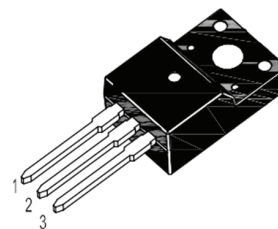
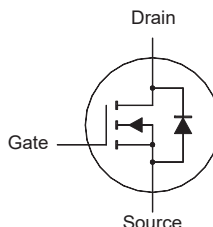


Features

- Low $R_{DS(on)}$
- Low Gate Charge
- Halogen and Antimony Free(HAF),
RoHS compliant

Application

- DC-DC converters
- Lighting



1.Gate 2.Drain 3.Source
TO-220F Plastic Package

Key Parameters

Parameter	Value	Unit
BV_{DSS}	650	V
$R_{DS(ON)}$ Max	0.96 @ $V_{GS} = 10\text{ V}$	Ω
$V_{GS(th)}$ typ	3	V
Q_g typ	10 @ $V_{GS} = 10\text{ V}$	nC

Absolute Maximum Ratings(at $T_a = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	650	V
Gate-Source Voltage	V_{GS}	± 30	V
Drain Current	I_D	4.8 3	A
		$T_c = 25^\circ\text{C}$ $T_c = 100^\circ\text{C}$	
Peak Drain Current, Pulsed ¹⁾	I_{DM}	13	A
Avalanche Current	I_{AS}	2	A
Single Pulse Avalanche Energy ²⁾	E_{AS}	158	mJ
Total Power Dissipation	P_{tot}	50	W
		$T_c = 25^\circ\text{C}$	
Operating Junction and Storage Temperature Range	T_J, T_{stg}	- 55 to + 150	$^\circ\text{C}$

Thermal Characteristics

Parameter	Symbol	Max.	Unit
Thermal Resistance from Junction to Case	$R_{\theta JC}$	2.5	$^\circ\text{C/W}$
Thermal Resistance from Junction to Ambient	$R_{\theta JA}$	45	$^\circ\text{C/W}$

¹⁾ Pulse Test: Pulse Width $\leq 100\text{ }\mu\text{s}$, Duty Cycle $\leq 2\%$, Repetitive rating, pulse width limited by junction temperature $T_{J(MAX)} = 150^\circ\text{C}$.

²⁾ Limited by $T_{J(MAX)}$, starting $T_J = 25^\circ\text{C}$, $L = 79\text{ mH}$, $R_g = 25\text{ }\Omega$, $I_D = 2\text{ A}$, $V_{GS} = 10\text{ V}$.

