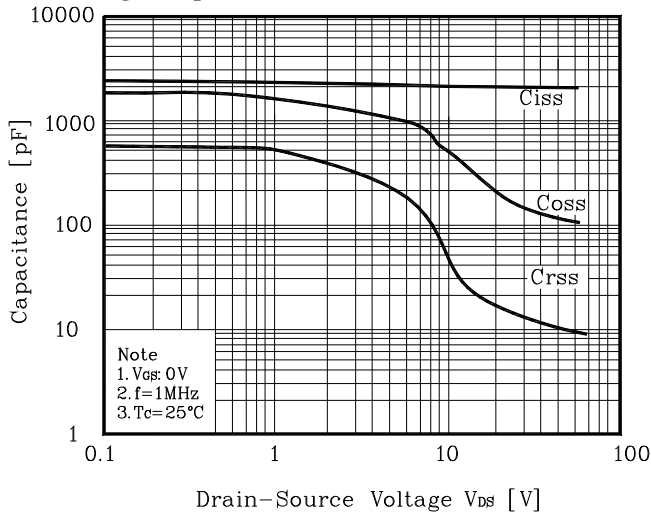
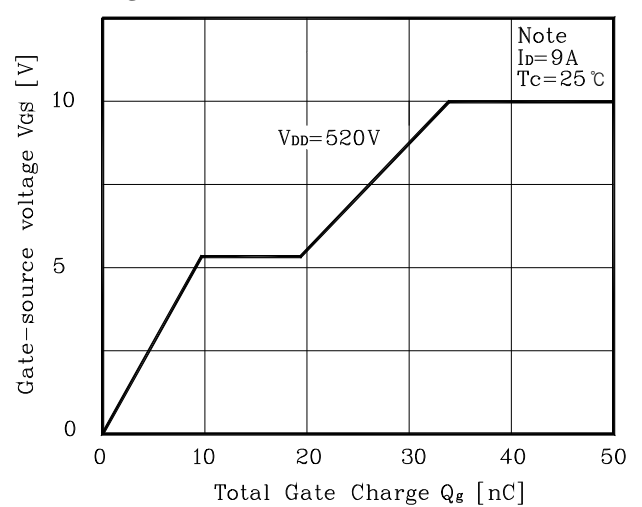
Characteristic	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Drain-source breakdown voltage	BV_{DSS}	$I_D=250\mu\text{A}, V_{GS}=0\text{V}$	650	-	-	V
Gate threshold voltage	$V_{GS(th)}$	$I_D=250\mu\text{A}, V_{DS}=V_{GS}$	2.0	-	4.0	V
Drain-source cut-off current	I_{DSS}	$V_{DS}=650\text{V}, V_{GS}=0\text{V}$	-	-	1	μA
Gate leakage current	I_{GSS}	$V_{DS}=0\text{V}, V_{GS}=\pm 30\text{V}$	-	-	± 100	nA
Drain-source on-resistance ④	$R_{DS(on)}$	$V_{GS}=10\text{V}, I_D=5.0\text{A}$	-	0.8	1.0	Ω
Forward transfer conductance ④	g_{fs}	$V_{DS}=10\text{V}, I_D=5.0\text{A}$	-	11	-	S
Input capacitance	C_{iss}	$V_{GS}=0\text{V}, V_{DS}=25\text{V}$ $f=1\text{ MHz}$	-	1143.2		pF
Output capacitance	C_{oss}		-	128		
Reverse transfer capacitance	C_{rss}		-	3.5		
Turn-on delay time	$t_{d(on)}$	$V_{DD}=300\text{V}, I_D=10\text{A}$ $R_G=25\Omega$	-	40	-	ns
Rise time	t_r		-	73.67		
Turn-off delay time	$t_{d(off)}$		-	52.13		
Fall time	t_f		-	34.8		
Total gate charge	Q_g	$V_{DS}=520\text{V}, V_{GS}=10\text{V}$ $I_D=10\text{A}$	-	20		nC
Gate-source charge	Q_{gs}		-	7.47		
Gate-drain charge	Q_{gd}		-	6.48		

