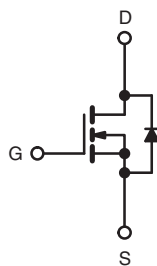
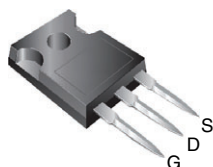


# Power MOSFET

**TO-247**


N-Channel MOSFET

## FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- Isolated central mounting hole
- Fast switching
- Ease of paralleling
- Simple drive requirements
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS\***  
Available

## 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

## DESCRIPTION

Third generation Power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The TO-247 package is preferred for commercial-industrial applications where higher power levels preclude the use of TO-220 devices. The TO-247 is similar but superior to the earlier TO-218 package because its isolated mounting hole. It also provides greater creepage distances between pins to meet the requirements of most safety specifications.

## PRODUCT SUMMARY

$V_{DS}$ (V)	500
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = 10\text{ V}$ 0.27
$Q_g$ (max.) (nC)	210
$Q_{gs}$ (nC)	29
$Q_{gd}$ (nC)	110
Configuration	Single

## ORDERING INFORMATION

Package	TO-247
Lead (Pb)-free	IRFP460PbF

## 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	$V_{GS}$	$\pm 20$	
Continuous drain current	$V_{GS}$ at 10 V	$T_C = 25\text{ }^\circ\text{C}$	A
		$T_C = 100\text{ }^\circ\text{C}$	
Pulsed drain current <sup>a</sup>	$I_{DM}$	80	
Linear derating factor		2.2	W/ $^\circ\text{C}$
Single pulse avalanche energy <sup>b</sup>	$E_{AS}$	960	mJ
Repetitive avalanche current <sup>a</sup>	$I_{AR}$	20	A
Repetitive avalanche energy <sup>a</sup>	$E_{AR}$	28	mJ
Maximum power dissipation	$P_D$	280	W
Peak diode recovery dV/dt <sup>c</sup>	dV/dt	3.5	V/ns
Operating junction and storage temperature range	$T_J, T_{stg}$	-55 to +150	$^\circ\text{C}$
Soldering recommendations (peak temperature)	for 10 s	300 <sup>d</sup>	
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)
- $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 4.3\text{ mH}$ ,  $R_G = 25\text{ }\Omega$ ,  $I_{AS} = 20\text{ A}$  (see fig. 12)
- $I_{SD} \leq 20\text{ A}$ ,  $dI/dt \leq 160\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$
- 1.6 mm from case

**THERMAL RESISTANCE RATINGS**

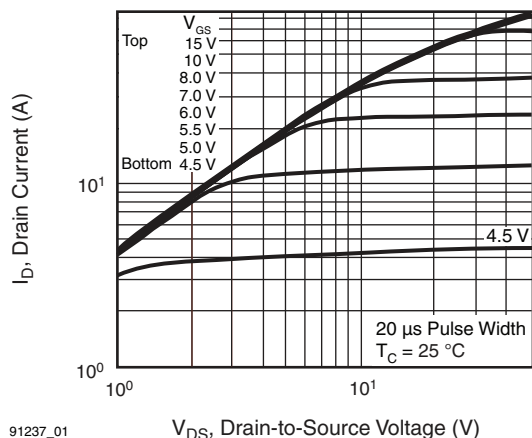
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	$R_{thJA}$	-	40	°C/W
Case-to-sink, flat, greased surface	$R_{thCS}$	0.24	-	
Maximum junction-to-case (drain)	$R_{thJC}$	-	0.45	

