



650V N-Channel Power MOSFET

Product Summary

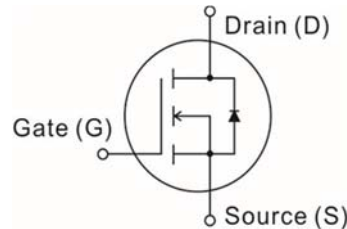
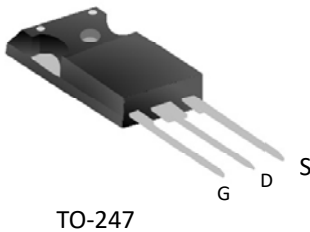
Parameter	Value	Unit
V _{DS} @ T _{jmax}	650	V
R _{DS(on)} , Max.	0.035	Ω
Qg, Typ.	172	nC
I _D , pulse	255	A
Q _{rr}	1.3	uC

Features

- * Ultra fast body diode
- * Best-in-class reverse recovery charge
- * Low gate charge
- * Low on-resistance

Application

- * ZVS Phase-Shift Converter
- * LLC application-Telecom, Server EV Charging



Package Marking and Ordering Information

Type / Ordering Code	Package	Packaging	Related Links
I3JA78N65Q	TO-247	Tube	see Package outline

Maximum ratings TA = 25°C unless otherwise noted				
Parameter		Symbol	Limit	Unit
Drain - source voltage		V _{DSS}	650	V
Continuous drain current	T _C @ 25°C	I _D	78	A
	T _C @ 100°C		46	
Pulsed drain current tp limited by T _j max (Note 1)	T _C @ 25°C	I _D pulsed	255	A
Single pulse avalanche energy (Note 2)		E _{AS}	3000	mJ
Avalanche current, repetitive		I _{AR}	13.7	A
MOSFET dv/dt ruggedness	V _{DS} = 0 ~ 400V	dv/dt	50	V/ns
Gate-source voltage		V _{GS}	± 30	V
Power dissipation	T _C @ 25°C	P _{tot}	500	W
Storage temperature range		T _{STG}	- 55 to +150	°C
Continuous diode forward current	T _C @ 25°C	I _S	72	A
Diode pulse current	T _C @ 25°C	I _S pulsed	255	A



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Electrical characteristics $T_A = 25^\circ\text{C}$ unless otherwise specified						
Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
On / Off characteristics						
Drain-source breakdown voltage	$V_{GS} = 0\text{V}, I_D = 1\text{mA}$	BV_{DSS}	650	---	---	V
Gate-source leakage	$V_{GS} = \pm 30\text{V}, V_{DS}=0\text{V}$	I_{GSS}	---	---	± 100	nA
Zero gate voltage drain current	$V_{DS}= 650\text{V}, V_{GS}= 0\text{V}, T_j=25^\circ\text{C}$	I_{DSS}	---	---	10	uA
	$V_{DS}= 520\text{V}, V_{GS}= 0\text{V}, T_j=125^\circ\text{C}$		---	350	---	
Drain-source on-state resistance	$V_{GS} = 10\text{V}, I_D= 34\text{A}, T_j=25^\circ\text{C}$	$R_{DS(on)}$	---	0.031	0.035	Ω
	$V_{GS} = 10\text{V}, I_D= 34\text{A}, T_j=150^\circ\text{C}$		---	0.078	---	
Gate-source threshold voltage	$V_{DS} = V_{GS}, I_D = 250\mu\text{A}$	$V_{GS(th)}$	3.5	4.0	4.5	V
Dynamic characteristics						
Input capacitance	$V_{GS} = 0\text{V}, V_{DS} = 100\text{V},$ $f = 1\text{MHz}$	C_{iss}	---	7500	---	pF
Output capacitance		C_{oss}	---	290	---	
Effective output capacitance, energy related	$V_{GS}=0\text{V}, V_{DD}=0\sim 400\text{V}$	$C_{O(er)}$	---	300	---	
Effective output capacitance, time related	$I_D = I_{CONST}, V_{GS}=0\text{V}, V_{DD}=0\sim 400\text{V}$	$C_{O(tr)}$	---	1400	---	
Turn-on delay time	$V_{DD} = 400\text{V}, I_D = 50\text{A}$ $V_{GS} = 13\text{V}, R_G = 1.8\Omega$	$t_{d(on)}$	---	32	---	ns
Rise time		t_r	---	23	---	
Turn-off delay time		$t_{d(off)}$	---	91.6	---	
Fall time		t_f	---	6.8	---	
Gate resistance	$f = 1\text{MHz}, \text{open drain}$	R_G	---	1.2	---	Ω
Gate-source charge	$V_{DD} = 480\text{V}, I_D = 50\text{A}$ $V_{GS} = 0 \text{ to } 10\text{V}$	Q_{gs}	---	50	---	nC
Gate-drain charge		Q_{gd}	---	65	---	
Gate charge total		Q_g	---	172	---	
Gate plateau voltage		V_p	---	6.2	---	