Characteristics at $T_a = 25^\circ\text{C}$ unless otherwise specified

Parameter	Symbol	Min.	Typ.	Max.	Unit
STATIC PARAMETERS					
Drain-Source Breakdown Voltage at $I_D = 250\ \mu\text{A}$	BV_{DSS}	650	-	-	V
Drain-Source Leakage Current at $V_{DS} = 650\ \text{V}$	I_{DSS}	-	-	1	μA
Gate Leakage Current at $V_{GS} = \pm 30\ \text{V}$	I_{GSS}	-	-	± 100	nA
Gate-Source Threshold Voltage at $V_{DS} = V_{GS}$, $I_D = 250\ \mu\text{A}$	$V_{GS(th)}$	2	-	4	V
Drain-Source On-State Resistance at $V_{GS} = 10\ \text{V}$, $I_D = 2.5\ \text{A}$	$R_{DS(on)}$	-	0.78	0.96	Ω
DYNAMIC PARAMETERS					
Forward Transconductance at $V_{DS} = 5\ \text{V}$, $I_D = 2.5\ \text{A}$	g_{fs}	-	3.1	-	S
Gate Resistance at $V_{GS} = 0\ \text{V}$, $V_{DS} = 0\ \text{V}$, $f = 1\ \text{MHz}$	R_g	-	3.9	-	Ω
Input Capacitance at $V_{GS} = 0\ \text{V}$, $V_{DS} = 100\ \text{V}$, $f = 1\ \text{MHz}$	C_{iss}	-	302	-	pF
Output Capacitance at $V_{GS} = 0\ \text{V}$, $V_{DS} = 100\ \text{V}$, $f = 1\ \text{MHz}$	C_{oss}	-	26	-	pF
Reverse Transfer Capacitance at $V_{GS} = 0\ \text{V}$, $V_{DS} = 100\ \text{V}$, $f = 1\ \text{MHz}$	C_{rss}	-	6	-	pF
Gate charge total at $V_{DS} = 325\ \text{V}$, $I_D = 2.5\ \text{A}$, $V_{GS} = 10\ \text{V}$	Q_g	-	10	-	nC
Gate to Source Charge at $V_{DS} = 325\ \text{V}$, $I_D = 2.5\ \text{A}$, $V_{GS} = 10\ \text{V}$	Q_{gs}	-	2	-	nC
Gate to Drain Charge at $V_{DS} = 325\ \text{V}$, $I_D = 2.5\ \text{A}$, $V_{GS} = 10\ \text{V}$	Q_{gd}	-	5	-	nC
Turn-On Delay Time at $V_{DS} = 325\ \text{V}$, $I_D = 2.5\ \text{A}$, $V_{GS} = 10\ \text{V}$, $R_g = 24\ \Omega$	$t_{d(on)}$	-	20	-	ns
Turn-On Rise Time at $V_{DS} = 325\ \text{V}$, $I_D = 2.5\ \text{A}$, $V_{GS} = 10\ \text{V}$, $R_g = 24\ \Omega$	t_r	-	11	-	ns
Turn-Off Delay Time at $V_{DS} = 325\ \text{V}$, $I_D = 2.5\ \text{A}$, $V_{GS} = 10\ \text{V}$, $R_g = 24\ \Omega$	$t_{d(off)}$	-	19	-	ns
Turn-Off Fall Time at $V_{DS} = 325\ \text{V}$, $I_D = 2.5\ \text{A}$, $V_{GS} = 10\ \text{V}$, $R_g = 24\ \Omega$	t_f	-	68	-	ns
Body-Diode PARAMETERS					
Drain-Source Diode Forward Voltage at $I_S = 1\ \text{A}$, $V_{GS} = 0\ \text{V}$	V_{SD}	-	-	1.4	V
Body-Diode Continuous Current	I_S	-	-	4.8	A
Body-Diode Continuous Current, Pulsed	I_{SM}	-	-	13	A
Body Diode Reverse Recovery Time at $I_S = 2.5\ \text{A}$, $di/dt = 100\ \text{A} / \mu\text{s}$	t_{rr}	-	239	-	ns
Body Diode Reverse Recovery Charge at $I_S = 2.5\ \text{A}$, $di/dt = 100\ \text{A} / \mu\text{s}$	Q_{rr}	-	1.2	-	μC

