

N-Channel Enhancement Mode MOSFET

Features

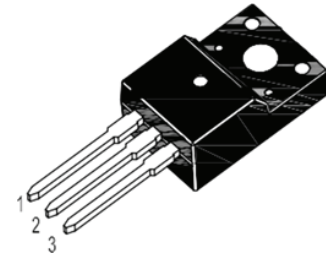
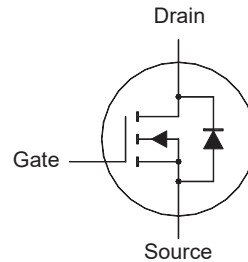
- Low Gate Charge
- Halogen and Antimony Free(HAF),
RoHS compliant

Application

- DC-DC Converters

Key Parameters

Parameter	Value	Unit
BV_{DSS}	600	V
$R_{DS(ON)}$ Max	160 @ $V_{GS} = 10\text{ V}$	m Ω
$V_{GS(th)}$ typ	3.1	V
Q_g typ	47 @ $V_{GS} = 10\text{ V}$	nC



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

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

Parameter	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	600	V
Gate-Source Voltage	V_{GS}	± 30	V
Drain Current	I_D	16 10	A
		$T_c = 25^\circ\text{C}$ $T_c = 100^\circ\text{C}$	
Peak Drain Current, Pulsed ¹⁾	I_{DM}	68	A
Avalanche Current	I_{AS}	4.9	A
Single Pulse Avalanche Energy ²⁾	E_{AS}	948	mJ
Power Dissipation	P_{tot}	104	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	$R_{\theta JC}$	1.2	$^\circ\text{C/W}$
Thermal Resistance from Junction to Ambient	$R_{\theta JA}$	50	$^\circ\text{C/W}$

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 $T_J = 25^\circ\text{C}$, $L = 79\text{ mH}$, $R_g = 25\text{ }\Omega$, $I_{AS} = 4.9\text{ A}$, $V_{GS} = 10\text{ V}$.

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}	600	-	-	V
Drain-Source Leakage Current at $V_{DS} = 600\ \text{V}$	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 $V_{GS} = 10\ \text{V}$, $I_D = 12\ \text{A}$	$R_{DS(on)}$	-	140	160	m Ω
DYNAMIC PARAMETERS					
Forward Transconductance at $V_{DS} = 5\ \text{V}$, $I_D = 10\ \text{A}$	g_{fs}	-	14.9	-	S
Gate Resistance at $V_{GS} = 0\ \text{V}$, $V_{DS} = 0\ \text{V}$, $f = 1\ \text{MHz}$	R_g	-	1.2	-	Ω
Input Capacitance at $V_{GS} = 0\ \text{V}$, $V_{DS} = 300\ \text{V}$, $f = 1\ \text{MHz}$	C_{iss}	-	1409	-	pF
Output Capacitance at $V_{GS} = 0\ \text{V}$, $V_{DS} = 300\ \text{V}$, $f = 1\ \text{MHz}$	C_{oss}	-	71	-	pF
Reverse Transfer Capacitance at $V_{GS} = 0\ \text{V}$, $V_{DS} = 300\ \text{V}$, $f = 1\ \text{MHz}$	C_{rss}	-	9	-	pF
Gate charge total at $V_{DS} = 300\ \text{V}$, $V_{GS} = 10\ \text{V}$, $I_D = 12\ \text{A}$	Q_g	-	47	-	nC
Gate to Source Charge at $V_{DS} = 300\ \text{V}$, $V_{GS} = 10\ \text{V}$, $I_D = 12\ \text{A}$	Q_{gs}	-	8.8	-	nC
Gate to Drain Charge at $V_{DS} = 300\ \text{V}$, $V_{GS} = 10\ \text{V}$, $I_D = 12\ \text{A}$	Q_{gd}	-	23	-	nC
Turn-On Delay Time at $V_{DS} = 300\ \text{V}$, $V_{GS} = 10\ \text{V}$, $I_D = 12\ \text{A}$, $R_g = 24\ \Omega$	$t_{d(on)}$	-	59	-	ns
Turn-On Rise Time at $V_{DS} = 300\ \text{V}$, $V_{GS} = 10\ \text{V}$, $I_D = 12\ \text{A}$, $R_g = 24\ \Omega$	t_r	-	25	-	ns
Turn-Off Delay Time at $V_{DS} = 300\ \text{V}$, $V_{GS} = 10\ \text{V}$, $I_D = 12\ \text{A}$, $R_g = 24\ \Omega$	$t_{d(off)}$	-	60	-	ns
Turn-Off Fall Time at $V_{DS} = 300\ \text{V}$, $V_{GS} = 10\ \text{V}$, $I_D = 12\ \text{A}$, $R_g = 24\ \Omega$	t_f	-	25	-	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	-	-	16	A
Body-Diode Continuous Current, Pulsed	I_{SM}	-	-	68	A
Body Diode Reverse Recovery Time at $I_S = 12\ \text{A}$, $di/dt = 100\ \text{A} / \mu\text{s}$	t_{rr}	-	372	-	ns
Body Diode Reverse Recovery Charge at $I_S = 12\ \text{A}$, $di/dt = 100\ \text{A} / \mu\text{s}$	Q_{rr}	-	5.9	-	μC