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

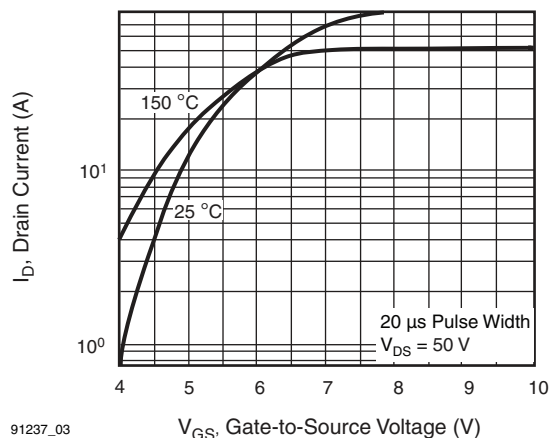
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Static							
Drain-source breakdown voltage	V <sub>DS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA		500	-	-	V
V <sub>DS</sub> temperature coefficient	ΔV <sub>DS</sub> /T <sub>J</sub>	Reference to 25 °C, I <sub>D</sub> = 1 mA		-	0.63	-	V/°C
Gate-source threshold voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA		2.0	-	4.0	V
Gate-source leakage	I <sub>GSS</sub>	V <sub>GS</sub> = ± 20 V		-	-	± 100	nA
Zero gate voltage drain current	I <sub>DSS</sub>	V <sub>DS</sub> = 500 V, V <sub>GS</sub> = 0 V		-	-	25	μA
		V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C		-	-	250	
Drain-source on-state resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = 10 V	I <sub>D</sub> = 12 A <sup>b</sup>	-	-	0.27	Ω
Forward transconductance	g <sub>fs</sub>	V <sub>DS</sub> = 50 V, I <sub>D</sub> = 12 A <sup>b</sup>		13	-	-	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		-	4200	-	pF
Output capacitance	C <sub>oss</sub>			-	870	-	
Reverse transfer capacitance	C <sub>rss</sub>			-	350	-	
Total gate charge	Q <sub>g</sub>	V <sub>GS</sub> = 10 V	I <sub>D</sub> = 20 A, V <sub>DS</sub> = 400 V see fig. 6 and 13 <sup>b</sup>	-	-	210	nC
Gate-source charge	Q <sub>gs</sub>			-	-	29	
Gate-drain charge	Q <sub>gd</sub>			-	-	110	
Turn-on delay time	t <sub>d(on)</sub>	V <sub>DD</sub> = 250 V, I <sub>D</sub> = 20 A , R <sub>G</sub> = 4.3 Ω, R <sub>D</sub> = 13 Ω, see fig. 10 <sup>b</sup>		-	18	-	ns
Rise time	t <sub>r</sub>			-	59	-	
Turn-off delay time	t <sub>d(off)</sub>			-	110	-	
Fall time	t <sub>f</sub>			-	58	-	
Internal drain inductance	L <sub>D</sub>	Between lead, 6 mm (0.25") from package and center of die contact		-	5.0	-	nH
Internal source inductance	L <sub>S</sub>			-	13	-	
Drain-Source Body Diode Characteristics							
Continuous source-drain diode current	I <sub>S</sub>	MOSFET symbol showing the integral reverse p - n junction diode		-	-	20	A
Pulsed diode forward current <sup>a</sup>	I <sub>SM</sub>			-	-	80	
Body diode voltage	V <sub>SD</sub>	T <sub>J</sub> = 25 °C, I <sub>S</sub> = 20 A, V <sub>GS</sub> = 0 V <sup>b</sup>		-	-	1.8	V
Body diode reverse recovery time	t <sub>rr</sub>	T <sub>J</sub> = 25 °C, I <sub>F</sub> = 20A, dI/dt = 100 A/μs <sup>b</sup>		-	570	860	ns
Body diode reverse recovery charge	Q <sub>rr</sub>			-	5.7	8.6	μC
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**

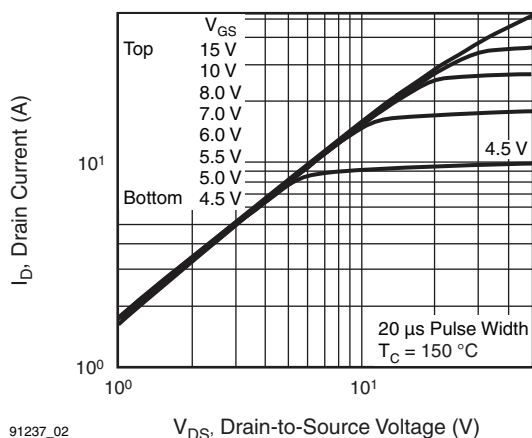
- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)  
b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$

**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted


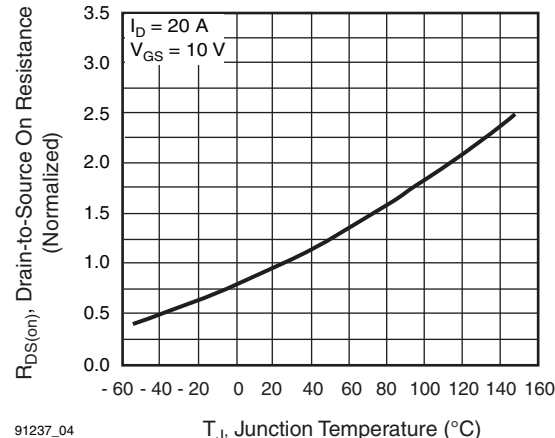
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**Fig. 1 - Typical Output Characteristics,  $T_C = 25^\circ\text{C}$** 