Electrical Characteristics Curves

Fig. 1 Typical Output Characteristics

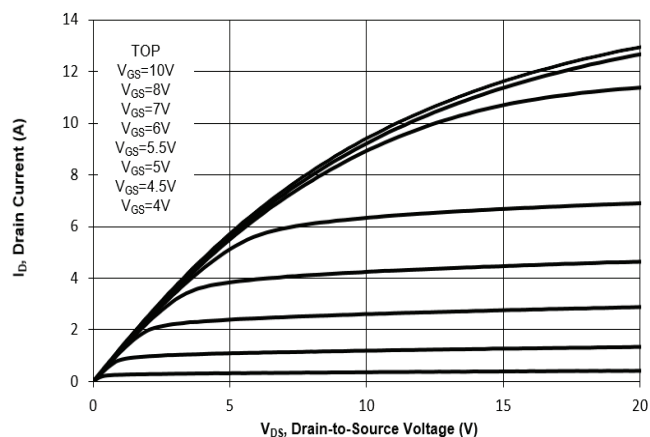


Fig. 2 Typical Transfer Characteristics

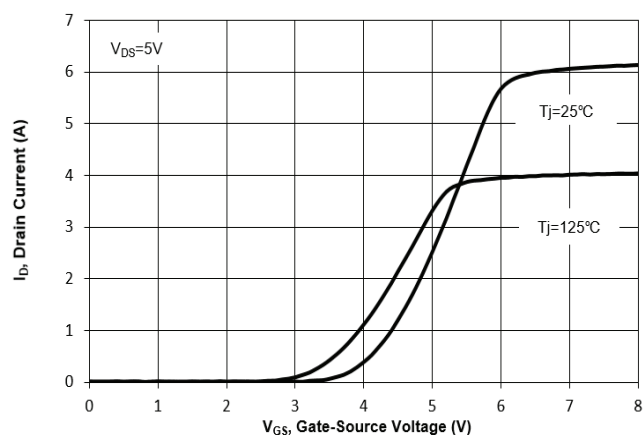


Fig. 3 On-Resistance vs. Drain Current

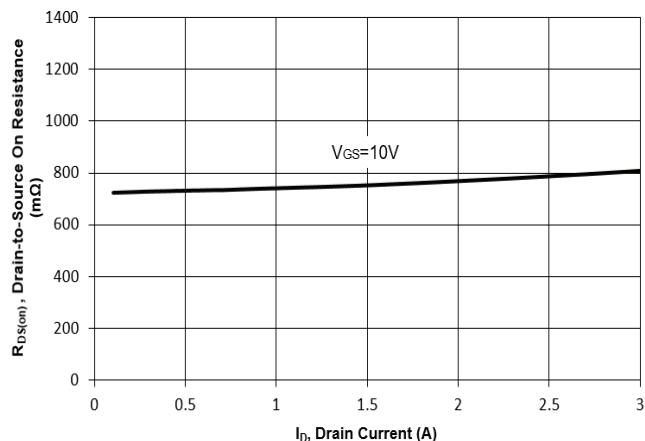


Fig. 4 On-Resistance vs. Gate-Source Voltage