Electrical Characteristics Curves

Fig. 1 Typical Output Characteristics

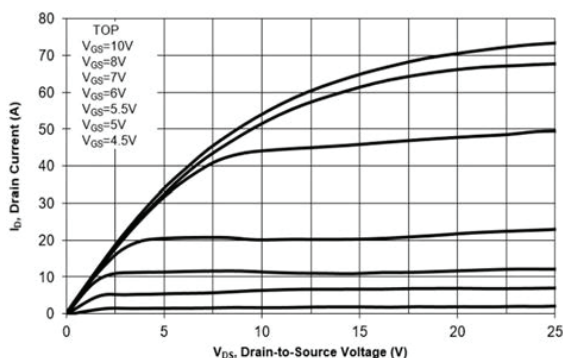


Fig. 2 Typical Transfer Characteristics

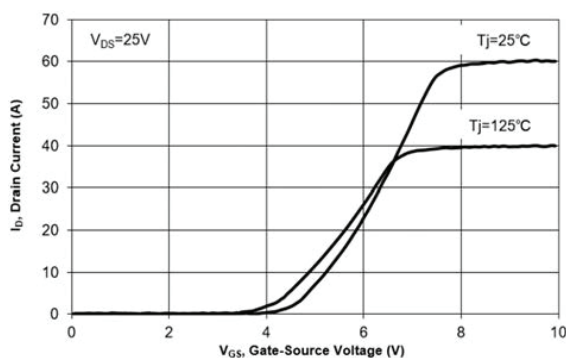


Fig. 3 on-Resistance vs. Drain Current

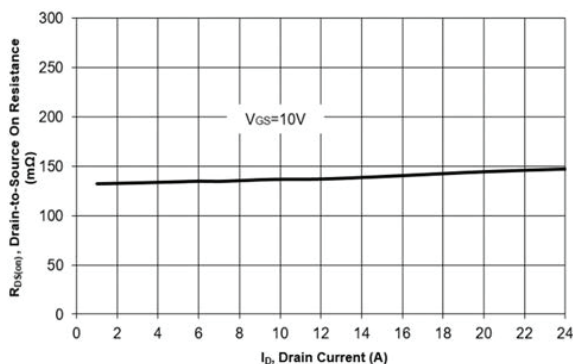


Fig. 4 on-Resistance vs. Gate to Source Voltage

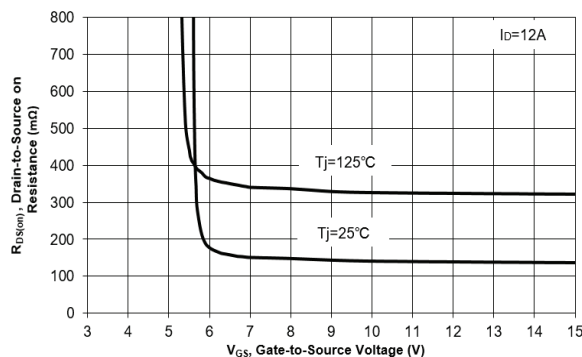


Fig. 5 on-Resistance vs. T_j

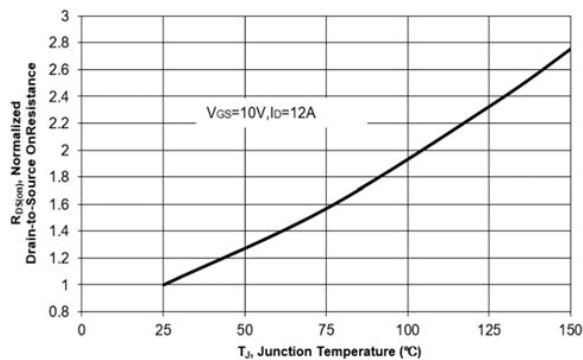


Fig. 6 Typical Body-Diode Forward Characteristics