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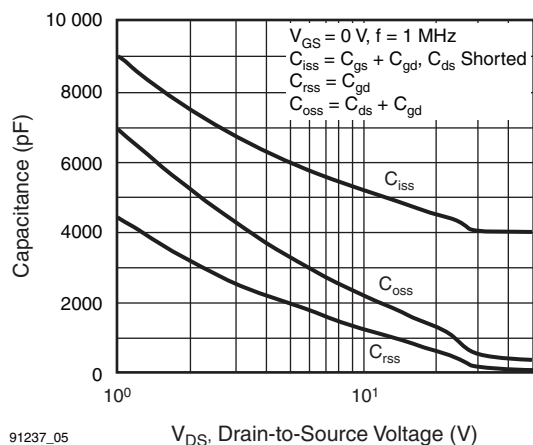
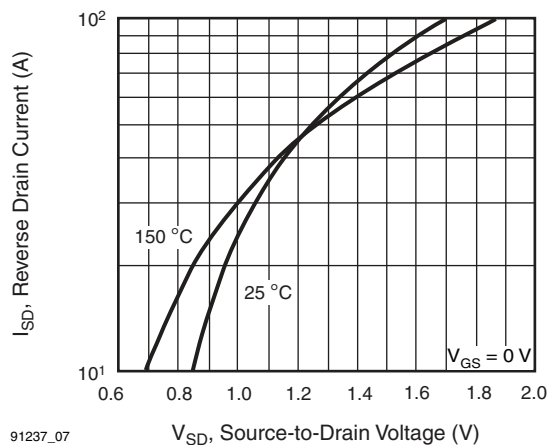
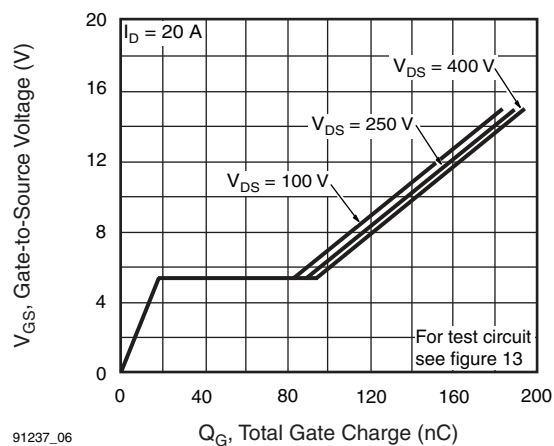
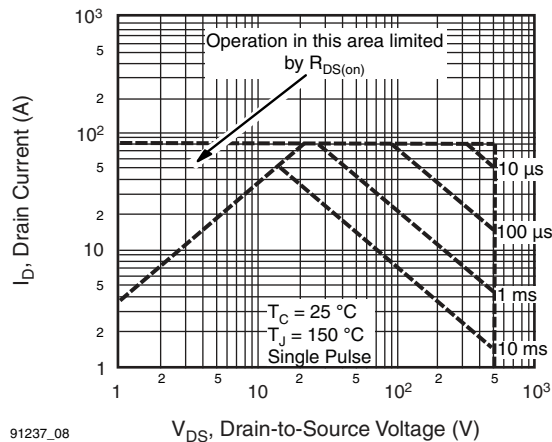
**Fig. 3 - Typical Transfer Characteristics**