Drain-source diode characteristics						
Inverse diode forward voltage	$I_S = 50\text{A}, V_{GS} = 0\text{V}, T_j=25^\circ\text{C}$	V_{SD}	---	1.0	---	V
Reverse recovery time	$V_R=400\text{V}, I_F = 10\text{A},$ $di_F / dt = 100\text{A} / \mu\text{S}$	t_{rr}	---	190	---	ns
Reverse recovery charge		Q_{rr}	---	1.3	---	uC
Peak reverse recovery current		I_{rm}	---	13	---	A

Notes:

1. Repetitive rating : pulsed width limited by maximum junction temperature.
2. $V_{DD} = 50\text{V}, \text{starting } T_j=25^\circ\text{C}.$



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Thermal characteristics			
Thermal resistance junction-to-case	R_{thJC}	0.25	°C / W
Thermal resistance junction-to-ambient	R_{thJA}	62	

Electrical characteristics diagrams

Fig 1: Power dissipation

$P_{tot} = f(T_c)$

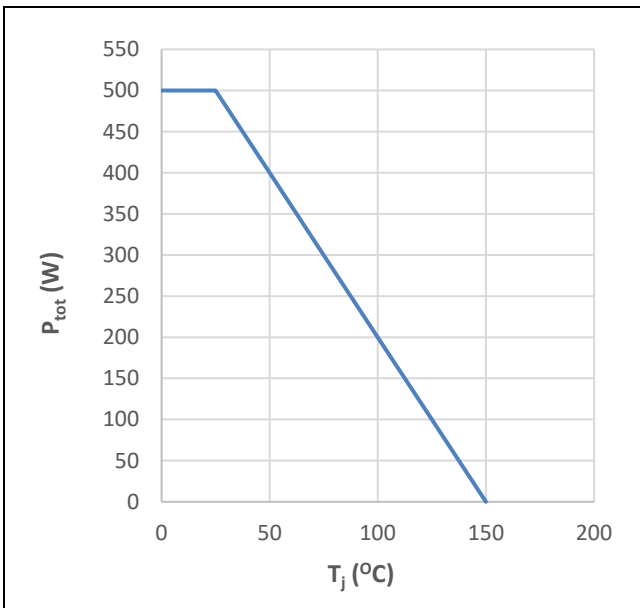
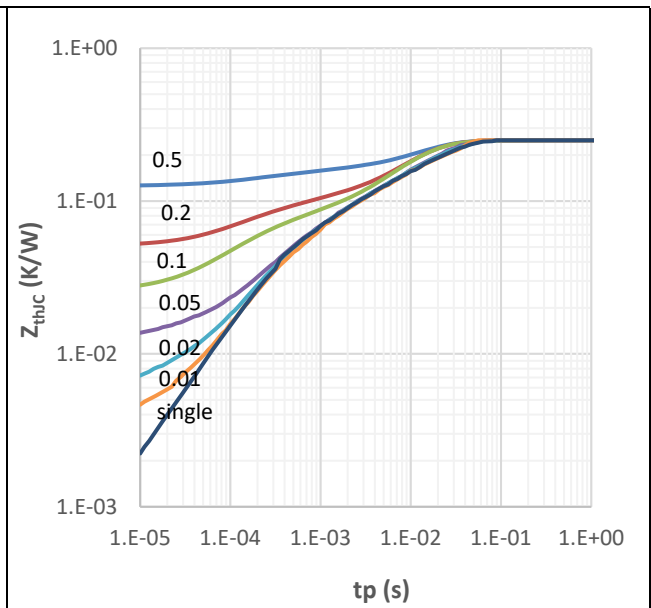


