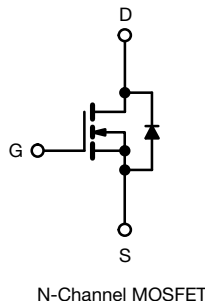
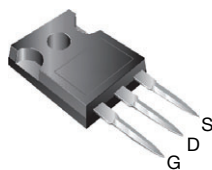


# Power MOSFET

**TO-247AC**


## FEATURES

- Superfast body diode eliminates the need for external diodes in ZVS applications
- Lower gate charge results in simpler drive requirements
- Enhanced dV/dt capabilities offer improved ruggedness
- Higher gate voltage threshold offers improved noise immunity
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS\***  
Available

## APPLICATIONS

- Zero voltage switching SMPS
- Telecom and server power supplies
- Uninterruptible power supplies
- Motor control applications

### Note

\* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

## PRODUCT SUMMARY

$V_{DS}$ (V)	500	
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = 10\text{ V}$	0.190
$Q_g$ max. (nC)	150	
$Q_{gs}$ (nC)	44	
$Q_{gd}$ (nC)	72	
Configuration	Single	

## ORDERING INFORMATION

Package	TO-247AC
Lead (Pb)-free	IRFP23N50LPbF

## ABSOLUTE MAXIMUM RATINGS ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	$V_{DS}$	500	V
Gate-source voltage	$V_{GS}$	$\pm 30$	
Continuous drain current	$I_D$	$T_C = 25\text{ }^\circ\text{C}$	A
		$T_C = 100\text{ }^\circ\text{C}$	
Pulsed drain current <sup>a</sup>	$I_{DM}$	92	
Linear derating factor		2.9	W/ $^\circ\text{C}$
Single pulse avalanche energy <sup>b</sup>	$E_{AS}$	410	mJ
Repetitive avalanche current <sup>a</sup>	$I_{AR}$	23	A
Repetitive avalanche energy <sup>a</sup>	$E_{AR}$	37	mJ
Maximum power dissipation	$P_D$	370	W
Peak diode recovery dV/dt <sup>c</sup>	dV/dt	21	V/ns
Operating junction and storage temperature range	$T_J, T_{stg}$	-55 to +150	$^\circ\text{C}$
Soldering recommendations (peak temperature) <sup>d</sup>	for 10 s	300	
Mounting torque	6-32 or M3 screw	10	lbf · in
		1.1	N · m


### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- Starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 1.5\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 23\text{ A}$  (see fig. 12)
- $I_{SD} \leq 23\text{ A}$ ,  $dI/dt \leq 650\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$
- 1.6 mm from case