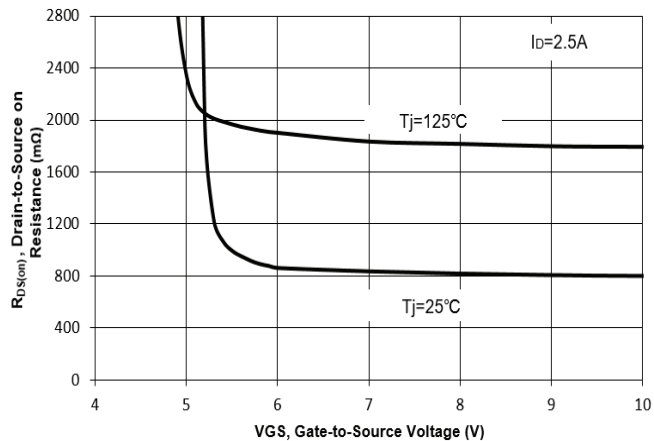


Fig. 5 On-Resistance vs. Tj

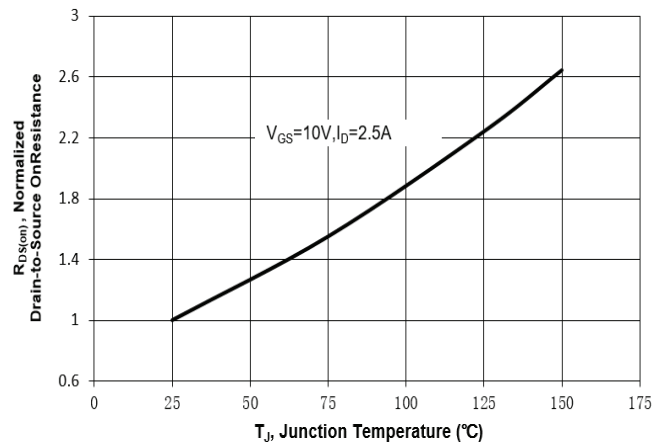


Fig. 6 Typical Body-Diode Forward Characteristics

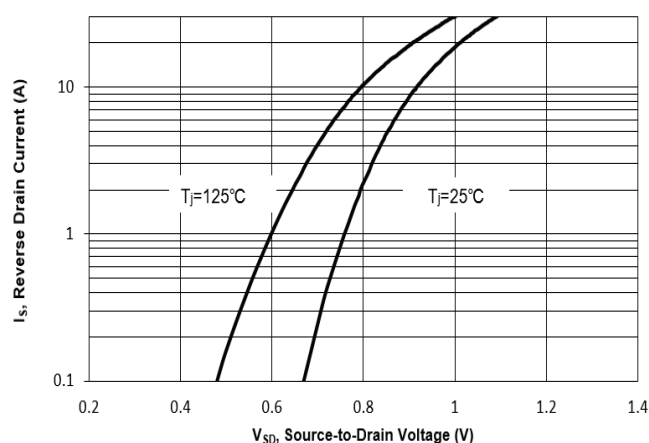


Fig. 7 Typical Junction Capacitance

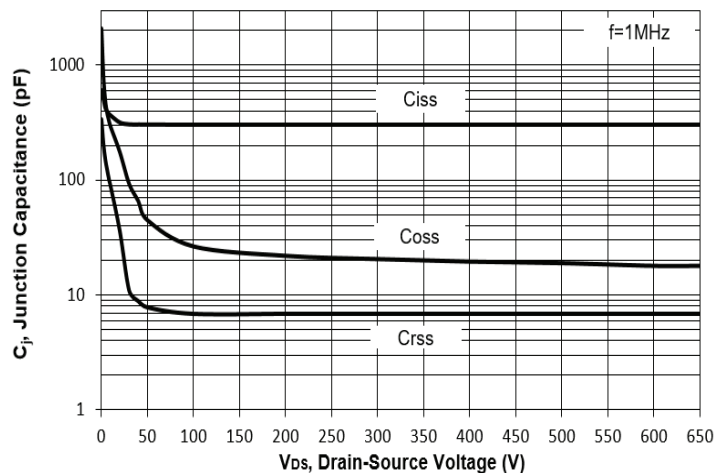


Fig. 8 Drain-Source Leakage Current vs. T_j

