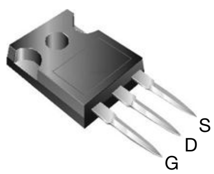
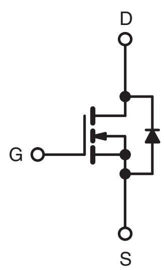
Power MOSFET

PRODUCT SUMMARY		
V_{DS} (V)	600	
$R_{DS(on)}$ (Ω)	V_{GS} = 10 V	0.27
Q_g (Max.) (nC)	150	
Q_{gs} (nC)	46	
Q_{gd} (nC)	64	
Configuration	Single	

TO-247AC





N-Channel MOSFET

FEATURES

- Superfast Body Diode Eliminates the Need for External Diodes in ZVS Applications
- Lower Gate Charge Results in Simple Drive Requirements
- Enhanced dV/dt Capabilities Offer Improved Ruggedness
- Higher Gate Voltage Threshold Offers Improved Noise Immunity
- Compliant to RoHS Directive 2002/95/EC

Pb Available
RoHS* COMPLIANT

APPLICATIONS

- Zero Voltage Switching SMPS
- Telecom and Server Power Supplies
- Uninterruptible Power Supplies
- Motor Control Applications

ORDERING INFORMATION	
Package	TO-247AC
Lead (Pb)-free	IRFP21N60LPbF
	SiHFP21N60L-E3
SnPb	IRFP21N60L
	SiHFP21N60L

ABSOLUTE MAXIMUM RATINGS (T_C = 25 °C, unless otherwise noted)

PARAMETER			SYMBOL	LIMIT	UNIT
Drain-Source Voltage			V_{DS}	600	V
Gate-Source Voltage			V_{GS}	± 30	
Continuous Drain Current	V_{GS} at 10 V	T_C = 25 °C	I_D	21	A
		T_C = 100 °C		13	
Pulsed Drain Current[a]			I_{DM}	84	
Linear Derating Factor				2.6	W/°C
Single Pulse Avalanche Energy[b]			E_{AS}	420	mJ
Repetitive Avalanche Current[a]			I_{AR}	21	A
Repetitive Avalanche Energy[a]			E_{AR}	33	mJ
Maximum Power Dissipation	T_C = 25 °C		P_D	330	W
Peak Diode Recovery dV/dt[c]			dV/dt	16	V/ns
Operating Junction and Storage Temperature Range			T_J, T_{stg}	- 55 to + 150	°C
Soldering Recommendations (Peak Temperature)	for 10 s			300[d]	
Mounting Torque	6-32 or M3 screw			10	lbf · in
				1.1	N · m

Notes

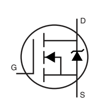
a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
b. Starting T_J = 25 °C, L = 1.9 mH, R_g = 25 Ω, I_{AS} = 21 A, dV/dt = 11 V/ns (see fig. 12a).
c. $I_{SD} \le 21$ A, dI/dt ≤ 530 A/μs, $V_{DD} \le V_{DS}$, $T_J \le 150$ °C.
d. 1.6 mm from case.

* Pb containing terminations are not RoHS compliant, exemptions may apply

THERMAL RESISTANCE RATINGS

PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	R_{thJA}	-	40	°C/W
Case-to-Sink, Flat, Greased Surface	R_{thCS}	0.24	-	
Maximum Junction-to-Case (Drain)	R_{thJC}	-	0.38	