**THERMAL RESISTANCE RATINGS**

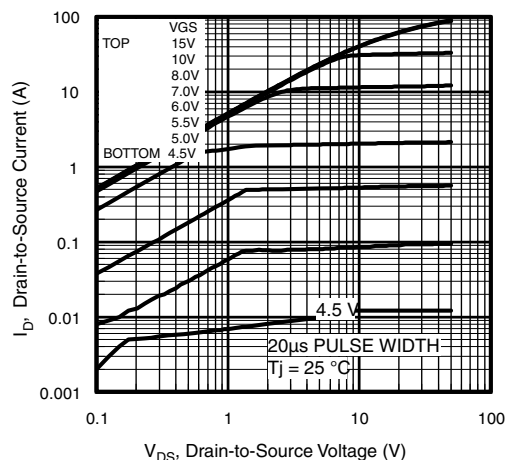
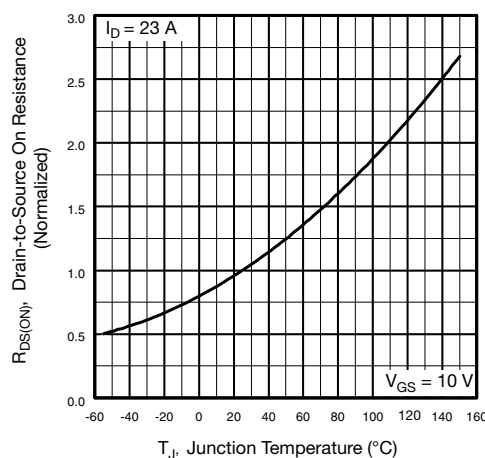
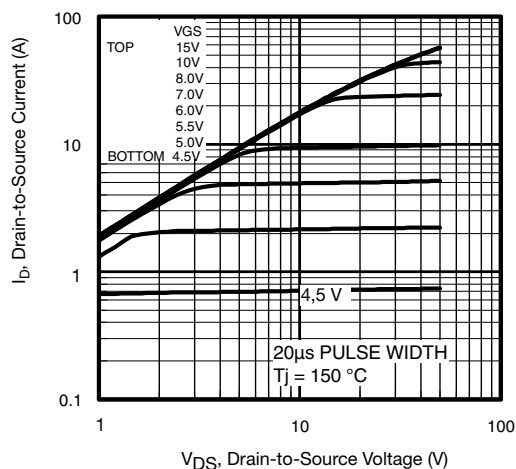
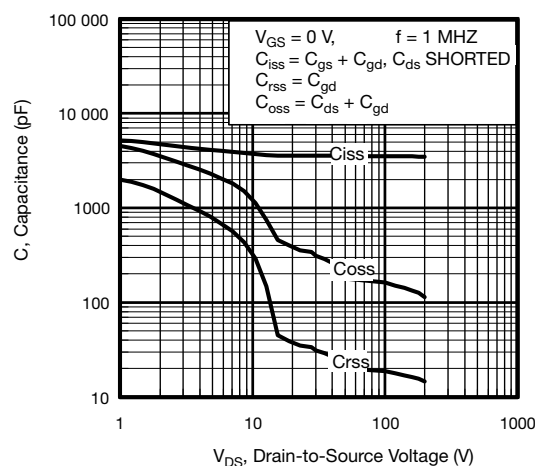
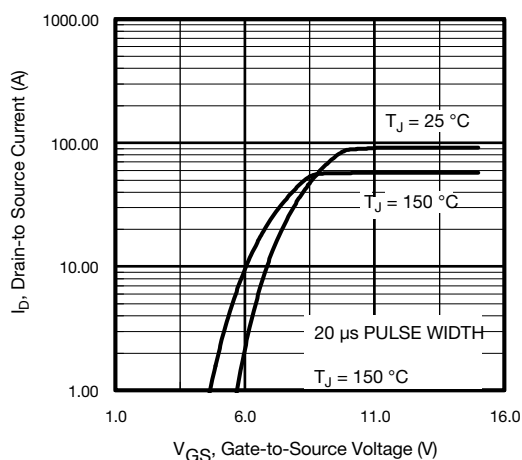
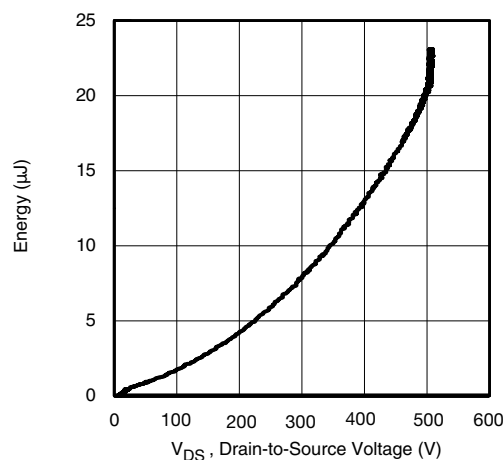
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	$R_{thJA}$	-	40	°C/W
Case-to-sink, flat, greased surface	$R_{thCS}$	0.24	-	
Maximum junction-to-case (drain)	$R_{thJC}$	-	0.34	