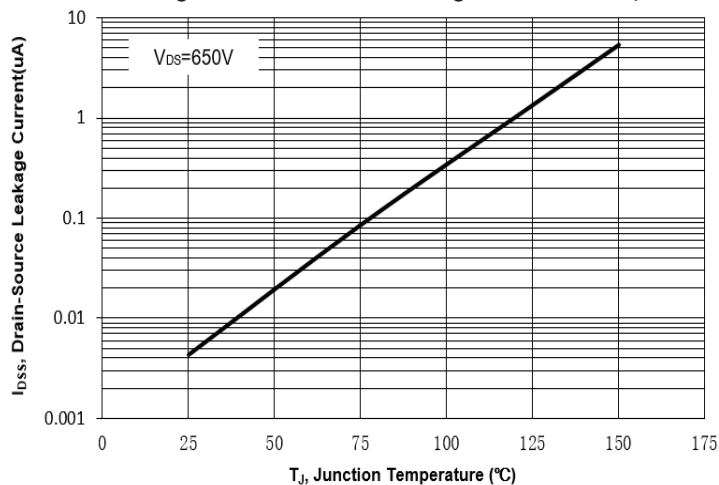


Fig. 9 $V_{(BR)DSS}$ vs. Junction Temperature

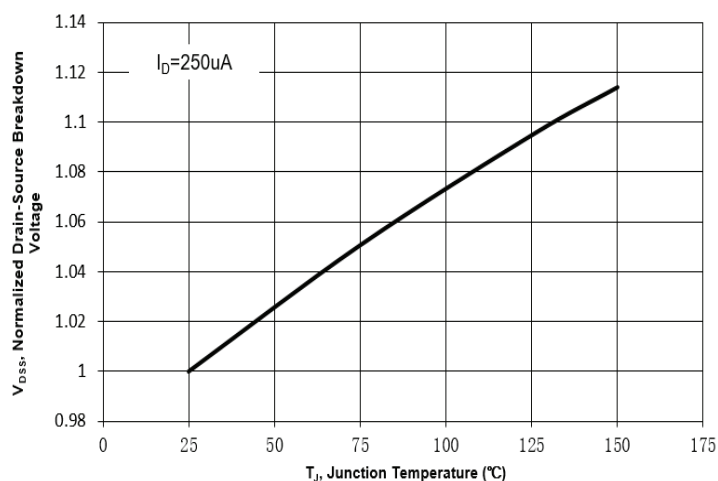


Fig. 10 Gate Threshold Variation vs. T_j

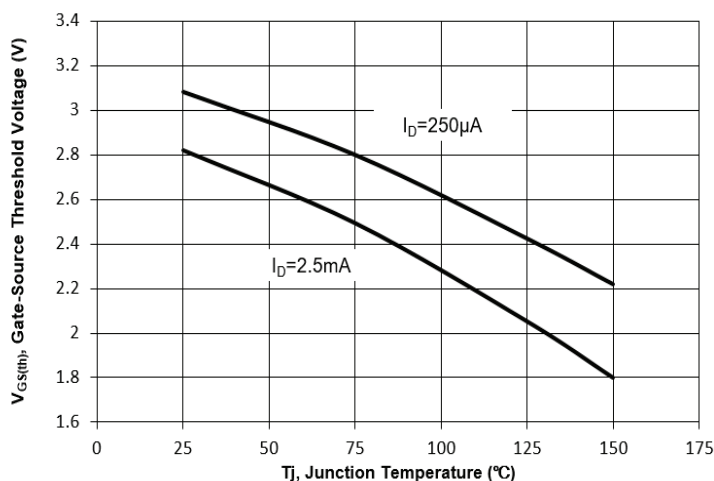


Fig. 11 Gate Charge

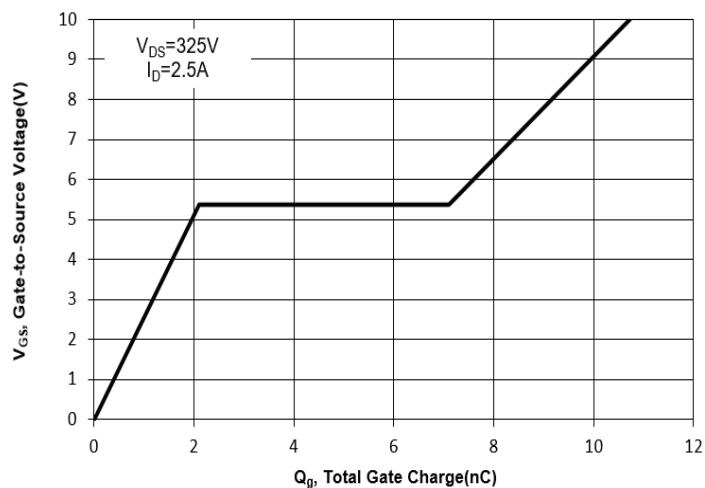
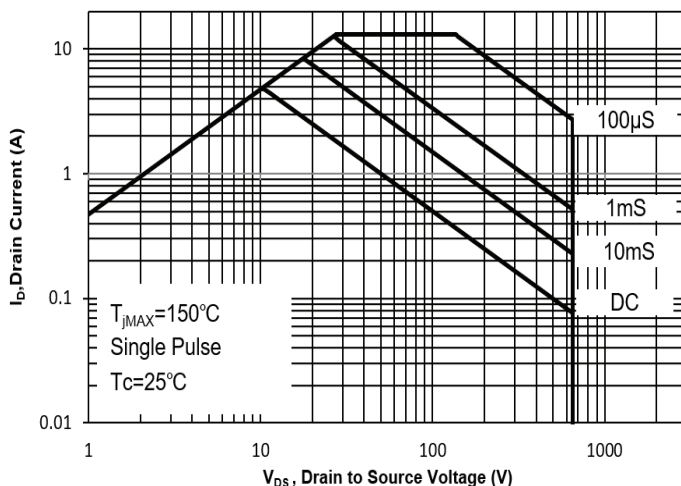