Fig 2: Transient thermal impedance

$Z_{thJC} = f(tp)$; parameter : $D = tp / T$





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Fig 3: Safe operating area

$I_D = f(V_{DS})$, $D = 0$, $T_C = 25^\circ\text{C}$; parameter: t_p , $V_{GS} > 7.5\text{V}$

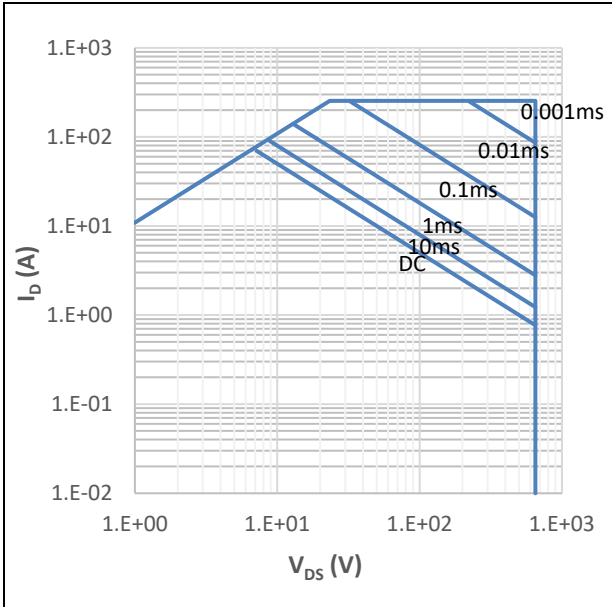


Fig 4: Typ. output characteristics

$I_D = f(V_{DS})$; $T_J = 25^\circ\text{C}$; parameter: V_{GS}

