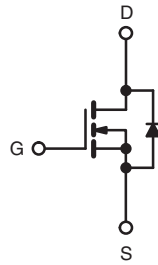
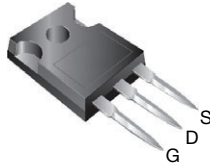


## Power MOSFET

**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 requirement
- 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)


 Available  
**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

### APPLICATIONS

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

### PRODUCT SUMMARY

$V_{DS}$ (V)	600	
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = 10$ V	0.27
$Q_g$ (max.) (nC)	150	
$Q_{gs}$ (nC)	46	
$Q_{gd}$ (nC)	64	
Configuration	Single	

### ORDERING INFORMATION

Package	TO-247AC
Lead (Pb)-free	IRFP21N60LPbF


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

PARAMETER		SYMBOL	LIMIT	UNIT	
Drain-source voltage		$V_{DS}$	600	V	
Gate-source voltage		$V_{GS}$	$\pm 30$		
Continuous drain current	$V_{GS}$ at 10 V	$I_D$	$T_C = 25^\circ\text{C}$	21	A
			$T_C = 100^\circ\text{C}$	13	
Pulsed drain current <sup>a</sup>		$I_{DM}$	84		
Linear derating factor			2.6	W/ $^\circ\text{C}$	
Single pulse avalanche energy <sup>b</sup>		$E_{AS}$	420	mJ	
Repetitive Avalanche Current <sup>a</sup>		$I_{AR}$	21	A	
Repetitive Avalanche Energy <sup>a</sup>		$E_{AR}$	33	mJ	
Maximum power dissipation	$T_C = 25^\circ\text{C}$	$P_D$	330	W	
Peak diode recovery dV/dt <sup>c</sup>		dV/dt	16	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 <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)
- Starting  $T_J = 25^\circ\text{C}$ ,  $L = 1.9$  mH,  $R_g = 25\ \Omega$ ,  $I_{AS} = 21$  A,  $dV/dt = 11$  V/ns (see fig. 12a)
- $I_{SD} \leq 21$  A,  $dI/dt \leq 530$  A/ $\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150^\circ\text{C}$
- 1.6 mm from case

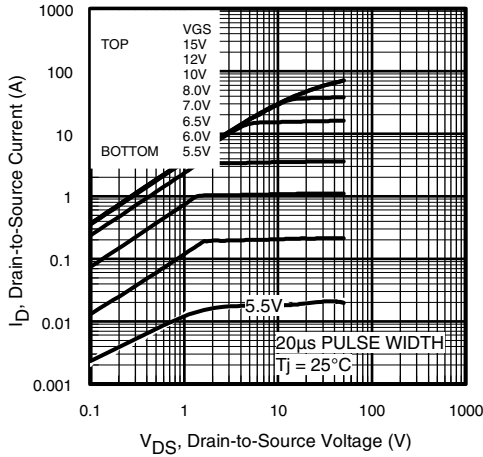
THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	$R_{thJA}$	-	40	°C/W
Case-to-sink, flat, greased surface	$R_{thCS}$	0.24	-	
Maximum junction-to-case (drain)	$R_{thJC}$	-	0.38	

SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Static						
Drain-source breakdown voltage	$V_{DS}$	$V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$	600	-	-	V
$V_{DS}$ temperature coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$	-	420	-	mV/°C
Gate-source threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	3.0	-	5.0	V
Gate-source leakage	$I_{GSS}$	$V_{GS} = \pm 30\text{ V}$	-	-	$\pm 100$	nA
Zero gate voltage drain current	$I_{DSS}$	$V_{DS} = 600\text{ V}$ , $V_{GS} = 0\text{ V}$	-	-	50	$\mu\text{A}$
		$V_{DS} = 480\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$	-	-	2.0	mA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$   $I_D = 13\text{ A}^b$	-	0.27	0.32	$\Omega$
Forward transconductance	$g_{fs}$	$V_{DS} = 50\text{ V}$ , $I_D = 13\text{ A}$	11	-	-	S
Dynamic						
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{ V}$ , $V_{DS} = 25\text{ V}$ , $f = 1.0\text{ MHz}$ , see fig. 5	-	4000	-	pF
Output capacitance	$C_{oss}$		-	340	-	
Reverse transfer capacitance	$C_{rss}$		-	29	-	
Output capacitance	$C_{oss}$ eff.	$V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ V to } 480\text{ V}^c$	-	170	-	
	$C_{oss}$ eff. (ER)		-	130	-	
Total gate charge	$Q_g$	$V_{GS} = 10\text{ V}$   $I_D = 21\text{ A}$ , $V_{DS} = 480\text{ V}$ see fig. 7 and 15 <sup>b</sup>	-	-	150	nC
Gate-source charge	$Q_{gs}$		-	-	46	
Gate-drain charge	$Q_{gd}$		-	-	64	
Gate resistance	$R_g$	$f = 1\text{ MHz}$ , open drain	-	0.63	-	$\Omega$
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 300\text{ V}$ , $I_D = 21\text{ A}$ , $R_g = 1.3\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ , see fig. 11a and 11b <sup>b</sup>	-	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 <sup>a</sup>	$I_{SM}$		-	-	84	
Body diode voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_S = 21\text{ A}$ , $V_{GS} = 0\text{ V}^b$	-	-	1.5	V
Body diode reverse recovery time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_F = 21\text{ A}$	-	160	240	ns
		$T_J = 125\text{ }^\circ\text{C}$ , $dI/dt = 100\text{ A}/\mu\text{s}^b$	-	400	610	
Body diode reverse recovery time	$Q_{rr}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_F = 21\text{ A}$ , $V_{GS} = 0\text{ V}^b$	-	480	730	nC
		$T_J = 125\text{ }^\circ\text{C}$ , $dI/dt = 100\text{ A}/\mu\text{s}^b$	-	1540	2310	
Reverse recovery time	$I_{RRM}$	$T_J = 25\text{ }^\circ\text{C}$	-	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 $L_D$ )				

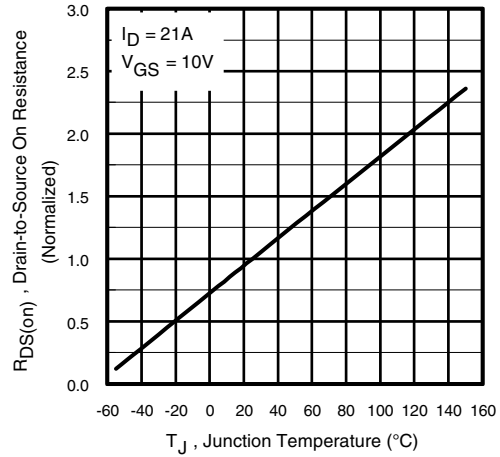
**Notes**

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

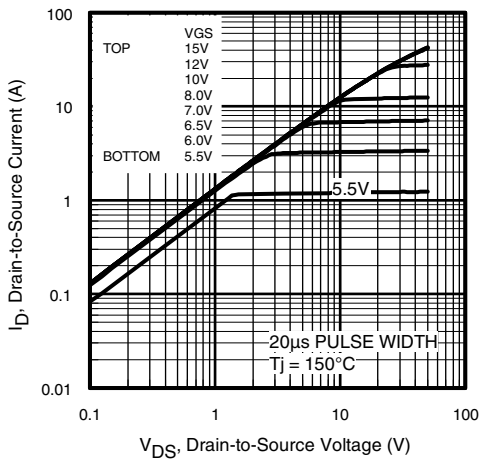
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



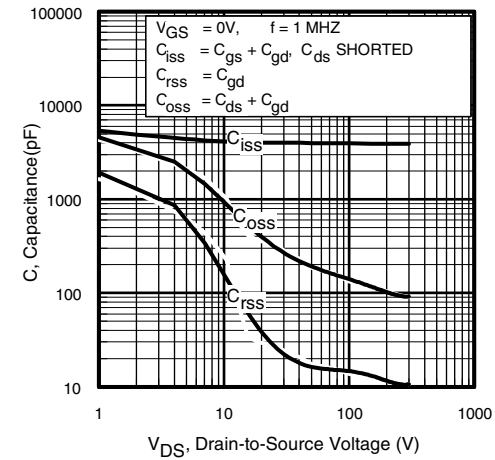
**Fig. 1 - Typical Output Characteristics**



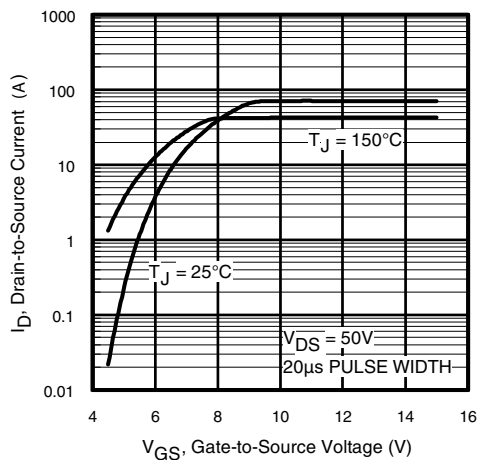
**Fig. 4 - Normalized On-Resistance vs. Temperature**