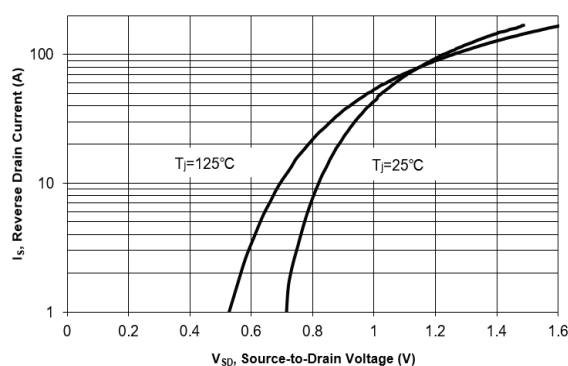


Fig. 7 Typical Junction Capacitance

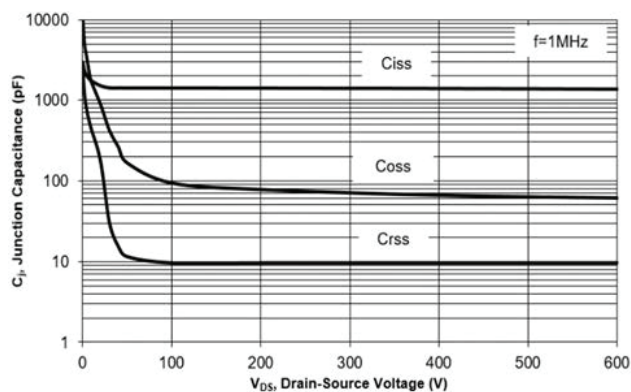


Fig. 8 Drain-Source Leakage Current vs. T_j

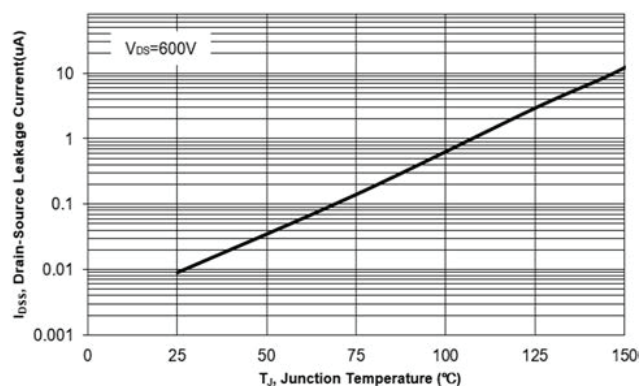


Fig. 9 $V_{(BR)DSS}$ vs. Junction Temperature

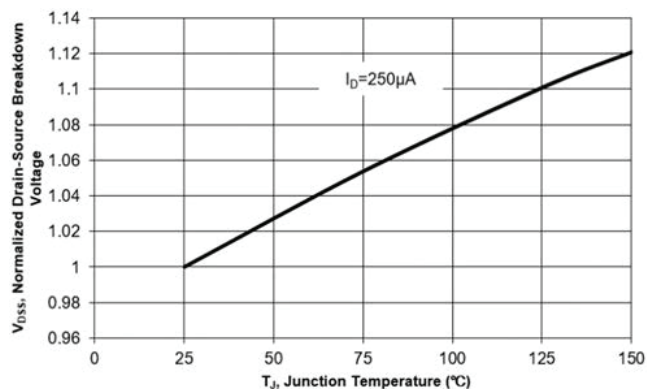


Fig. 10 Gate Threshold Variation vs. T_j

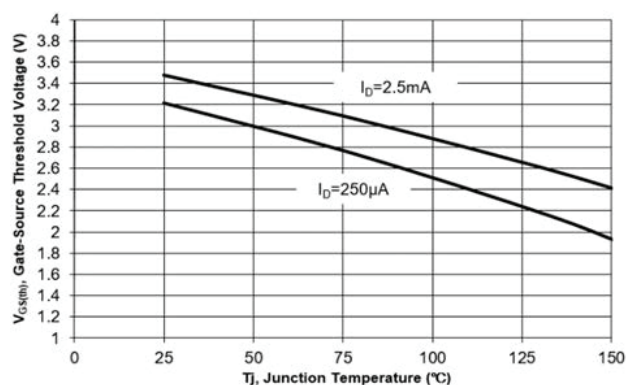


Fig. 11 Gate Charge

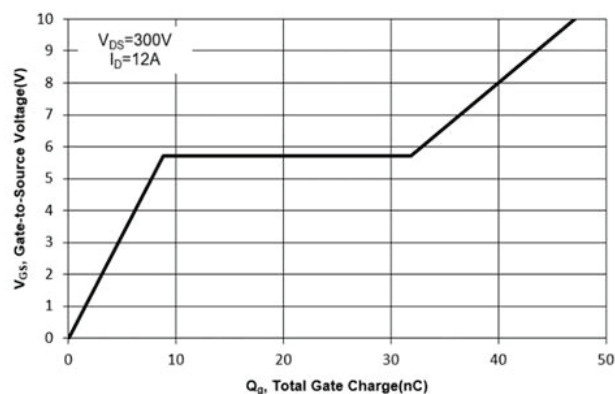
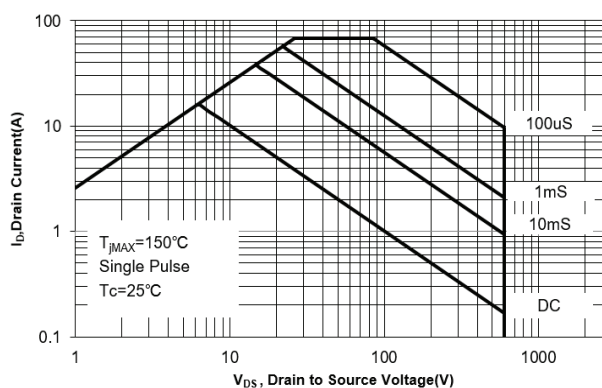