SPECIFICATIONS (T_J = 25 °C, unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Static							
Drain-Source Breakdown Voltage	V_{DS}	V_{GS} = 0 V, I_D = 250 μA		600	-	-	V
V_{DS} Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, I_D = 1 mA		-	420	-	mV/°C
Gate-Source Threshold Voltage	$V_{GS(th)}$	V_{DS} = V_{GS}, I_D = 250 μA		3.0	-	5.0	V
Gate-Source Leakage	I_{GSS}	V_{GS} = ± 30 V		-	-	± 100	nA
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS} = 600 V, V_{GS} = 0 V		-	-	50	μA
		V_{DS} = 480 V, V_{GS} = 0 V, T_J = 125 °C		-	-	2.0	mA
Drain-Source On-State Resistance	$R_{DS(on)}$	V_{GS} = 10 V	I_D = 13 A[b]	-	0.27	0.32	Ω
Forward Transconductance	g_{fs}	V_{DS} = 50 V, I_D = 13 A		11	-	-	S
Dynamic							
Input Capacitance	C_{iss}	V_{GS} = 0 V, V_{DS} = 25 V, f = 1.0 MHz, see fig. 5		-	4000	-	pF
Output Capacitance	C_{oss}			-	340	-	
Reverse Transfer Capacitance	C_{rss}			-	29	-	
Effective Output Capacitance	C_{oss} eff.	V_{GS} = 0 V, V_{DS} = 0 V to 480 V[c]		-	170	-	
Effective Output Capacitance (Energy Related)	C_{oss} eff. (ER)			-	130	-	
Total Gate Charge	Q_g	V_{GS} = 10 V	I_D = 21 A, V_{DS} = 480 V see fig. 7 and 15[b]	-	-	150	nC
Gate-Source Charge	Q_{gs}			-	-	46	
Gate-Drain Charge	Q_{gd}			-	-	64	
Gate Resistance	R_g	f = 1 MHz, open drain		-	0.63	-	Ω
Turn-On Delay Time	$t_{d(on)}$	V_{DD} = 300 V, I_D = 21 A, R_g = 1.3 Ω, V_{GS} = 10 V, see fig. 11a and 11b[b]		-	20	-	ns
Rise Time	t_r			-	58	-	
Turn-Off Delay Time	$t_{d(off)}$			-	33	-	
Fall Time	t_f			-	10	-	
Drain-Source Body Diode Characteristics							
Continuous Source-Drain Diode Current	I_S	MOSFET symbol showing the integral reverse p - n junction diode		-	-	21	A
Pulsed Diode Forward Current[a]	I_{SM}			-	-	84	
Body Diode Voltage	V_{SD}	T_J = 25 °C, I_S = 21 A, V_{GS} = 0 V[b]		-	-	1.5	V
Body Diode Reverse Recovery Time	t_{rr}	T_J = 25 °C, I_F = 21 A		-	160	240	ns
		T_J = 125 °C, dI/dt = 100 A/μs[b]		-	400	610	
Body Diode Reverse Recovery Charge	Q_{rr}	T_J = 25 °C, I_F = 21 A, V_{GS} = 0 V[b]		-	480	730	nC
		T_J = 125 °C, dI/dt = 100 A/μs[b]		-	1540	2310	
Reverse Recovery Time	I_{RRM}	T_J = 25 °C		-	5.3	7.9	A
Forward Turn-On Time	t_{on}	Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D)					

Notes

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
b. Pulse width ≤ 300 μs; duty cycle ≤ 2 %.
c. C_{oss} eff. is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising form 0 % to 80 % V_{DS}.
C_{oss} eff. (ER) is a fixed capacitance that stores the same energy as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DS}.