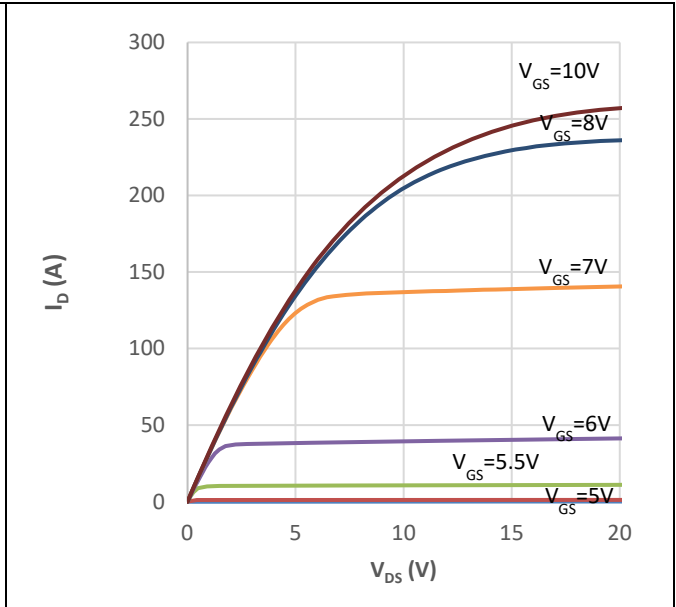


Fig 5: Typ. output characteristics

$I_D = f(V_{DS})$; $T_J = 125^\circ\text{C}$; parameter: V_{GS}

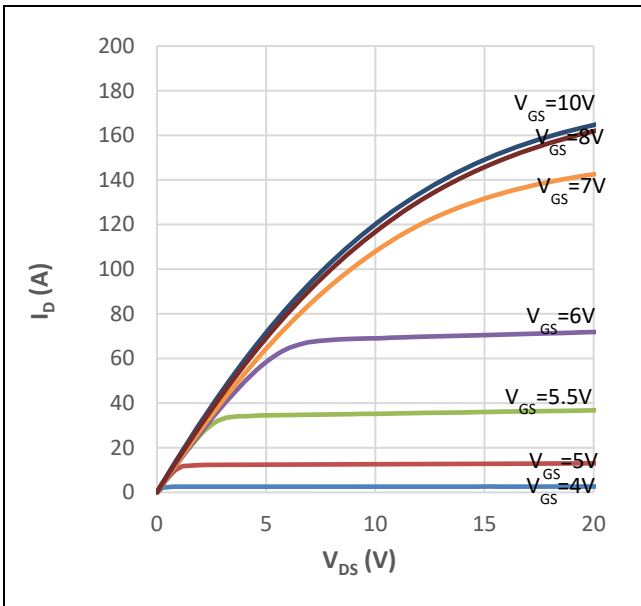
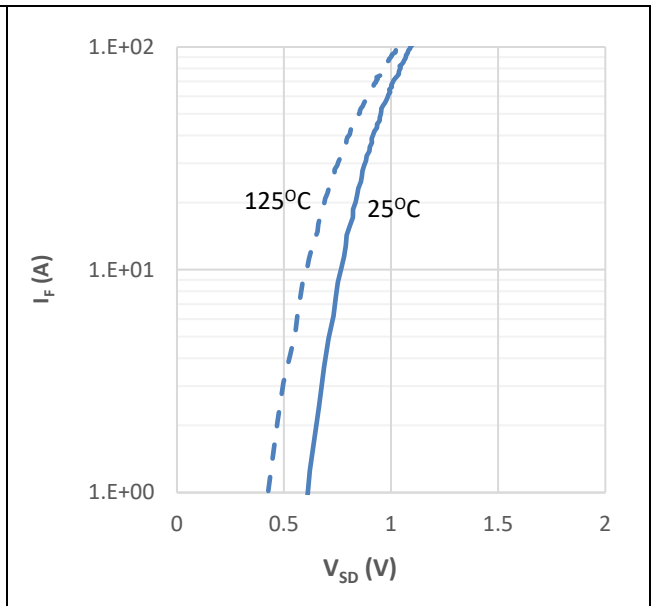


Fig 6: Forward characteristics of body diode

$I_F = f(V_{SD})$; parameter: T_J





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Fig 7: Typ. Drain source on-resistance