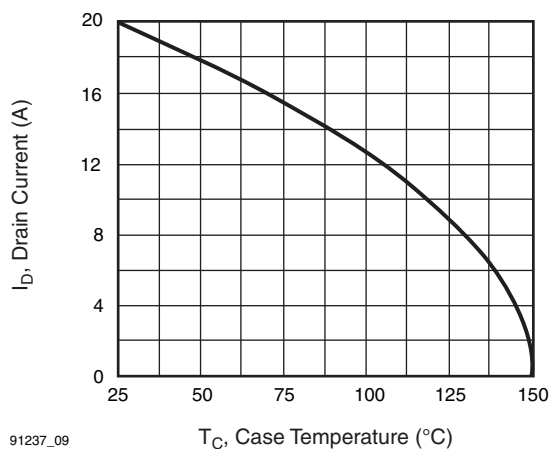
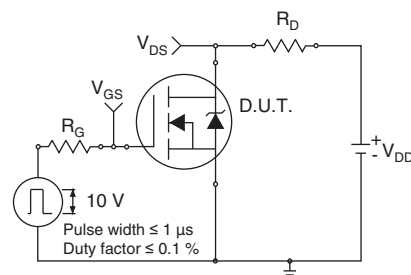
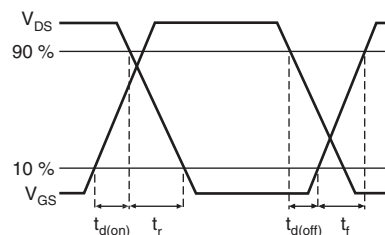
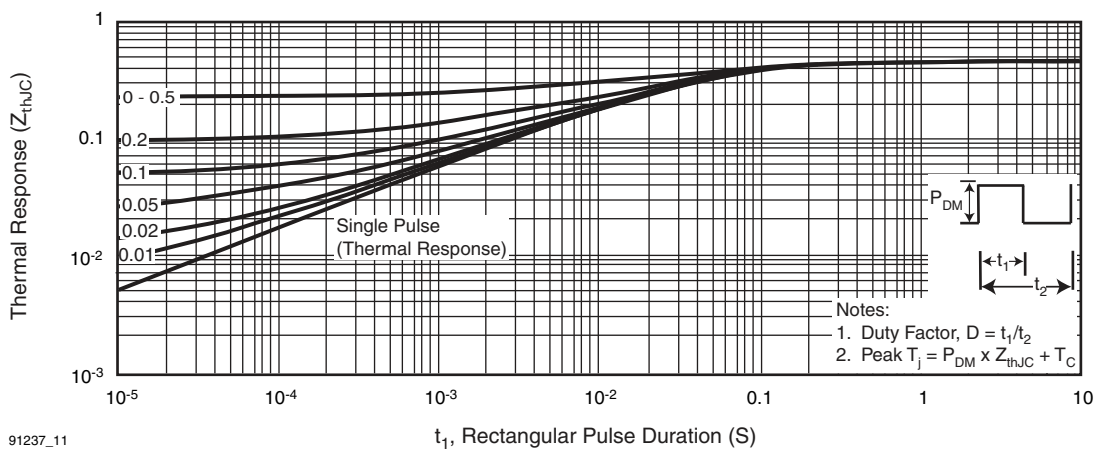
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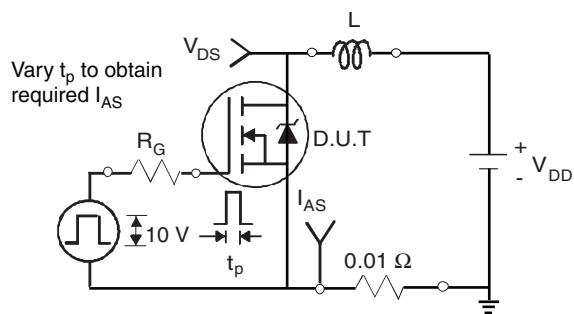
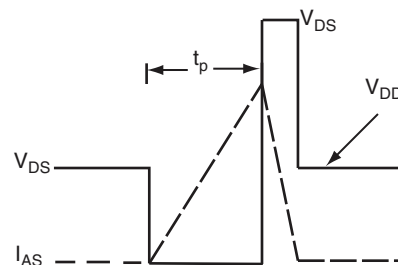
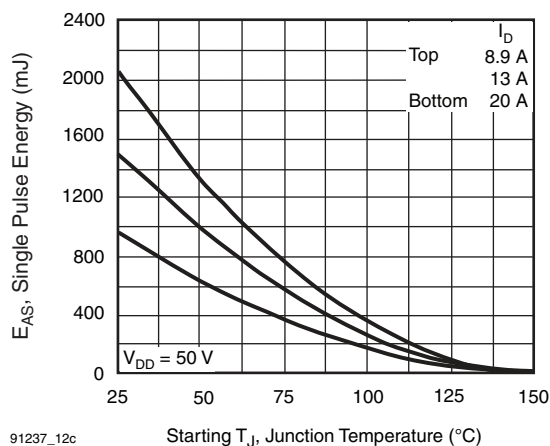
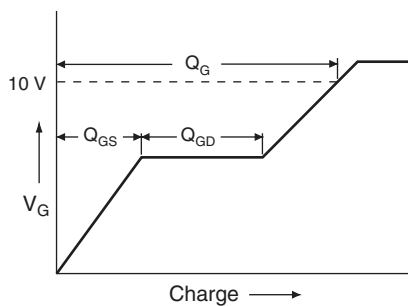
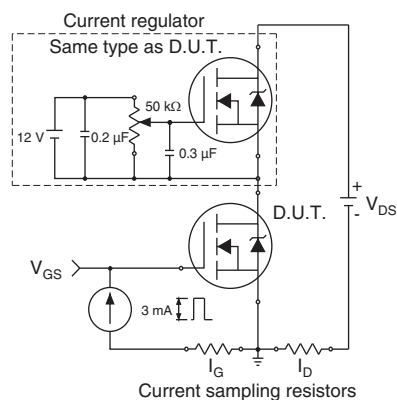
**Fig. 2 - Typical Output Characteristics,  $T_C = 150^\circ\text{C}$** 