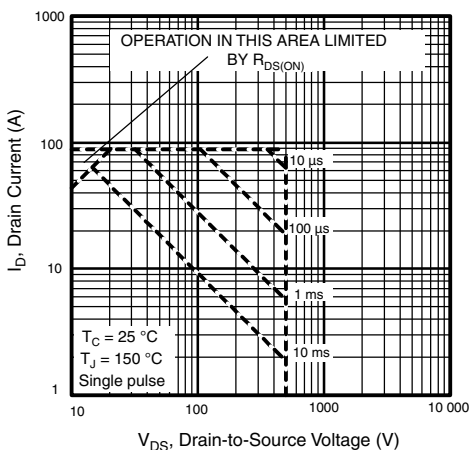
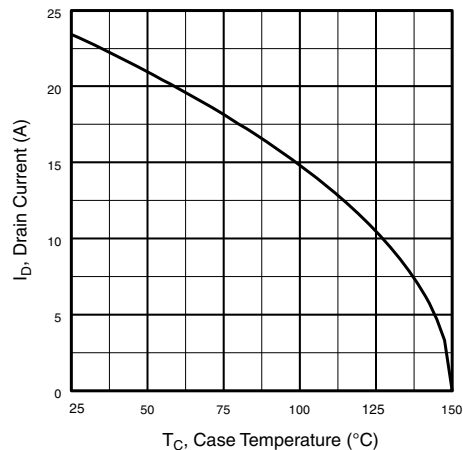
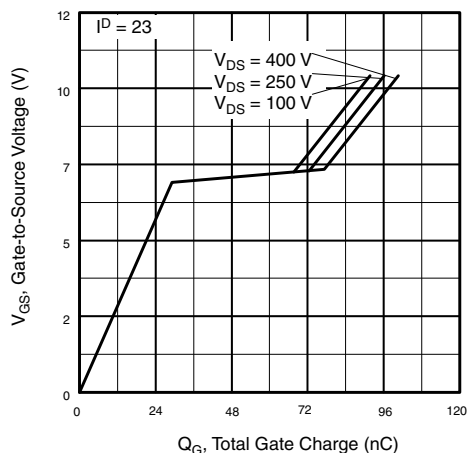
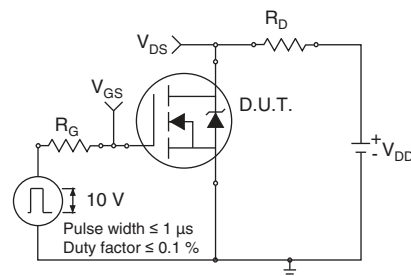
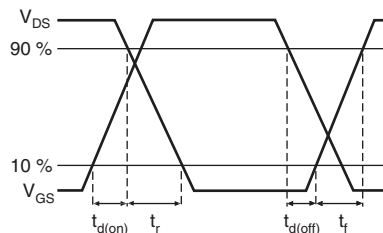
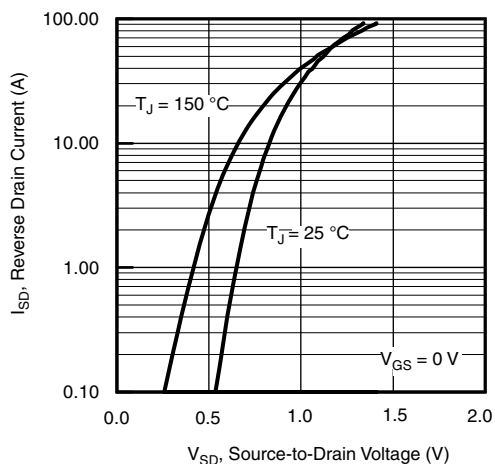
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