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	-	-	10	A
Source current (Pulsed) ①	I_{SM}		-	-	40	
Forward voltage ④	V_{SD}	$V_{GS}=0\text{V}, I_S=10\text{A}$	-	-	1.3	V
Reverse recovery time	t_{rr}	$I_S=10\text{A}, V_{GS}=0\text{V}$ $dI_F/dt=100\text{A}/\mu\text{s}$	-	450	-	ns
Reverse recovery charge	Q_{rr}		-	4.2	-	μC

Note ;

- ① Repetitive rating : Pulse width limited by maximum junction temperature
- ② $L=5.7\text{mH}, I_{AS}=10\text{A}, V_{DD}=50\text{V}, R_G=25\Omega$, 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 $V_{DSS} - T_J$

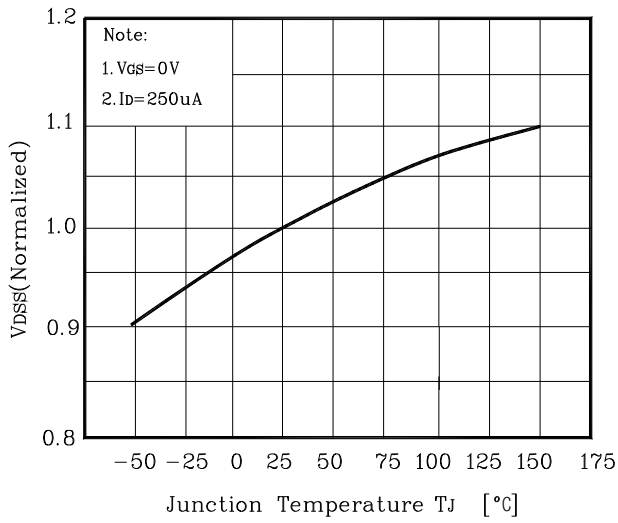


Fig. 8 $R_{DS(on)} - T_J$

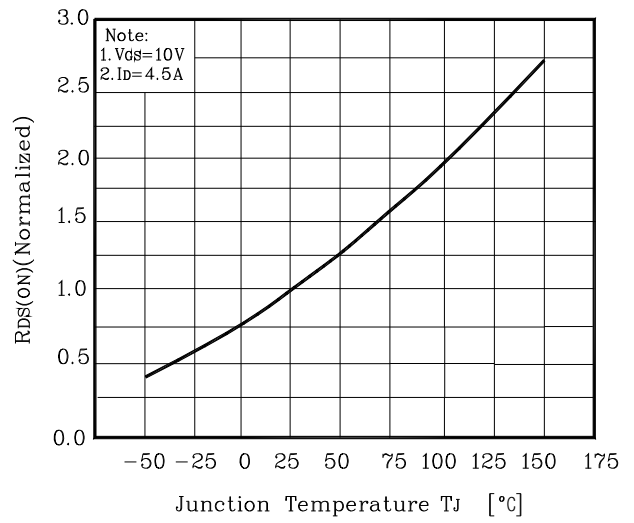


Fig. 9 $I_D - T_C$