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

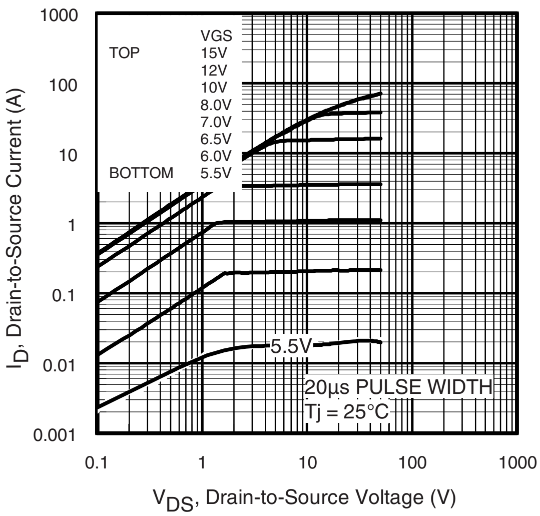


Fig. 1 - Typical Output Characteristics

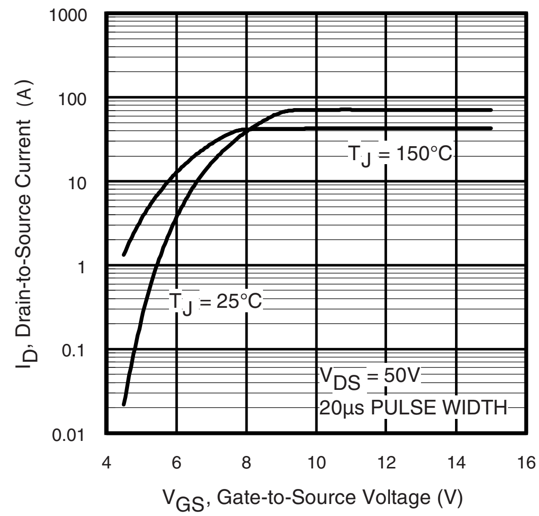


Fig. 3 - Typical Transfer Characteristics

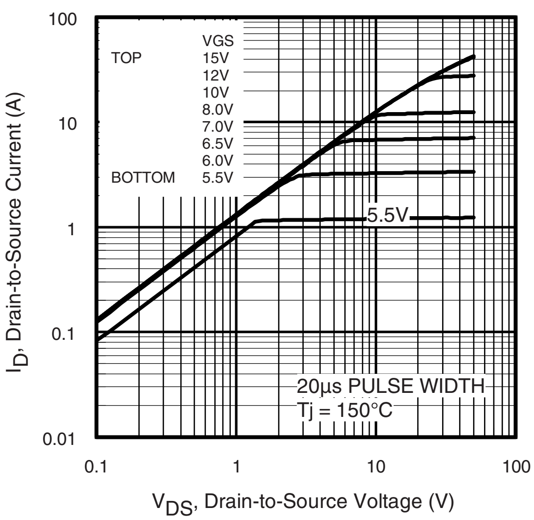


Fig. 2 - Typical Output Characteristics

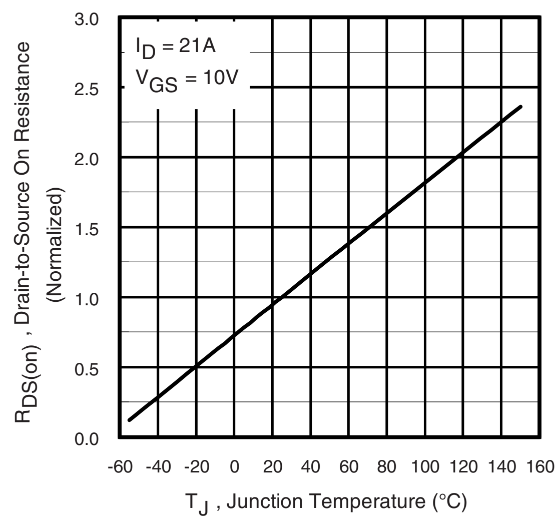


Fig. 4 - Normalized On-Resistance vs. Temperature

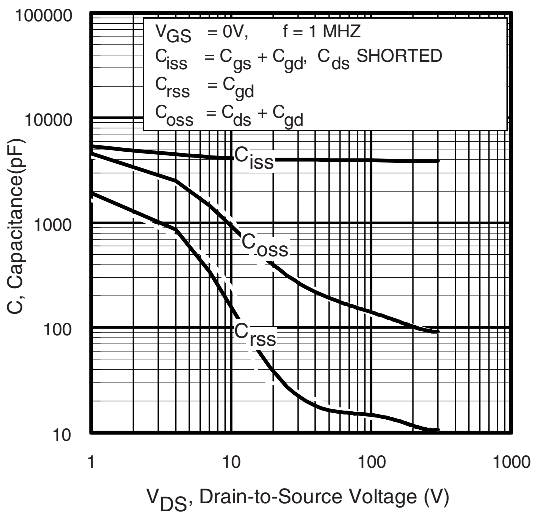


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

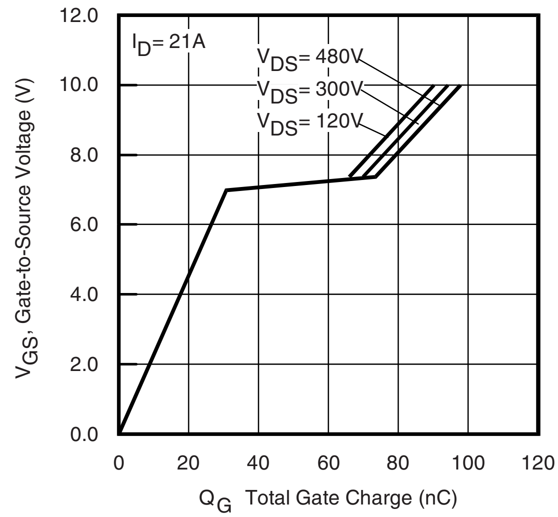