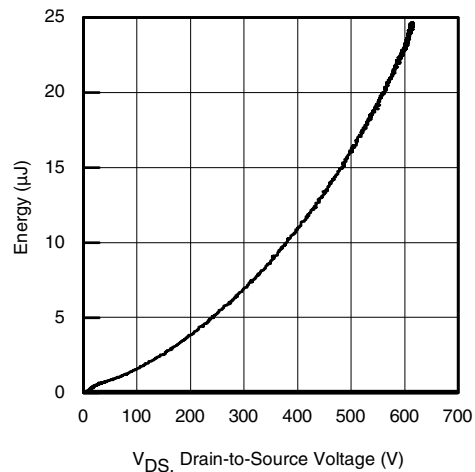
**Fig. 2 - Typical Output Characteristics**



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



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 6 - Typical Output Capacitance Stored Energy vs. VDS**

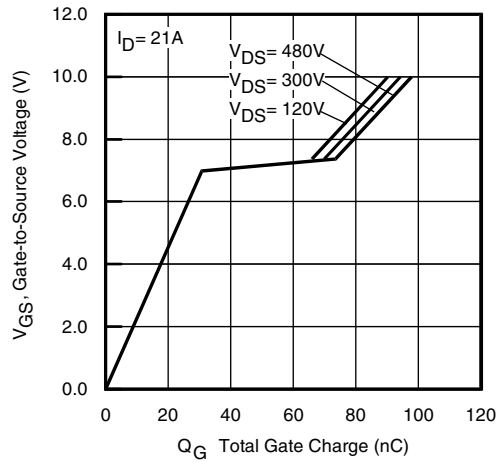


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

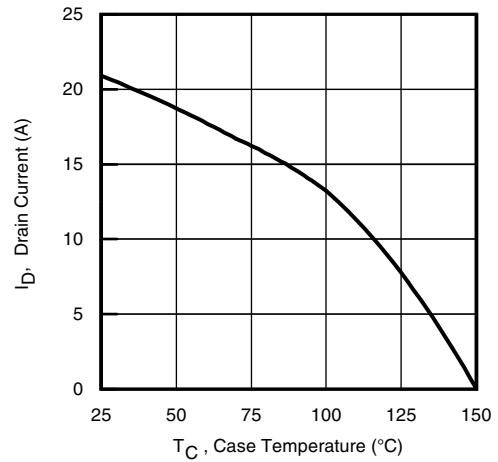


Fig. 10 - Maximum Drain Current vs. Case Temperature

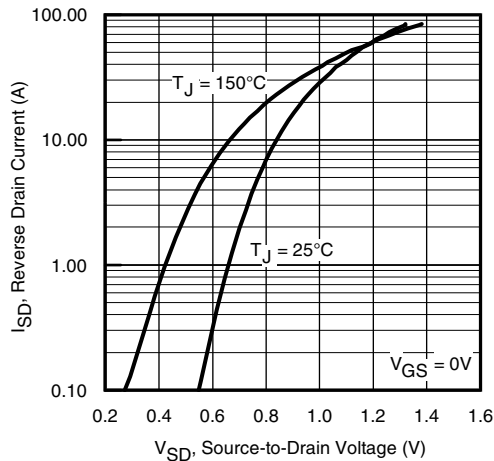


Fig. 8 - Typical Source-Drain Diode Forward Voltage

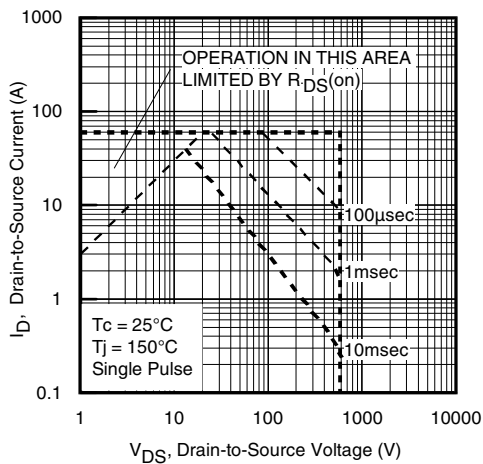


Fig. 9 - Maximum Safe Operating Area

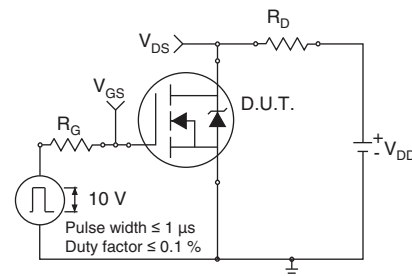