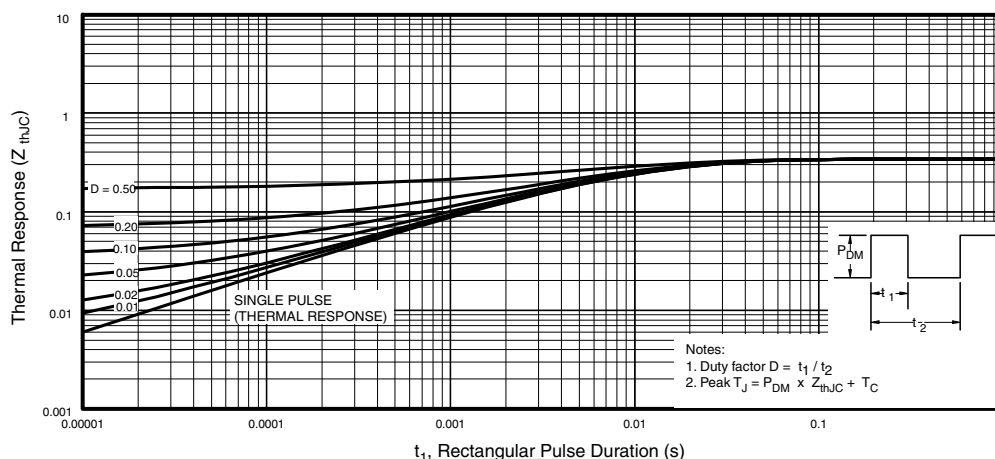
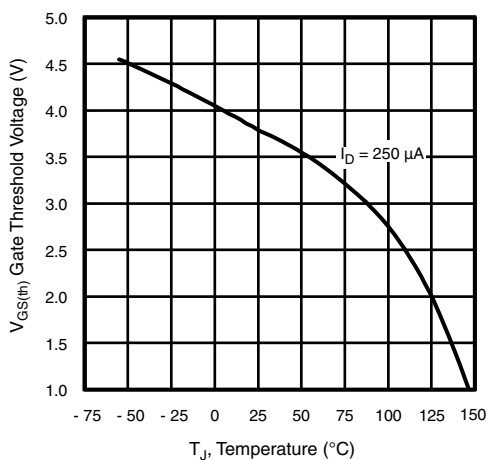
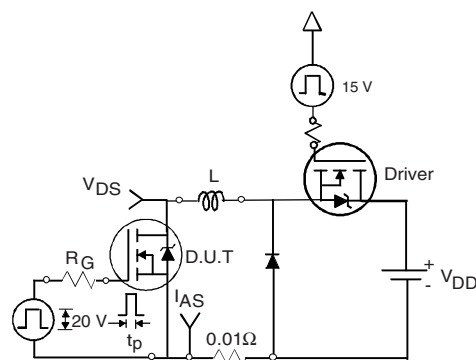
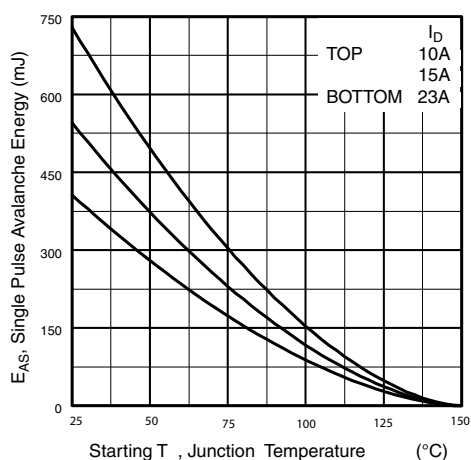
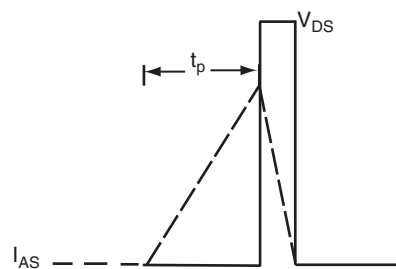
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Static							
Drain-source breakdown voltage	V <sub>DS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA		500	-	-	V
V <sub>DS</sub> temperature coefficient	ΔV <sub>DS</sub> /T <sub>J</sub>	Reference to 25 °C, I <sub>D</sub> = 1 mA <sup>d</sup>		-	0.27	-	V/°C
Gate-source threshold voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA		3.0	-	5.0	V
Gate-source leakage	I <sub>GSS</sub>	V <sub>GS</sub> = ± 30 V		-	-	± 100	nA
Zero gate voltage drain current	I <sub>DSS</sub>	V <sub>DS</sub> = 500 V, V <sub>GS</sub> = 0 V		-	-	50	μA
		V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C		-	-	2.0	mA
Drain-source on-state resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = 10 V	I <sub>D</sub> = 14 A <sup>b</sup>	-	0.190	0.235	Ω
Forward transconductance	g <sub>fs</sub>	V <sub>DS</sub> = 50 V, I <sub>D</sub> = 14 A <sup>b</sup>		-	9	-	S
Dynamic							
Input capacitance	C <sub>iss</sub>	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 25 V, f = 1.0 MHz, see fig. 5		-	3600	-	pF
Output capacitance	C <sub>oss</sub>			-	380	-	
Reverse transfer capacitance	C <sub>rss</sub>			-	37	-	
Output capacitance	C <sub>oss</sub>	V <sub>GS</sub> = 0 V	V <sub>DS</sub> = 1.0 V, f = 1.0 MHz	-	4800	-	pF
			V <sub>DS</sub> = 400 V, f = 1.0 MHz	-	100	-	
Effective output capacitance	C <sub>oss eff.</sub>		V <sub>DS</sub> = 0 V to 400 V <sup>c</sup>	-	220	-	
Effective output capacitance (energy related)	C <sub>oss eff. (ER)</sub>		V <sub>DS</sub> = 0 V to 400 V <sup>d</sup>	-	160	-	
Internal gate resistance	R <sub>G</sub>	f = 1 MHz, open drain		-	1.2	-	Ω
Total gate charge	Q <sub>g</sub>	V <sub>GS</sub> = 10 V	I <sub>D</sub> = 23 A, V <sub>DS</sub> = 400 V see fig. 6 and 13 <sup>b</sup>	-	-	150	nC
Gate-source charge	Q <sub>gs</sub>			-	-	44	
Gate-drain charge	Q <sub>gd</sub>			-	-	72	
Turn-on delay time	t <sub>d(on)</sub>	V <sub>DD</sub> = 250 V, I <sub>D</sub> = 23 A R <sub>g</sub> = 6.0, V <sub>GS</sub> = 10 V see fig. 10 <sup>b</sup>		-	26	-	ns
Rise time	t <sub>r</sub>			-	94	-	
Turn-off delay time	t <sub>d(off)</sub>			-	53	-	
Fall time	t <sub>f</sub>			-	45	-	
Drain-Source Body Diode Characteristics							
Continuous source-drain diode current	I <sub>S</sub>	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	23	A
Pulsed diode forward current <sup>a</sup>	I <sub>SM</sub>			-	-	92	
Body diode voltage	V <sub>SD</sub>	T <sub>J</sub> = 25 °C, I <sub>S</sub> = 14 A, V <sub>GS</sub> = 0 V <sup>b</sup>		-	-	1.5	V
Body diode reverse recovery time	t <sub>rr</sub>	T <sub>J</sub> = 25 °C	I <sub>F</sub> = 23 A, dI/dt = 100 A/μs <sup>b</sup>	-	170	250	ns
		T <sub>J</sub> = 125 °C		-	220	330	
Body diode reverse recovery charge	Q <sub>rr</sub>	T <sub>J</sub> = 25 °C		-	560	840	μC
		T <sub>J</sub> = 125 °C		-	980	1500	
Reverse recovery current	I <sub>RRM</sub>	T <sub>J</sub> = 25 °C		-	7.6	11	A
Forward turn-on time	t <sub>on</sub>	Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> and L <sub>D</sub> )					