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

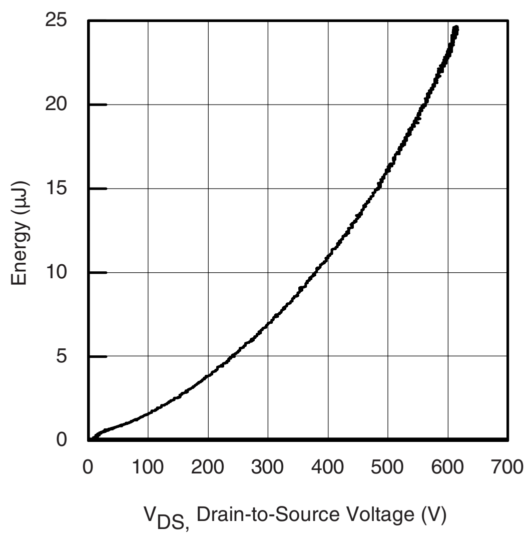


Fig. 6 - Typical Output Capacitance Stored Energy vs. V_{DS}

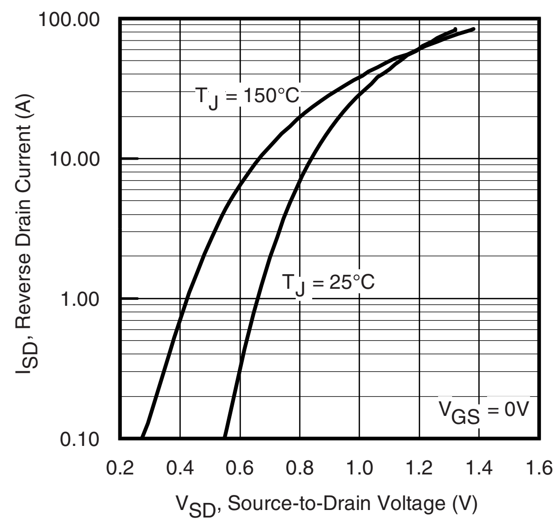


Fig. 8 - Typical Source-Drain Diode Forward Voltage

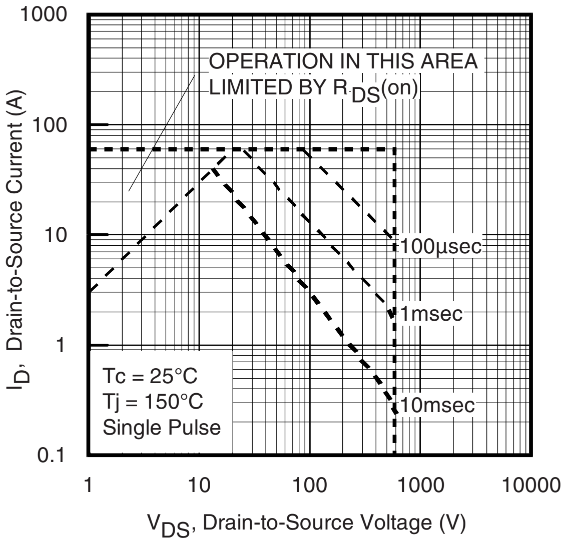


Fig. 9 - Maximum Safe Operating Area

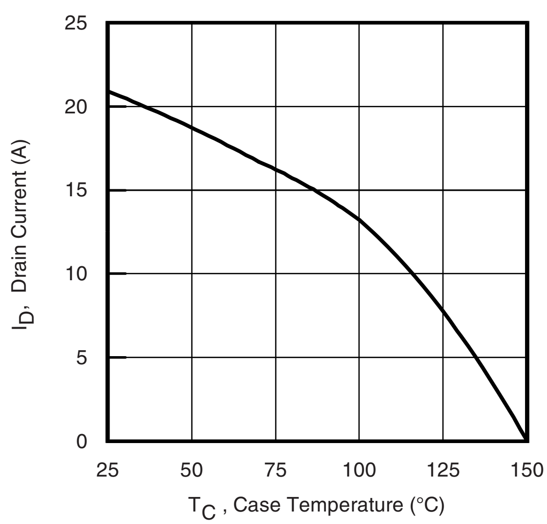


Fig. 10 - Maximum Drain Current vs. Case Temperature

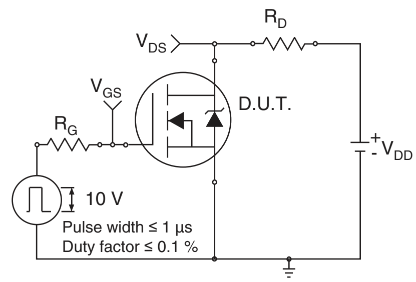


Fig. 11a - Switching Time Test Circuit