Fig. 12 Safe Operation Area



Electrical Characteristics Curves

Fig. 13 Normalized Maximum Transient Thermal Impedance($Z_{\theta JC}$)

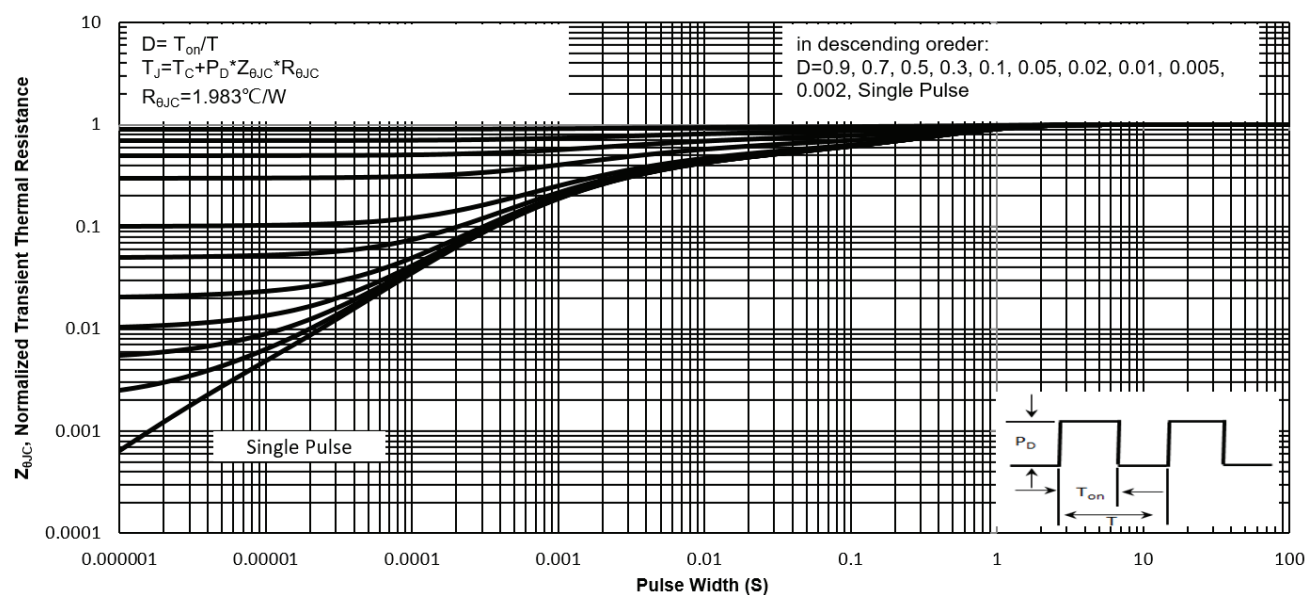
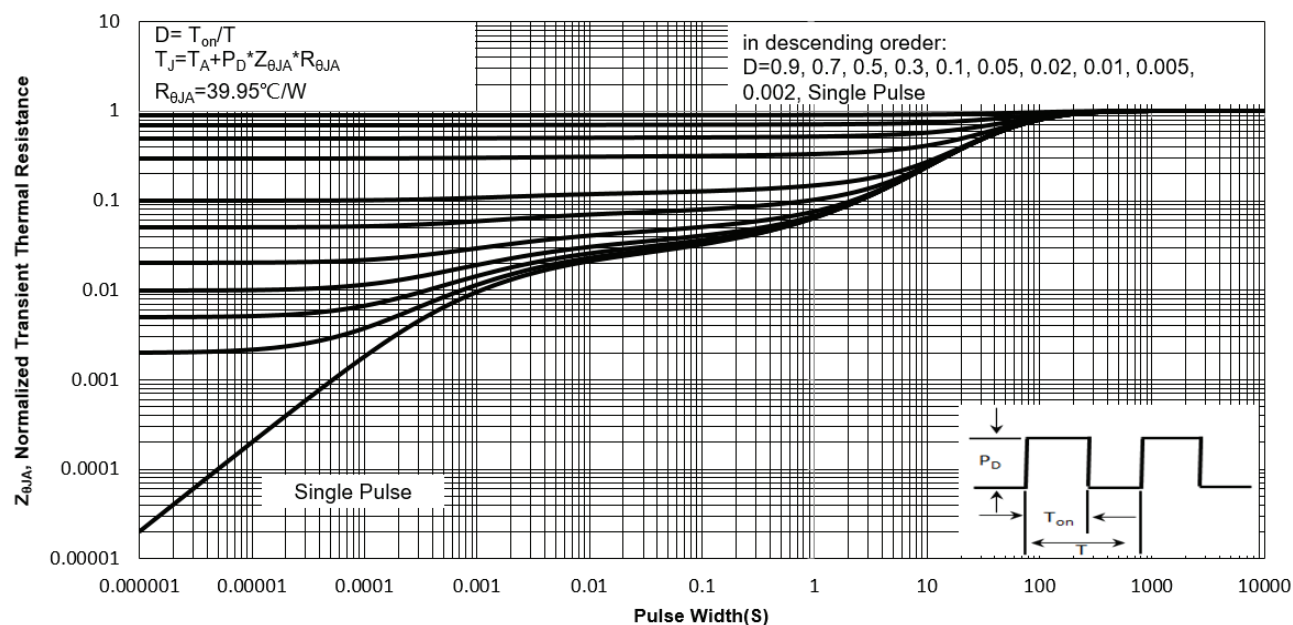