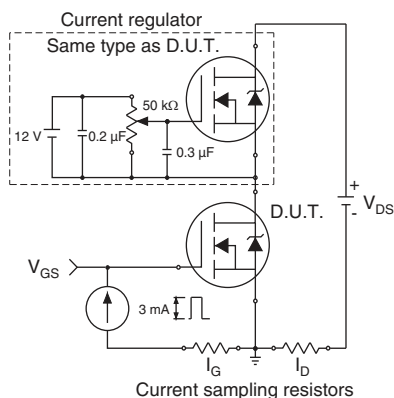
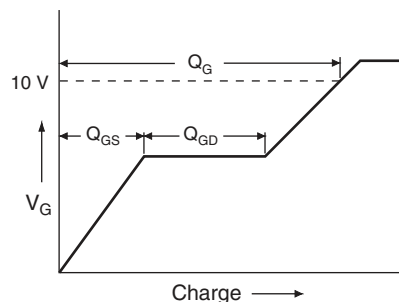
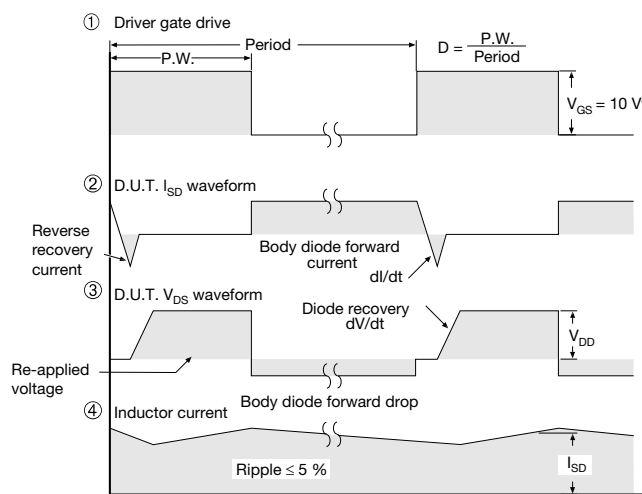
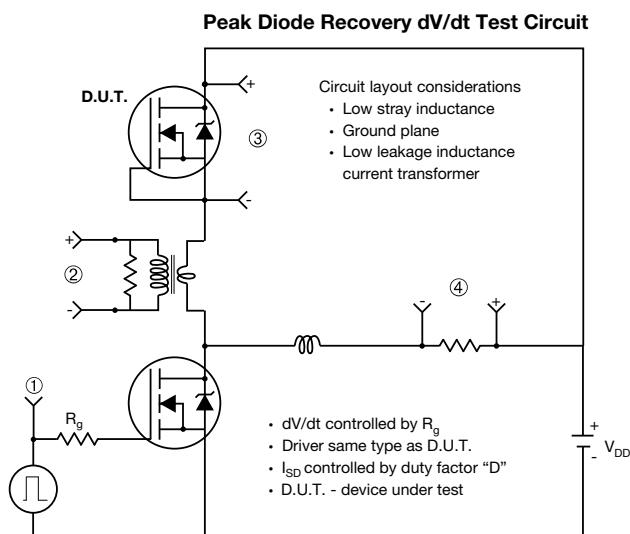
**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)  
b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$   
c.  $C_{oss\text{ eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$   
d.  $C_{oss\text{ eff. (ER)}}$  is a fixed capacitance that stores the same energy time 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. 4 - Normalized On-Resistance vs. Temperature**