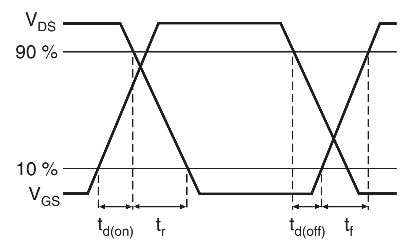


Fig. 11b - Switching Time Waveforms

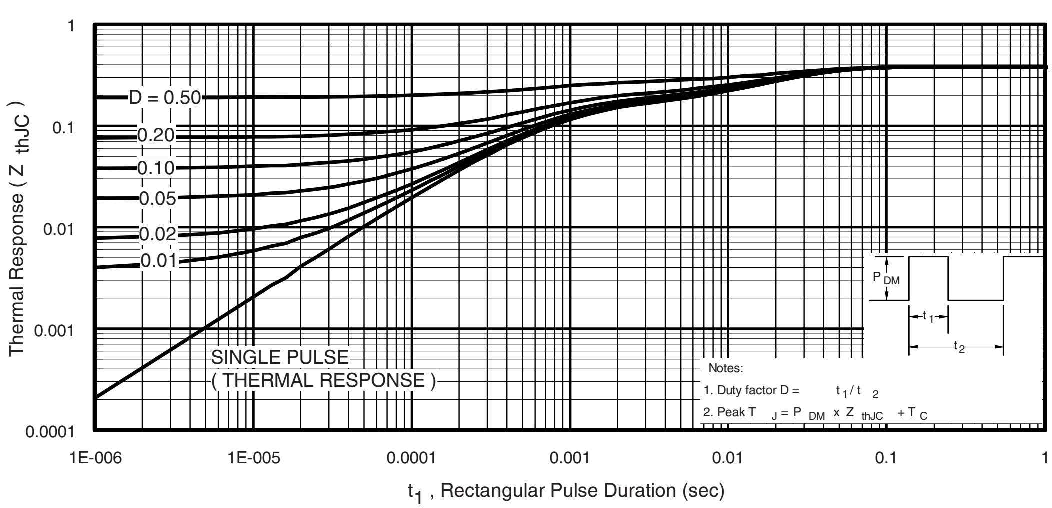


Fig. 12 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

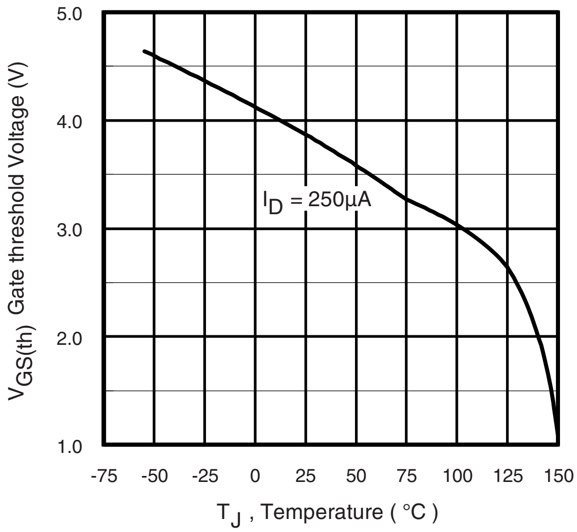


Fig. 13 - Threshold Voltage vs. Temperature

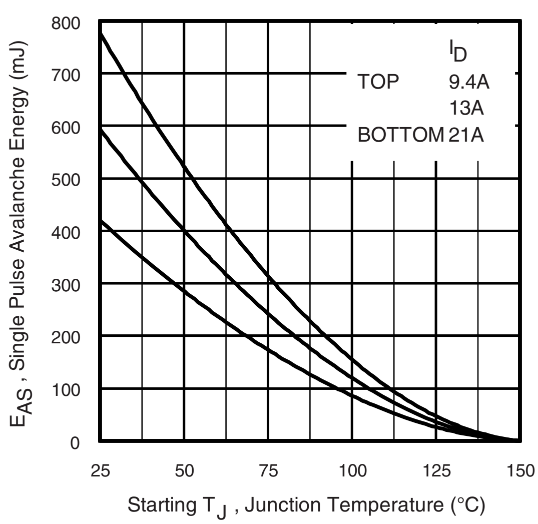


Fig. 14a - Maximum Avalanche Energy vs. Drain Current

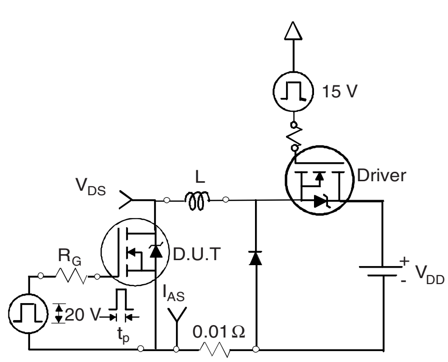


Fig. 14b - Unclamped Inductive Test Circuit

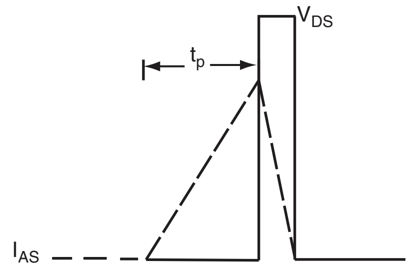