$R_{DS(on)} = f(I_D)$, $T_j = 125^\circ\text{C}$; parameter : V_{GS}

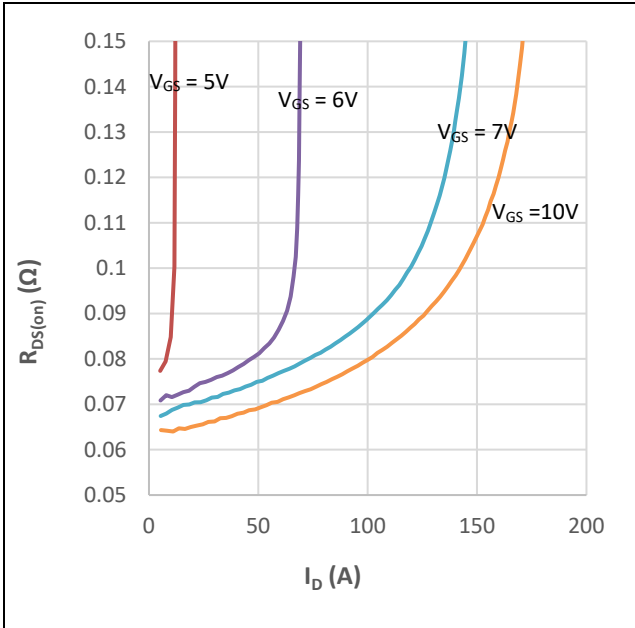


Fig 8: Drain-source on-state resistance

$R_{DS(on)} = f(T_j)$, $I_D = 34A$, $V_{GS} = 10V$

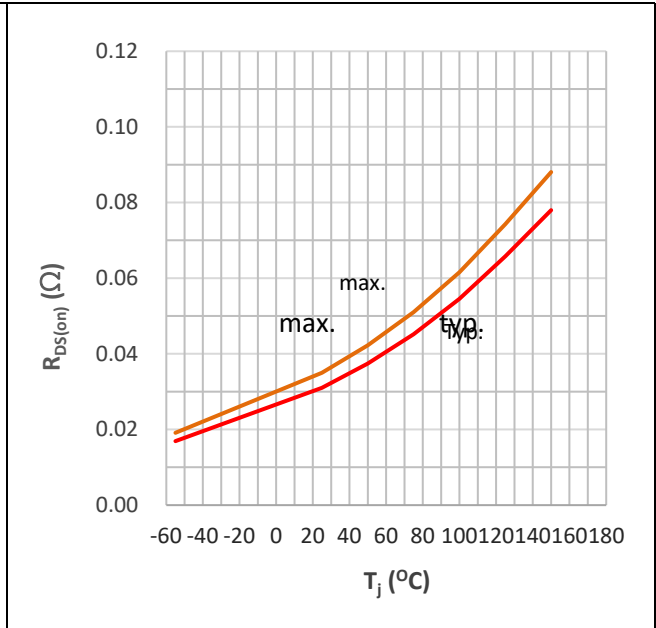


Fig 9: Typ. transfer characteristics

$I_D = f(V_{GS})$; $V_{DS} = 20V$; parameter : T_j

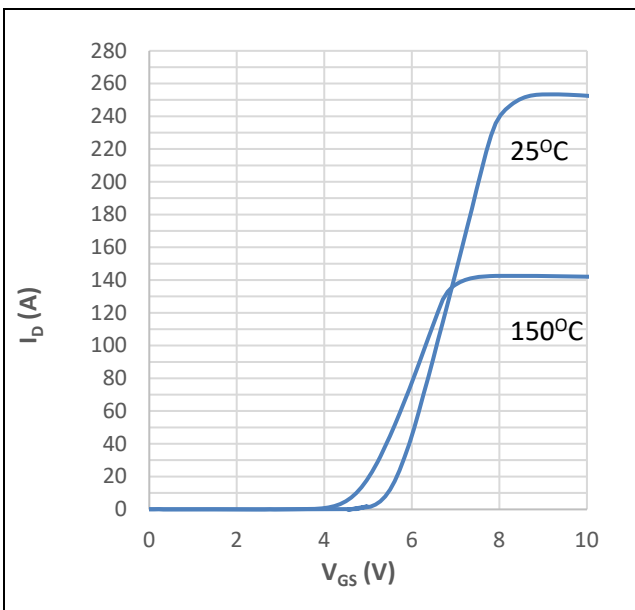
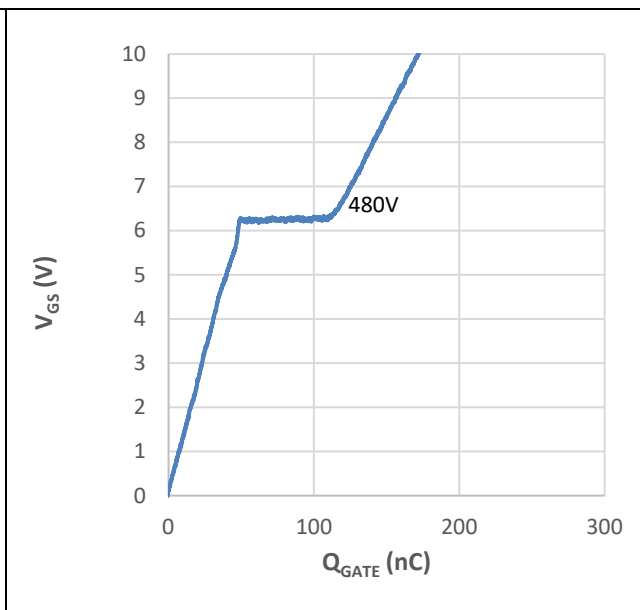