Fig. 14 Normalized Maximum Transient Thermal Impedance($Z_{\theta JA}$)



Test Circuits

Fig.1-1 Switching times test circuit

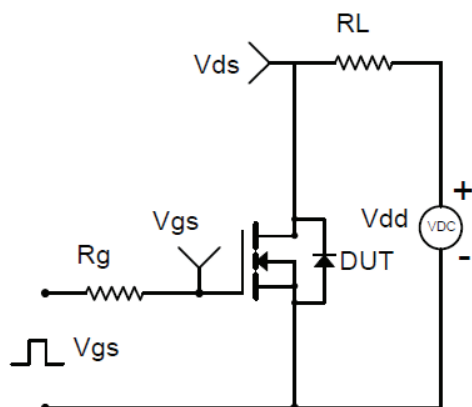


Fig.1-2 Switching Waveform

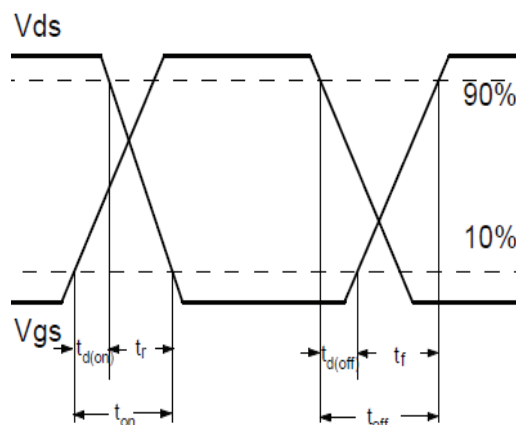


Fig.2-1 Gate charge test circuit

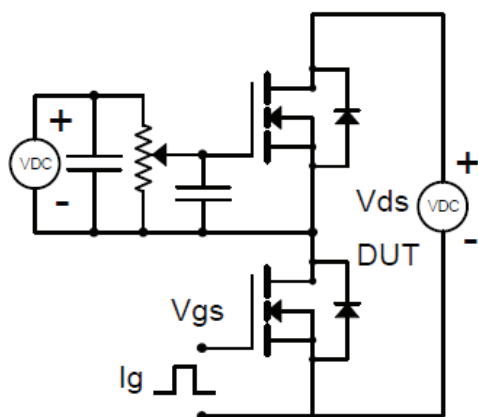


Fig.2-2 Gate charge waveform

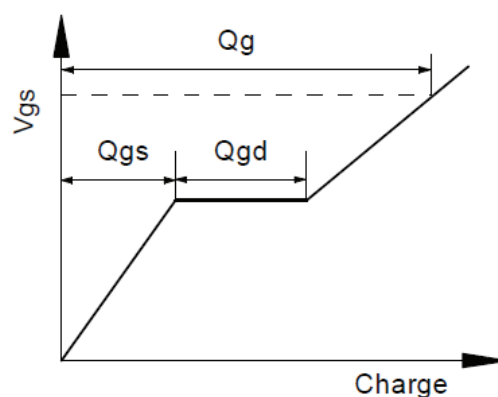


Fig.3-1 Avalanche test circuit

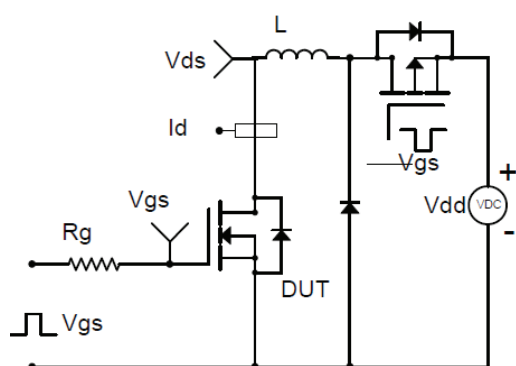
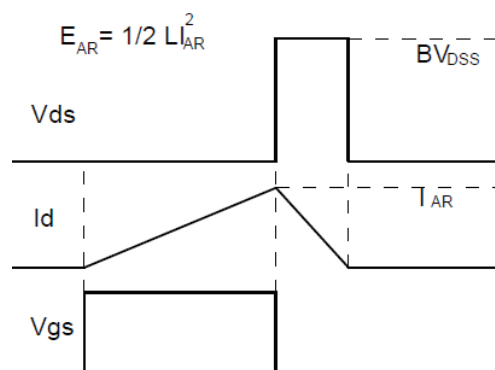
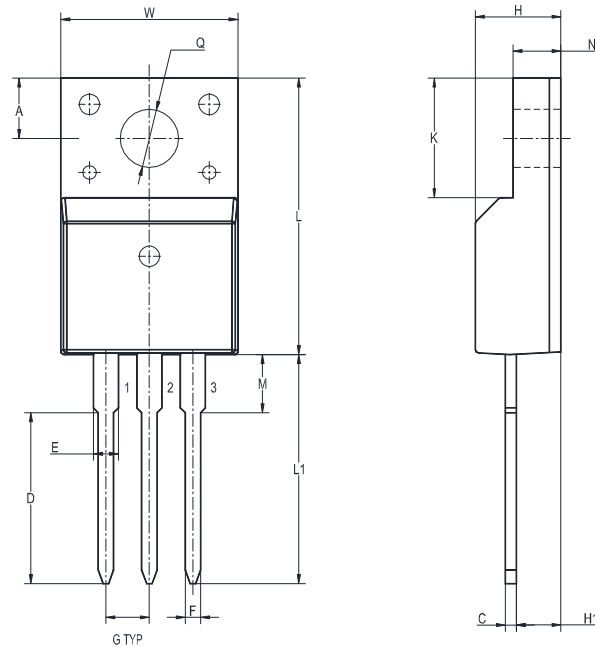


Fig.3-2 Avalanche waveform



Package Outline Dimensions (Units: mm)

TO-220F



UNIT	A	C	D	E	F	G	W	H	H1	Q	L	L1	M	K	N
mm	3.5	0.7	10.3	1.5	0.9	2.54	10.5	4.9	2.9	3.4	16	13.5	3.5	6.7	2.8
	2.8	0.4	9.7	1.1	0.7	TYP.	9.5	4.5	2.5	2.9	15	12.5	2.9	6.2	2.3

Packing information

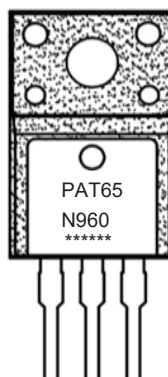
Package	Carton Quantity	Box Quantity	Base Quantity	Delivery Mode
TO-220F	5 K / Carton	1 K / Box	50 pcs / Tube	Tube

Marking information

" PAT65N960 " = Part No.

" ***** " = Date Code Marking

Font type: Arial



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