Fig. 14c - Unclamped Inductive Waveforms

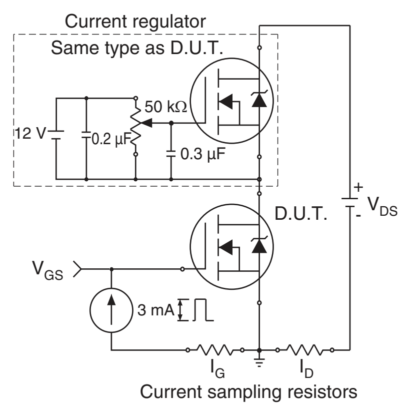


Fig. 15a - Gate Charge Test Circuit

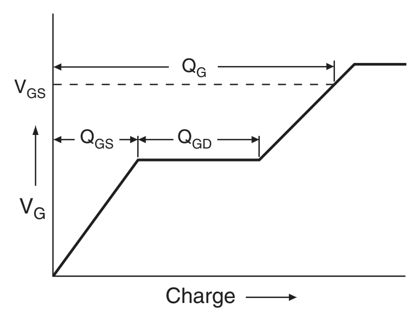
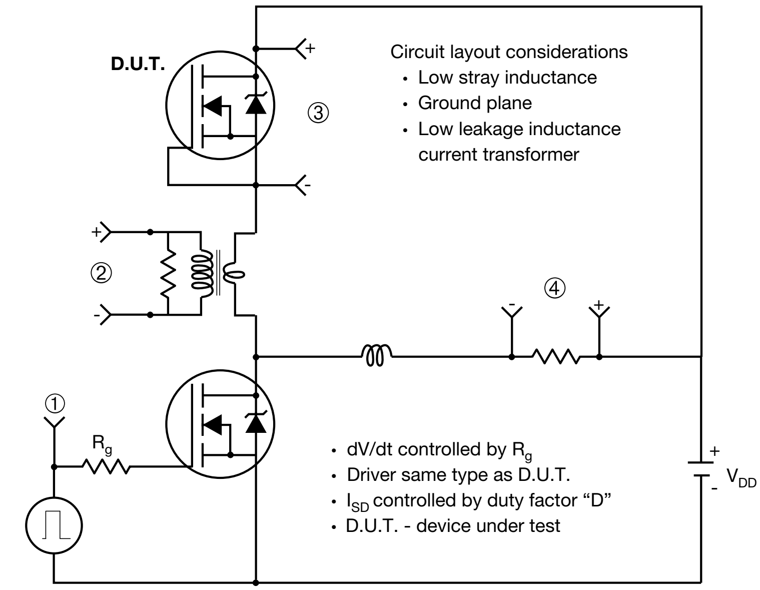
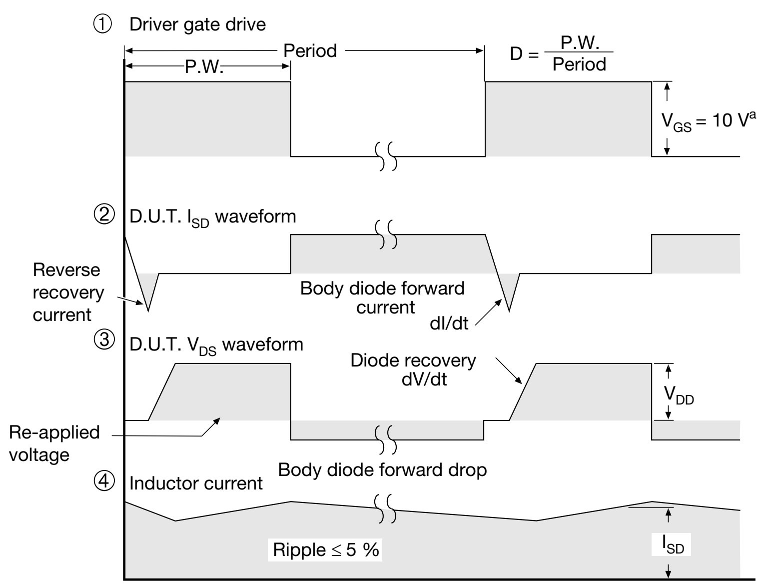


Fig. 15b - Basic Gate Charge Waveform

Peak Diode Recovery dV/dt Test Circuit





Note

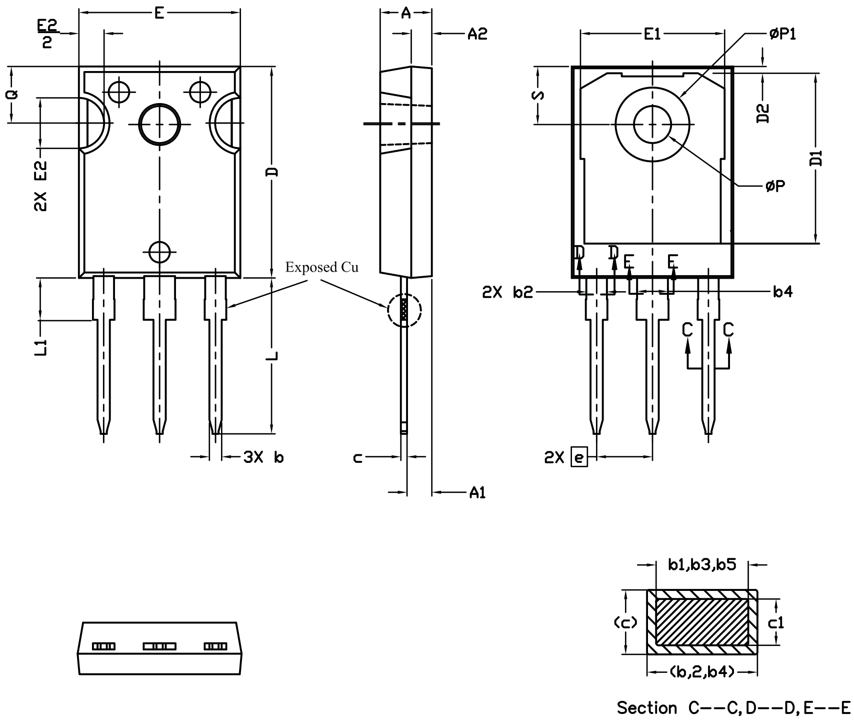
a. V_{GS} = 5 V for logic level devices

Fig. 16 - For N-Channel

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see www.vishay.com/ppg?91206.