Fig. 12 Safe Operation Area



Electrical Characteristics Curves

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

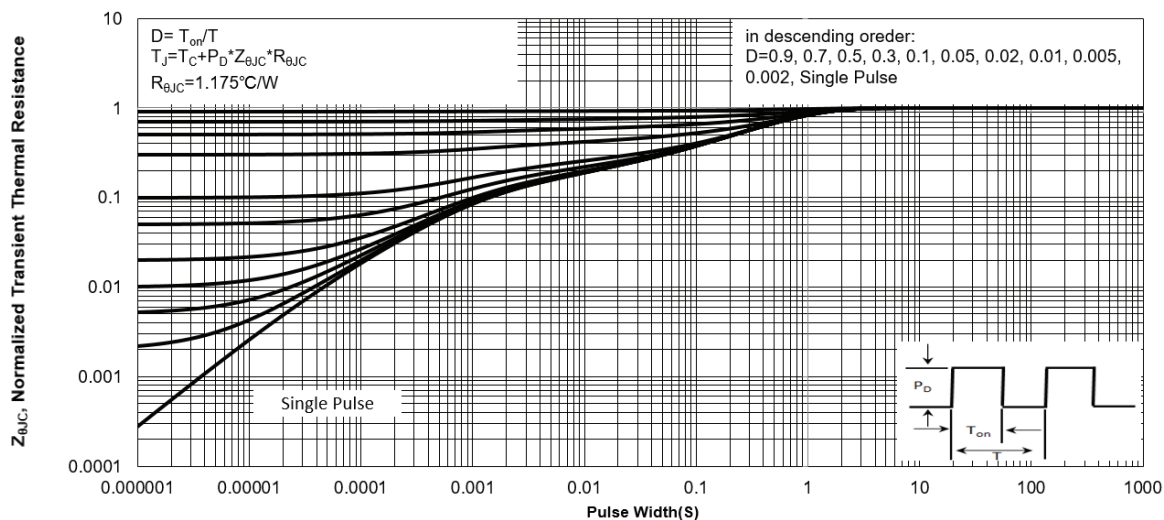
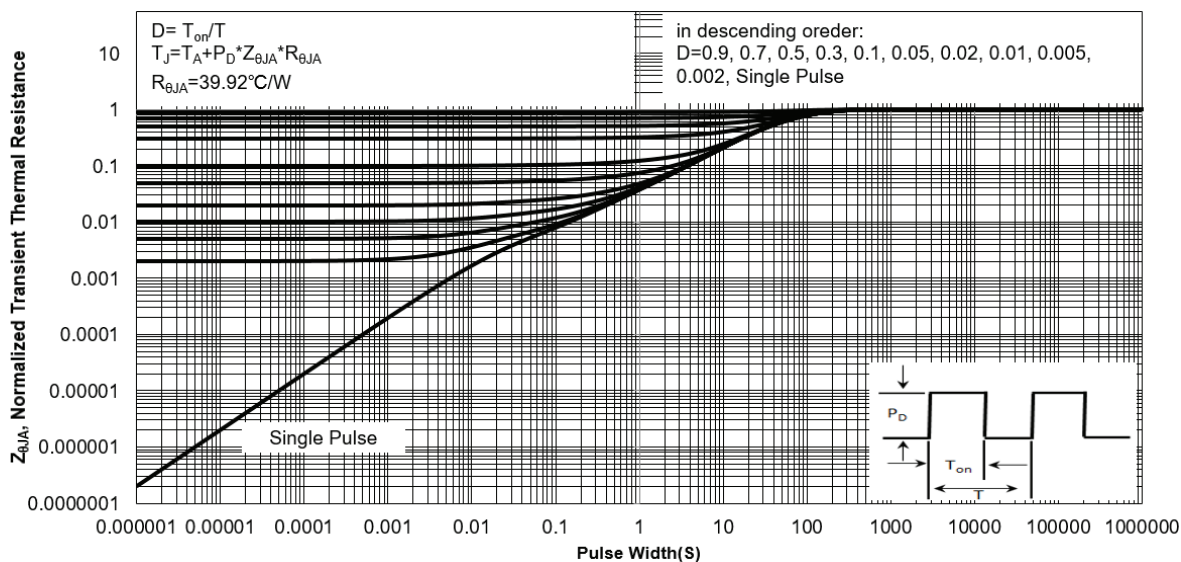
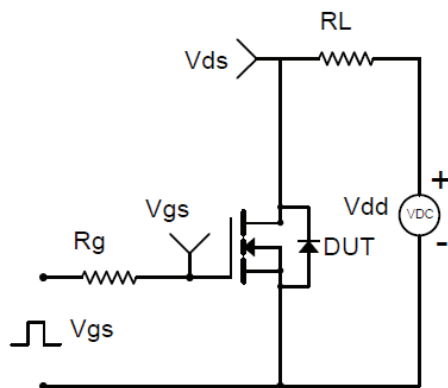