**Fig. 2 - Typical Output Characteristics**

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

**Fig. 3 - Typical Transfer Characteristics**

**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**


**Fig. 7 - Maximum Safe Operating Area**

**Fig. 10 - Maximum Drain Current vs. Case Temperature**

**Fig. 8 - Typical Gate Charge vs. Gate-to-Source Voltage**

**Fig. 11a - Switching Time Test Circuit**

**Fig. 11b - Switching Time Waveforms**

**Fig. 9 - Typical Source-Drain Diode Forward Voltage**


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

**Fig. 13 - Threshold Voltage vs. Temperature**

**Fig. 15a - Unclamped Inductive Test Circuit**

**Fig. 14 - Maximum Avalanche Energy s. Drain Current**

**Fig. 15b - Unclamped Inductive Waveforms**


**Fig. 16a - Gate Charge Test Circuit**

**Fig. 16b - Basic Gate Charge Waveform**


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

**Fig. 17 - For N-Channel**

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## TO-247AC (High Voltage)

**VERSION 1: FACILITY CODE = 9**


Section C---C, D---D, E---E

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

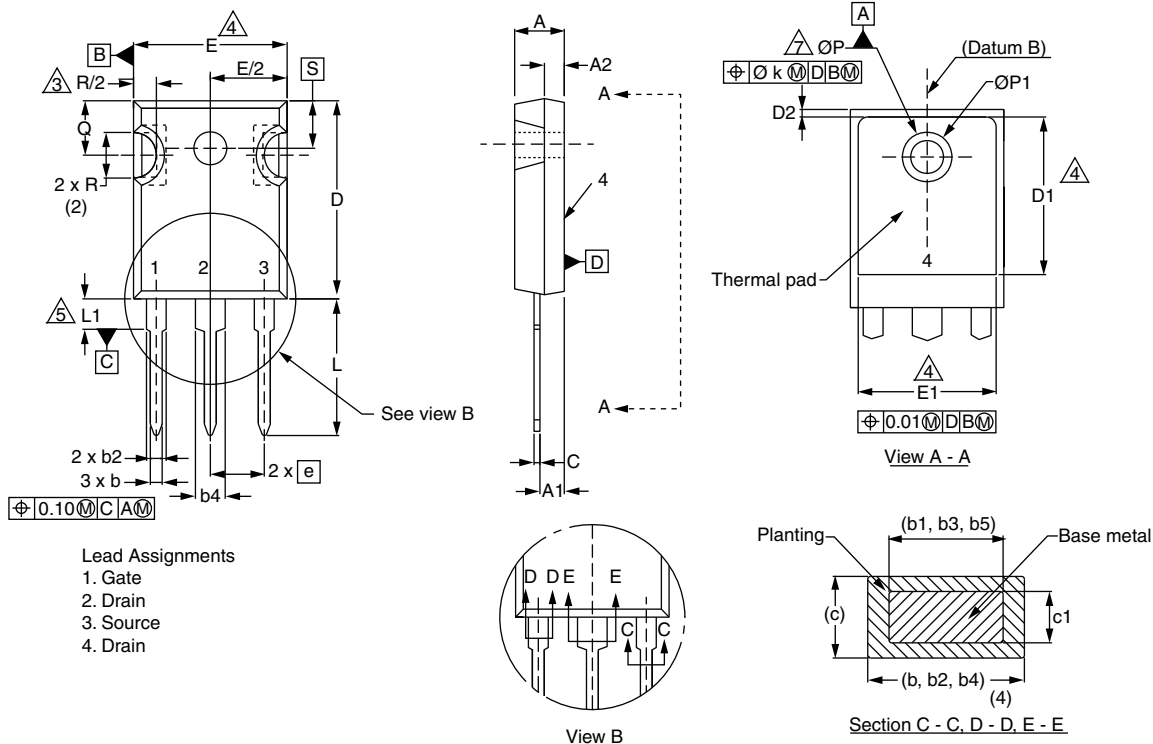
MILLIMETERS			
DIM.	MIN.	MAX.	NOTES
D1	16.25	16.85	5
D2	0.56	0.76	
E	15.50	15.87	4
E1	13.46	14.16	5
E2	4.52	5.49	3
e	5.44 BSC		
L	14.90	15.40	
L1	3.96	4.16	6
Ø P	3.56	3.65	7
Ø P1	7.19 ref.		
Q	5.31	5.69	
S	5.54	5.74	