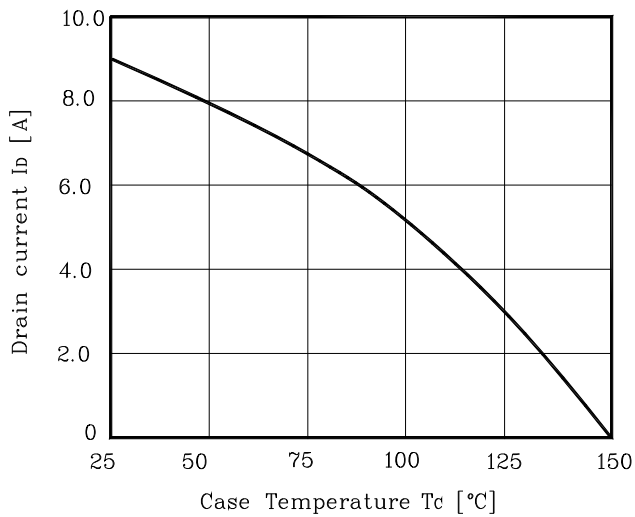


Fig. 10 Safe Operating Area

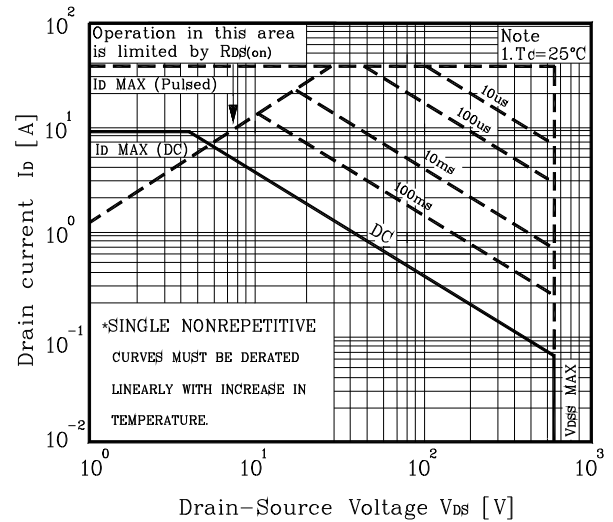


Fig. 11 Gate Charge Test Circuit & Waveform

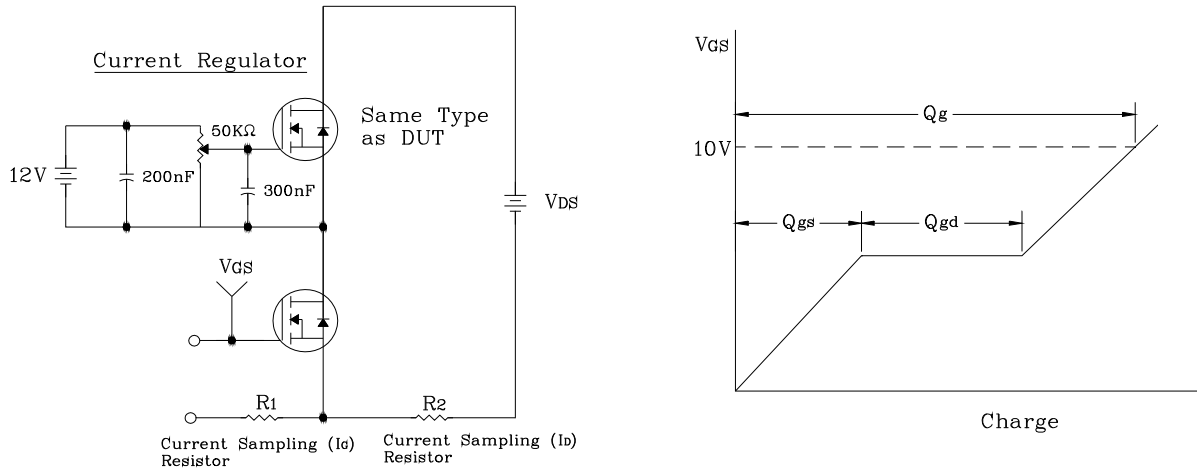


Fig. 12 Resistive Switching Test Circuit & Waveform

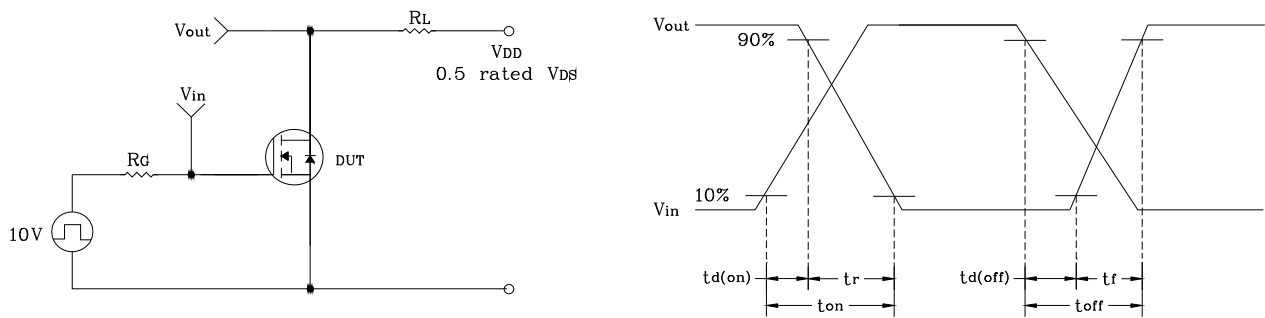


Fig. 13 EAS Test Circuit & Waveform