Fig. 11a - Switching Time Test Circuit

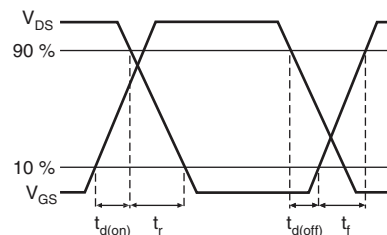


Fig. 11b - Switching Time Waveforms

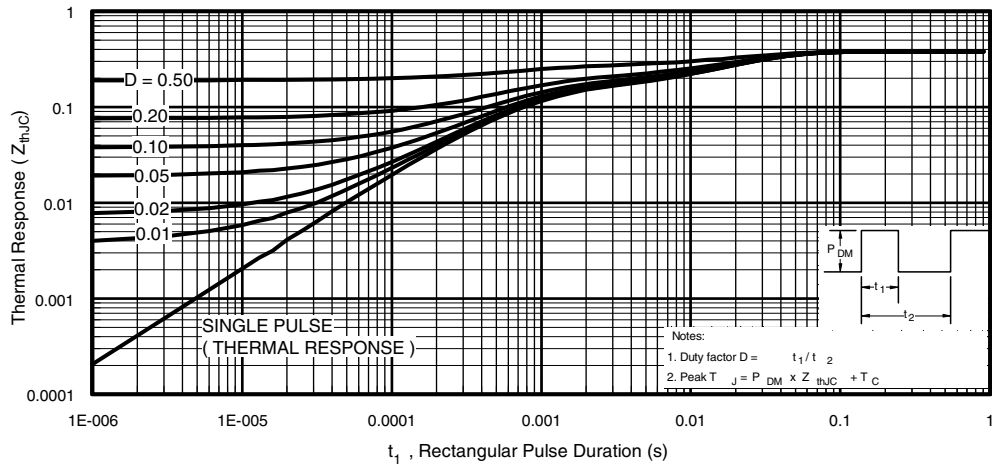


Fig. 12 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

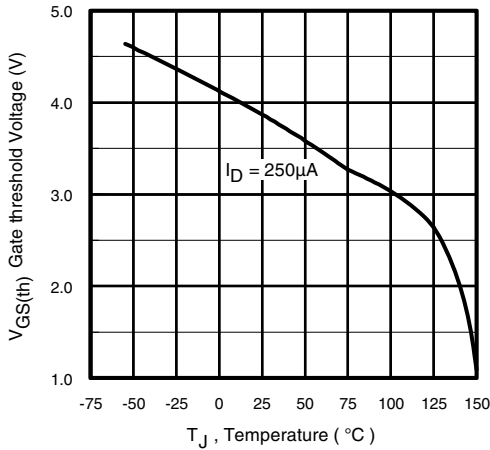


Fig. 13 - Threshold Voltage vs. Temperature

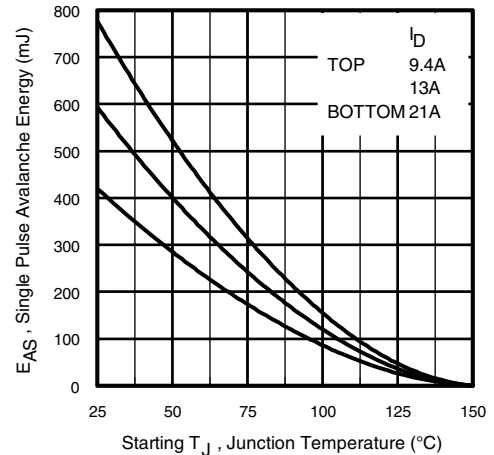


Fig. 14a - Maximum Avalanche Energy vs. Drain Current

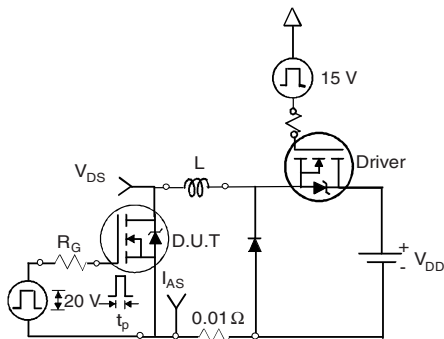


Fig. 14b - Unclamped Inductive Test Circuit

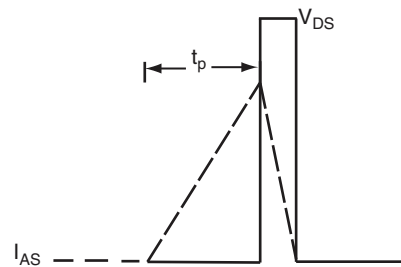


Fig. 14c - Unclamped Inductive Waveforms

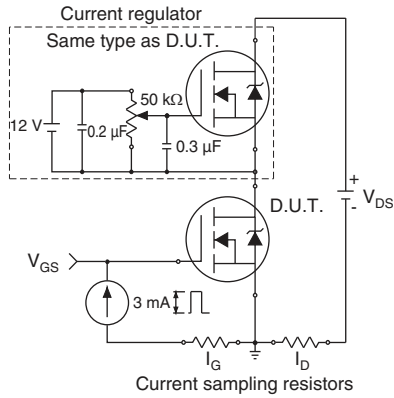


Fig. 15a - Gate Charge Test Circuit