TO-247AC (High Voltage)

VERSION 1: FACILITY CODE = 9



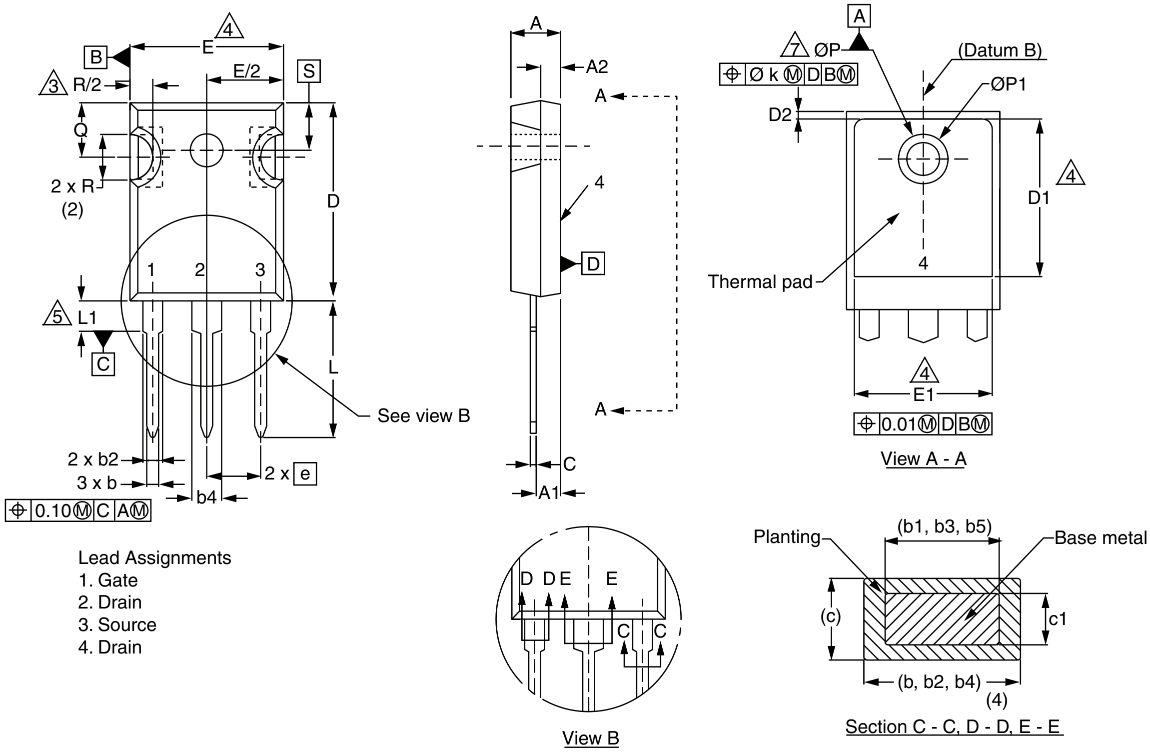
	MILLIMETERS		
DIM.	**MIN.**	**MAX.**	**NOTES**
A	4.83	5.21	
A1	2.29	2.55	
A2	1.50	2.49	
b	1.12	1.33	
b1	1.12	1.28	
b2	1.91	2.39	6
b3	1.91	2.34	
b4	2.87	3.22	6, 8
b5	2.87	3.18	
c	0.55	0.69	6
c1	0.55	0.65	
D	20.40	20.70	4

	MILLIMETERS		
DIM.	**MIN.**	**MAX.**	**NOTES**
D1	16.25	16.85	5
D2	0.56	0.76	
E	15.50	15.87	4
E1	13.46	14.16	5
E2	4.52	5.49	3
e	5.44 BSC		
L	14.90	15.40	
L1	3.96	4.16	6
Ø P	3.56	3.65	7
Ø P1	7.19 ref.		
Q	5.31	5.69	
S	5.54	5.74	

Notes

(1) Package reference: JEDEC® TO247, variation AC
(2) All dimensions are in mm
(3) Slot required, notch may be rounded
(4) Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm per side. These dimensions are measured at the outermost extremes of the plastic body
(5) Thermal pad contour optional with dimensions D1 and E1
(6) Lead finish uncontrolled in L1
(7) Ø P to have a maximum draft angle of 1.5° to the top of the part with a maximum hole diameter of 3.91 mm
(8) Dimension b2 and b4 does not include dambar protrusion. Allowable dambar protrusion shall be 0.1 mm total in excess of b2 and b4 dimension at maximum material condition