Fig 10: Typ. gate charge

$V_{GS} = f(Q_{GATE})$; $I_D = 50A$ pulsed parameter : V_{DD}





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Fig 11: Avalanche energy

$E_{AS} = f(T_j)$; $I_D = 13.7A$; $V_{DD} = 50A$

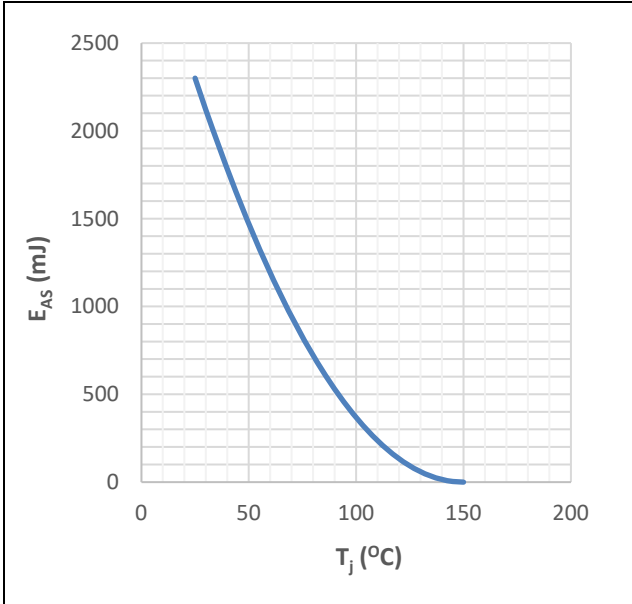


Fig 12: Typ. c_{oss} stored energy

$E_{oss} = f(V_{DS})$

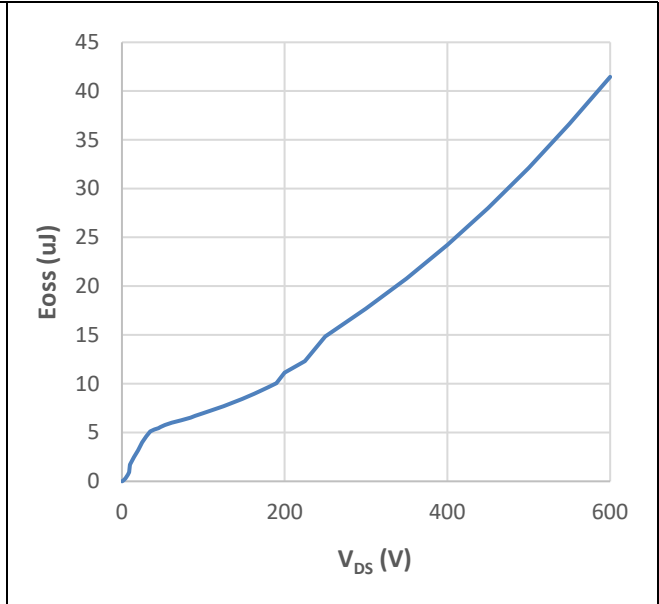
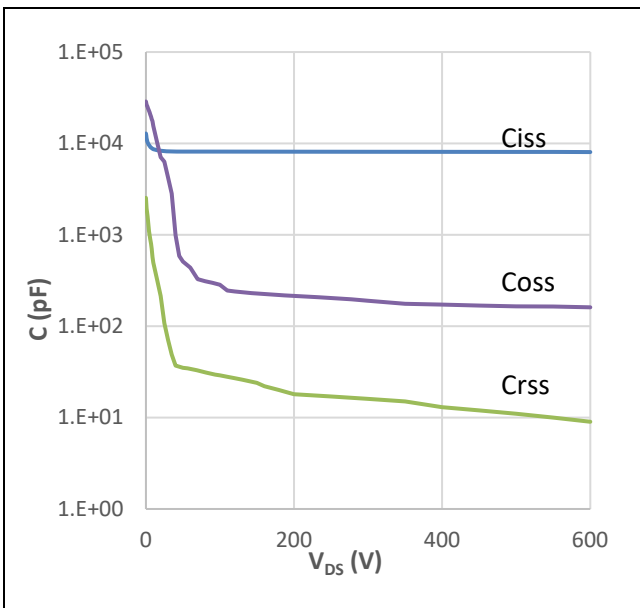