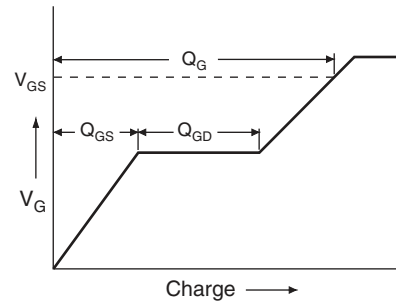
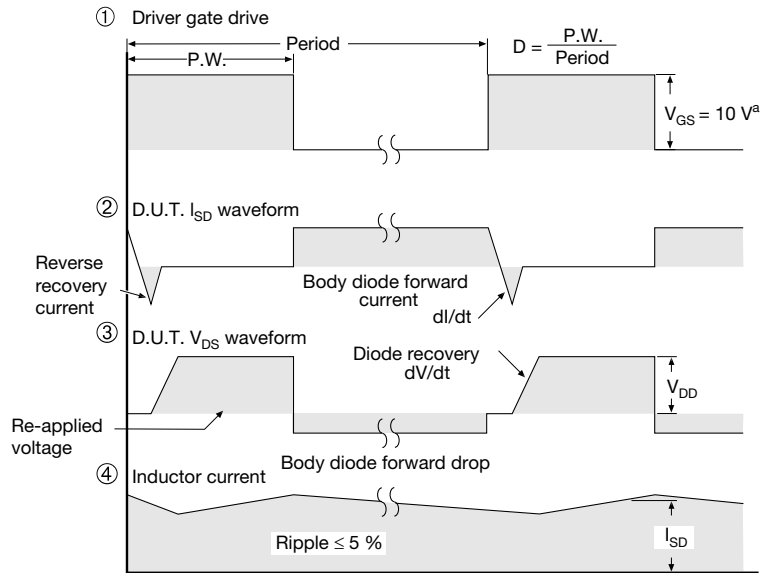
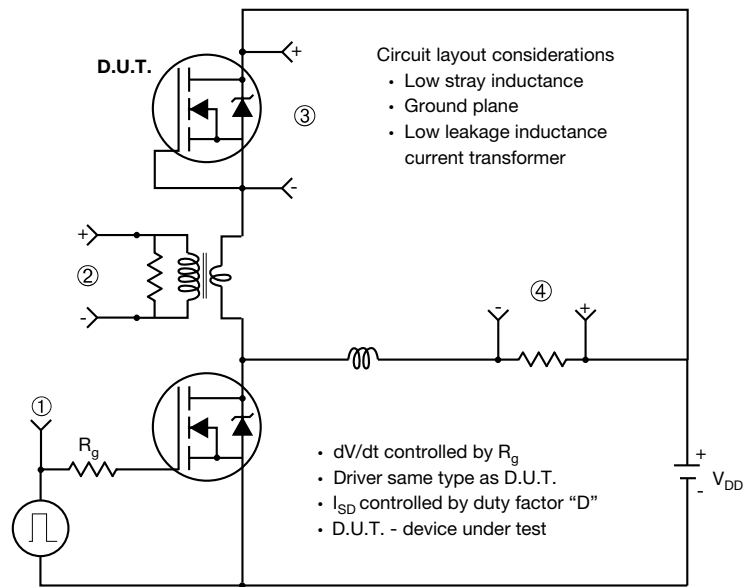


Fig. 15b - Basic Gate Charge Waveform

Peak Diode Recovery dV/dt Test Circuit



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

Fig. 16 - For N-Channel

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# TO-247AC (High Voltage)

VERSION 1: FACILITY CODE = 9



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

DIM.	MILLIMETERS		NOTES
	MIN.	MAX.	
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

DIM.	MILLIMETERS		NOTES
	MIN.	MAX.	
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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