VERSION 2: FACILITY CODE = Y



	MILLIMETERS		
DIM.	MIN.	MAX.	NOTES
A	4.58	5.31	
A1	2.21	2.59	
A2	1.17	2.49	
b	0.99	1.40	
b1	0.99	1.35	
b2	1.53	2.39	
b3	1.65	2.37	
b4	2.42	3.43	
b5	2.59	3.38	
c	0.38	0.86	
c1	0.38	0.76	
D	19.71	20.82	
D1	13.08	-	

	MILLIMETERS		
DIM.	MIN.	MAX.	NOTES
D2	0.51	1.30	
E	15.29	15.87	
E1	13.72	-	
e	5.46 BSC		
Ø k	0.254		
L	14.20	16.25	
L1	3.71	4.29	
Ø P	3.51	3.66	
Ø P1	-	7.39	
Q	5.31	5.69	
R	4.52	5.49	
S	5.51 BSC		

Notes

(1) Dimensioning and tolerancing per ASME Y14.5M-1994

(2) Contour of slot optional

(3) Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outermost extremes of the plastic body

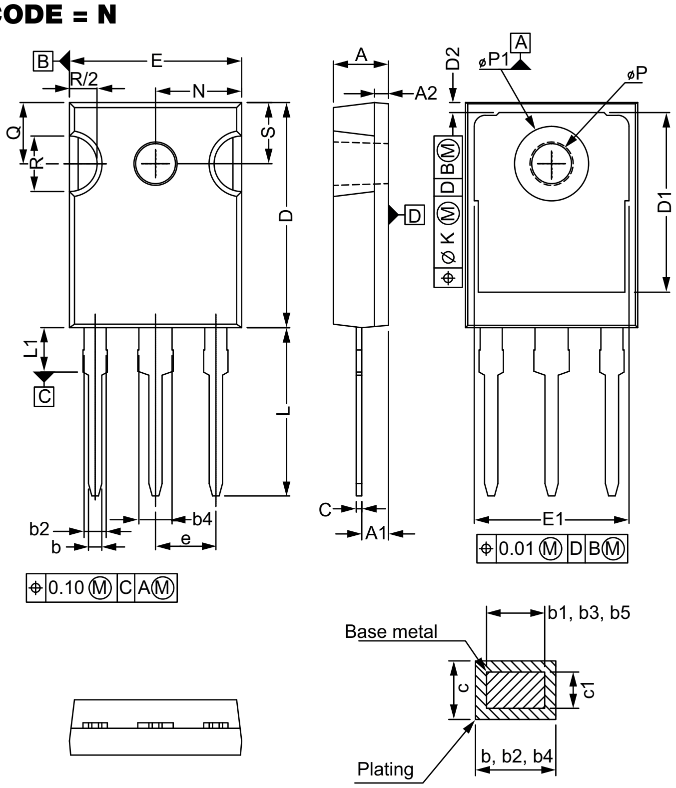
(4) Thermal pad contour optional with dimensions D1 and E1

(5) Lead finish uncontrolled in L1

(6) Ø P to have a maximum draft angle of 1.5 to the top of the part with a maximum hole diameter of 3.91 mm (0.154")

(7) Outline conforms to JEDEC outline TO-247 with exception of dimension c

VERSION 3: FACILITY CODE = N



	MILLIMETERS			MILLIMETERS	
DIM.	**MIN.**	**MAX.**	**DIM.**	**MIN.**	**MAX.**
A	4.65	5.31	D2	0.51	1.35
A1	2.21	2.59	E	15.29	15.87
A2	1.17	1.37	E1	13.46	-
b	0.99	1.40	e	5.46 BSC	
b1	0.99	1.35	k	0.254	
b2	1.65	2.39	L	14.20	16.10
b3	1.65	2.34	L1	3.71	4.29
b4	2.59	3.43	N	7.62 BSC	
b5	2.59	3.38	P	3.56	3.66
c	0.38	0.89	P1	-	7.39
c1	0.38	0.84	Q	5.31	5.69
D	19.71	20.70	R	4.52	5.49
D1	13.08	-	S	5.51 BSC	

ECN: E20-0545-Rev. F, 19-Oct-2020
DWG: 5971

Notes

(1) Dimensioning and tolerancing per ASME Y14.5M-1994

(2) Contour of slot optional

(3) Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outermost extremes of the plastic body

(4) Thermal pad contour optional with dimensions D1 and E1

(5) Lead finish uncontrolled in L1

(6) Ø P to have a maximum draft angle of 1.5 to the top of the part with a maximum hole diameter of 3.91 mm (0.154")

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