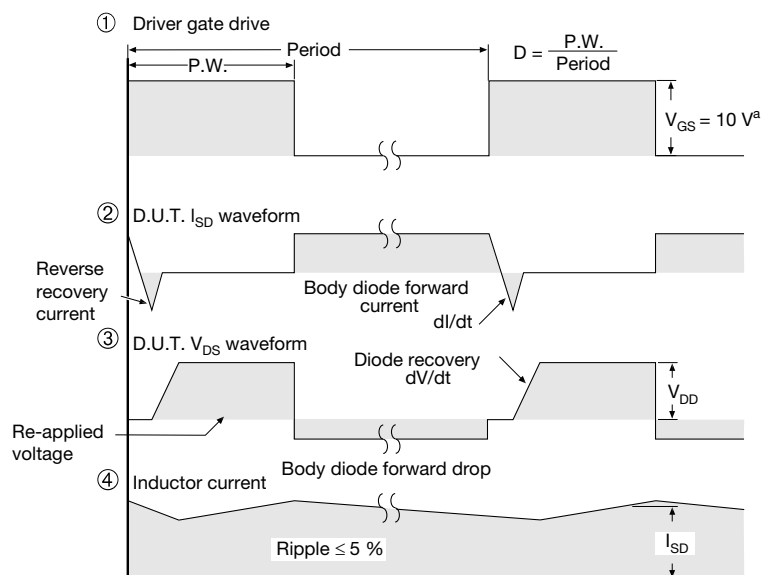
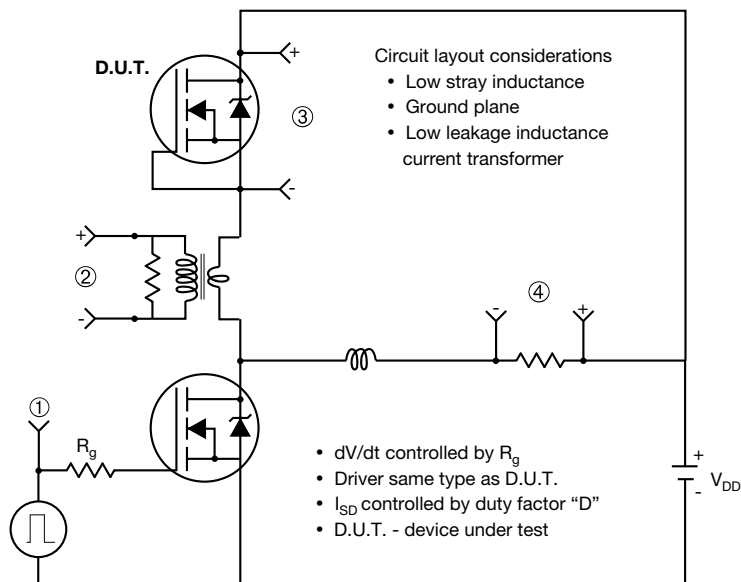
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**Fig. 4 - Normalized On-Resistance vs. Temperature**