### 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



DIM.	MILLIMETERS		NOTES
	MIN.	MAX.	
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	-	

DIM.	MILLIMETERS		NOTES
	MIN.	MAX.	
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		

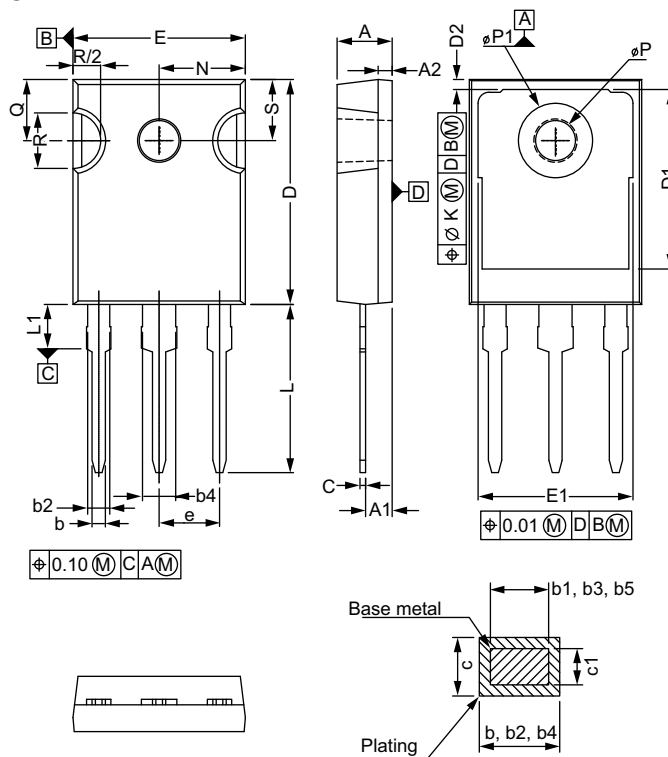
### Notes

- (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		
DIM.	MIN.	MAX.
A	4.65	5.31
A1	2.21	2.59
A2	1.17	1.37
b	0.99	1.40
b1	0.99	1.35
b2	1.65	2.39
b3	1.65	2.34
b4	2.59	3.43
b5	2.59	3.38
c	0.38	0.89
c1	0.38	0.84
D	19.71	20.70
D1	13.08	-

MILLIMETERS		
DIM.	MIN.	MAX.
D2	0.51	1.35
E	15.29	15.87
E1	13.46	-
e	5.46 BSC	
k	0.254	
L	14.20	16.10
L1	3.71	4.29
N	7.62 BSC	
P	3.56	3.66
P1	-	7.39
Q	5.31	5.69
R	4.52	5.49
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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