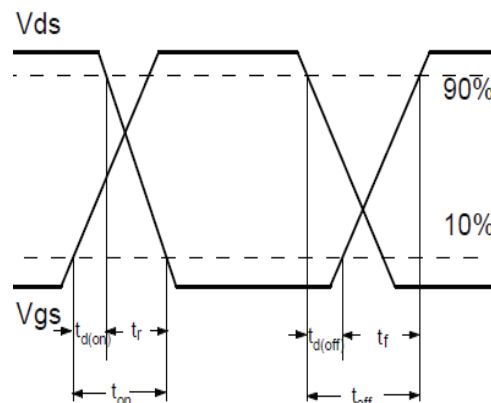
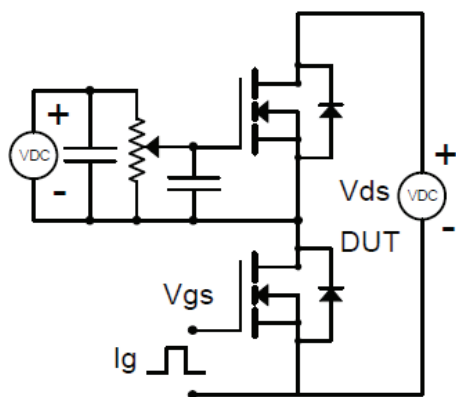
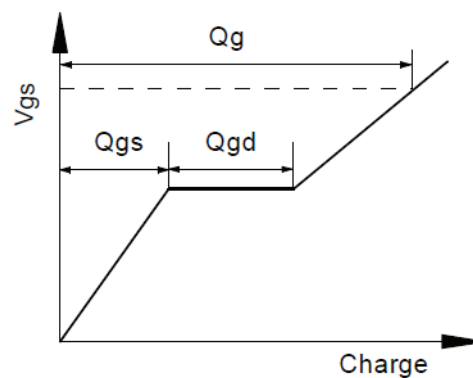
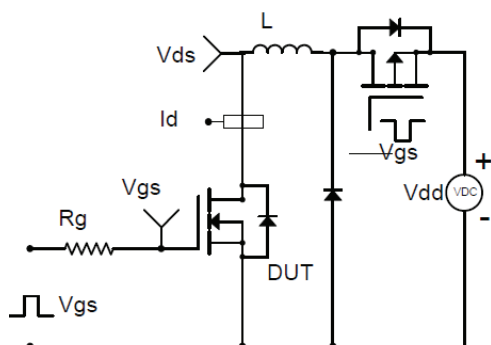
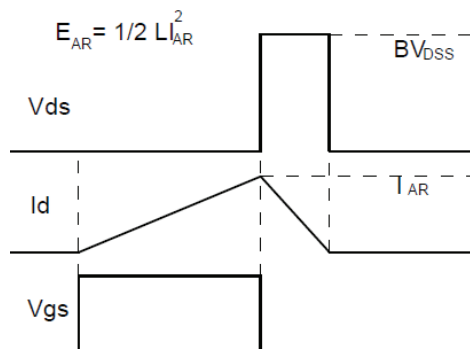