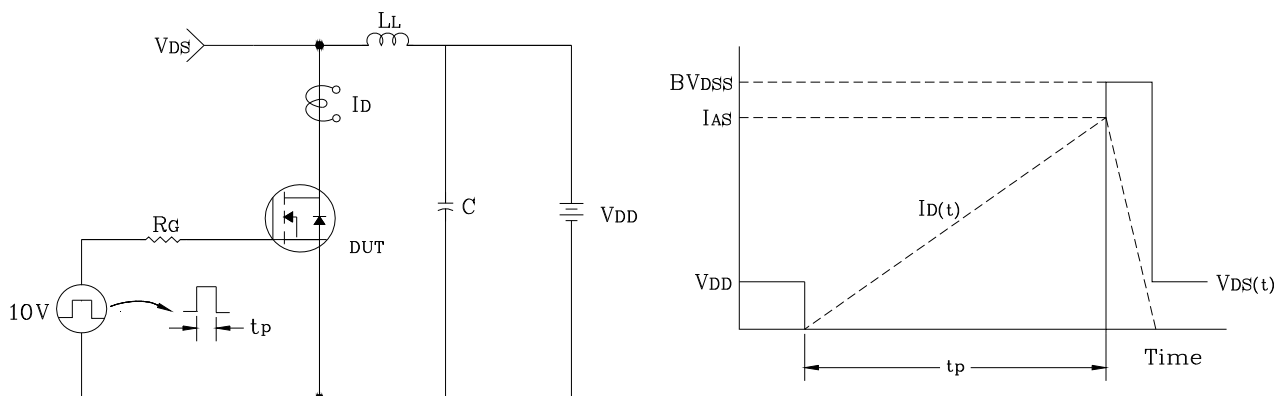
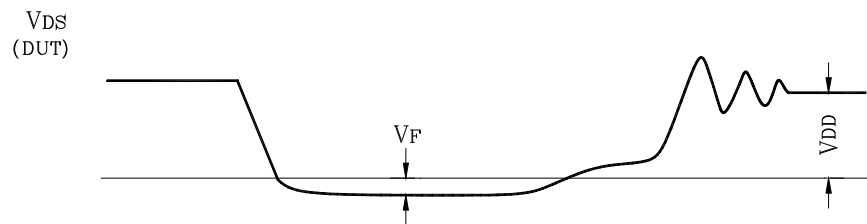
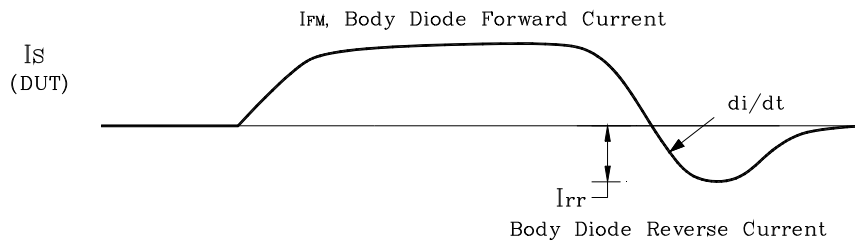
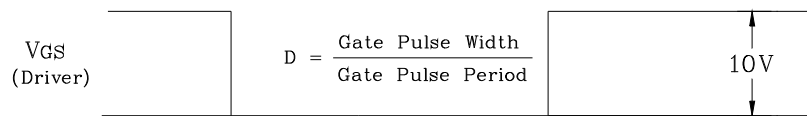
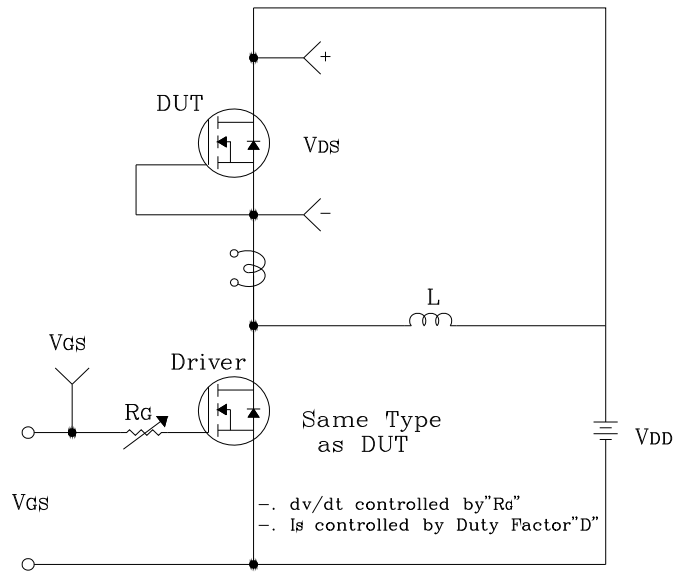
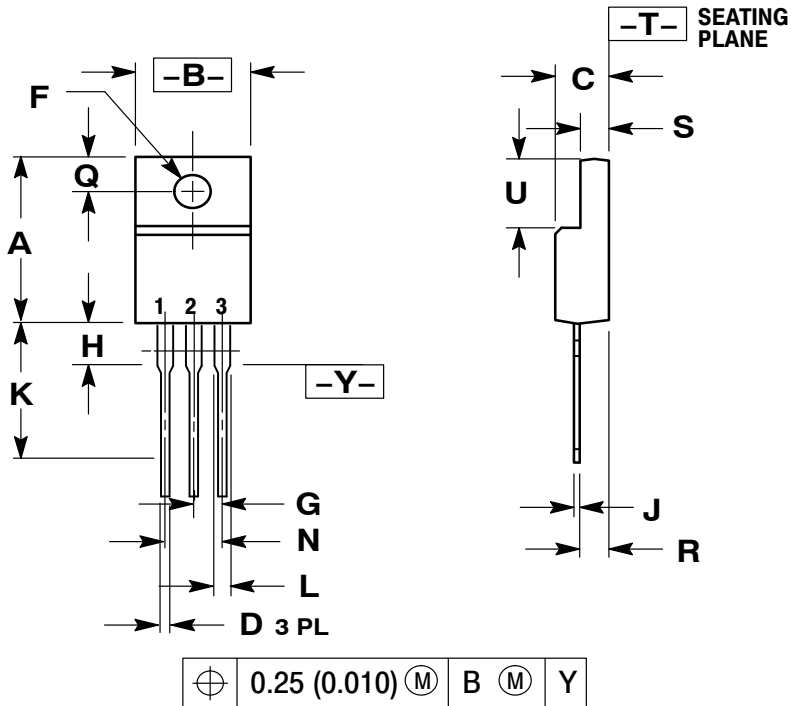


Fig. 14 Diode Reverse Recovery Time Test Circuit & Waveform



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