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

**Fig. 7 - Typical Source-Drain Diode Forward Voltage**

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

**Fig. 8 - Maximum Safe Operating Area**


**Fig. 9 - Maximum Drain Current vs. Case Temperature**

**Fig. 10 - Switching Time Test Circuit**

**Fig. 11 - Switching Time Waveforms**

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


**Fig. 13 - Unclamped Inductive Test Circuit**

**Fig. 14 - Unclamped Inductive Waveforms**

**Fig. 15 - Maximum Avalanche Energy vs. Drain Current**

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

**Fig. 17 - Gate Charge Test Circuit**

**Peak Diode Recovery  $dV/dt$  Test Circuit**

**Note**

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

**Fig. 18 - 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.	NOM.	MAX.	NOTES
A	4.83	5.02	5.21	
A1	2.29	2.41	2.55	
A2	1.17	1.27	1.37	
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	2.87	3.00	3.22	6, 8
b5	2.87	3.00	3.18	
c	0.40	0.50	0.60	6
c1	0.40	0.50	0.56	
D	20.40	20.55	20.70	4

MILLIMETERS				
DIM.	MIN.	NOM.	MAX.	NOTES
D1	16.46	16.76	17.06	5
D2	0.56	0.66	0.76	
E	15.50	15.70	15.87	4
E1	13.46	14.02	14.16	5
E2	4.52	4.91	5.49	3
e	5.46 BSC			
L	14.90	15.15	15.40	
L1	3.96	4.06	4.16	6
Ø P	3.56	3.61	3.65	7
Ø P1	7.19 ref.			
Q	5.31	5.50	5.69	
S	5.51 BSC			

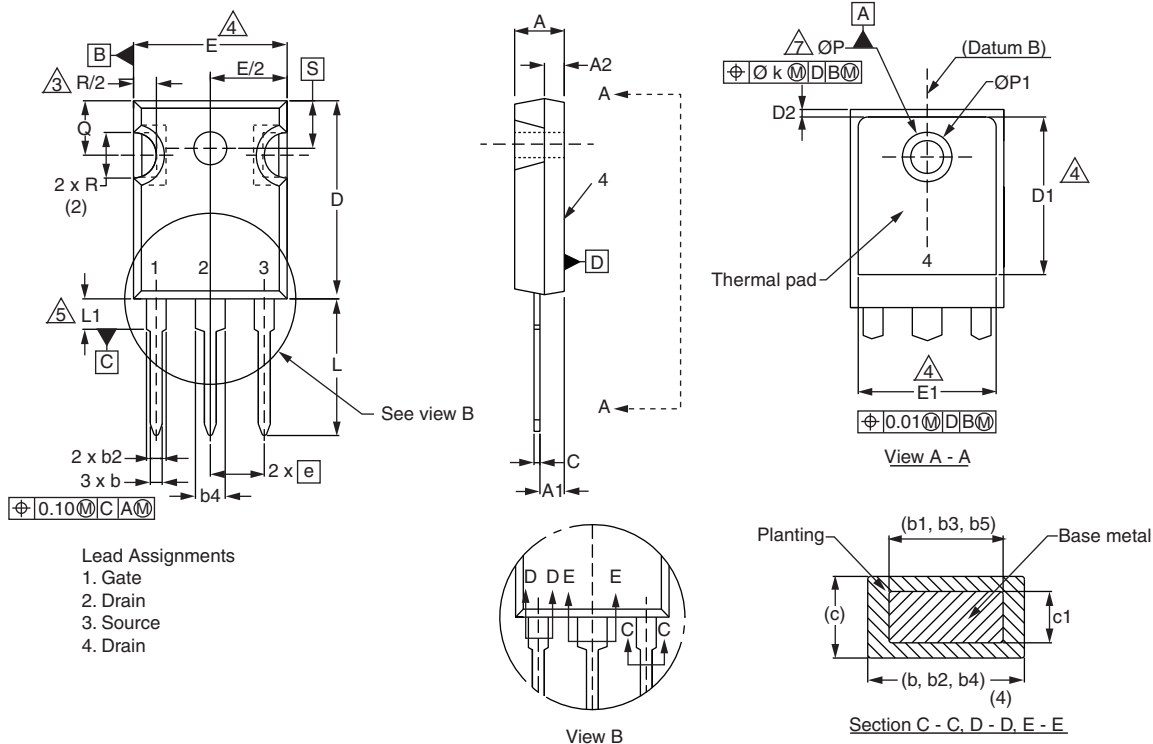
## Notes

- (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: E22-0452-Rev. G, 31-Oct-2022  
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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