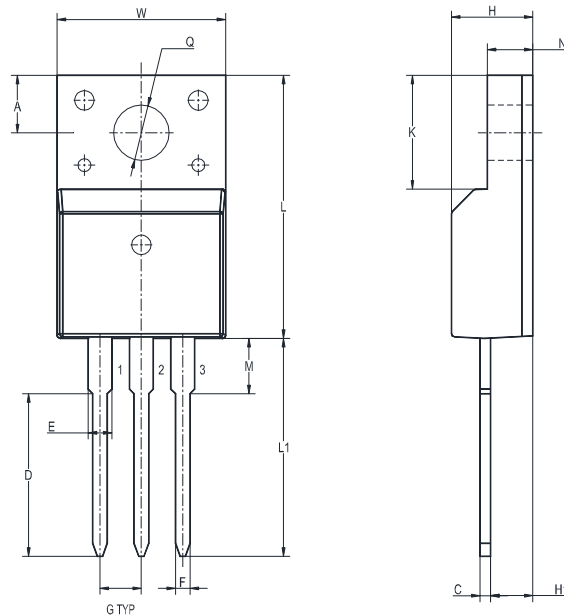
Fig. 14 Normalized Maximum Transient Thermal Impedance($Z_{\theta JA}$)



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

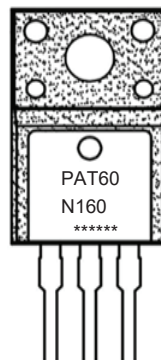
Package	Carton Quantity	Box Quantity	Base Quantity	Delivery Mode
TO-220F	5 K / Carton	1 K / Box	50 pcs / Tube	Tube

Marking information

" PAT60N160 " = Part No.

" ***** " = Date Code Marking

Font type: Arial



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