Fig 13: Typ. Capacitances

$C = f(V_{DS})$ parameter : $V_{GS} = 0V$, $f = 1MHz$





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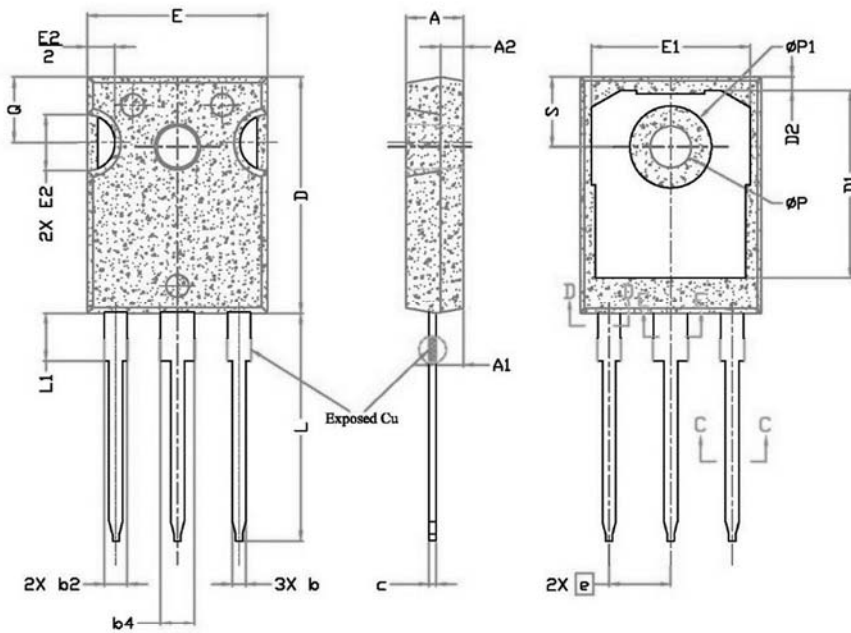
Test Circuit

<p>Unclamped test circuit</p>	<p>Unclamped test waveform</p>
<p>Gate charge test circuit</p> <p>10V Pulse width ≤ 1us Duty factor ≤ 0.1%</p>	<p>Basic gate charge waveform</p>
<p>Diode recovery test circuit</p> <p>Current regulator Same type as D.U.T. 50kΩ 2uF 0.3uF 12V 3mA Current sampling resistors</p>	<p>Diode recovery test waveform</p>
<p>Switching test circuit (resistor load)</p>	<p>Switching test waveform</p>



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Package outline



- Note:
1. Package Reference: JEDEC TO247, Variation AD.
 2. All Dimensions Are In mm.
 3. Slot Required, Notch May Be Rounded
 4. Dimension D & E Do Not Include Mold Flash. Mold Flash Shall Not Exceed 0.127mm Pre Side. These Dimensions Are Measured At The Outermost Extreme Of The Plastic Body.
 5. Thermal Pad Contour Optional Within Dimension D1 & E1.
 6. Lead Finish Uncontrolled In L1.
 7. ØP To Have A Maximum Draft Angle Of 1.5° To The Top Of The Part With A Maximum Hole Diameter Of 3.91mm.
 8. Dimension "b2" And "b4" Does Not Include Dambar Protrusion. Allowable Dambar Protrusion Shall Be 0.10mm Total In Excess Of "b2" And "b4" Dimension At Maximum Material Condition.

SYMBOL	DIMENSIONS			NOTES
	MIN.	NOM.	MAX.	
A	4.83	5.02	5.21	
A1	2.29	2.41	2.55	
A2	1.50	2.00	2.49	
b	1.12	1.20	1.33	
b1	1.12	1.20	1.28	
b2	1.91	2.00	2.39	6
b3	1.91	2.00	2.34	
b4	2.67	3.00	3.22	6, 8
b5	2.67	3.00	3.18	
c	0.55	0.60	0.69	6
c1	0.55	0.60	0.65	
D	20.80	20.95	21.10	4
D1	16.25	16.55	17.65	5
D2	0.51	1.19	1.35	
E	15.75	15.94	16.13	4
E1	13.46	14.02	14.16	5
E2	4.32	4.91	5.49	3
e	5.44BSC			
L	19.81	20.07	20.32	
L1	4.10	4.19	4.40	6
ØP	3.56	3.61	3.65	7
ØP1	7.19REF.			
Q	5.39	5.79	6.20	
S	6.04	6.17	6.30	