

# NDD60N360U1

## N-Channel Power MOSFET 600 V, 360 mΩ

### Features

- 100% Avalanche Tested
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

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

Parameter	Symbol	NDD	Unit
Drain-to-Source Voltage	$V_{DS}$	600	V
Gate-to-Source Voltage	$V_{GS}$	$\pm 25$	V
Continuous Drain Current $R_{\theta JC}$	Steady State	$T_C = 25^\circ\text{C}$	11
		$T_C = 100^\circ\text{C}$	6.9
Power Dissipation – $R_{\theta JC}$	Steady State	$T_C = 25^\circ\text{C}$	114
Pulsed Drain Current	$t_p = 10 \mu\text{s}$	$I_{DM}$	44
Operating Junction and Storage Temperature	$T_J, T_{STG}$	-55 to +150	$^\circ\text{C}$
Source Current (Body Diode)	$I_S$	13	A
Single Pulse Drain-to-Source Avalanche Energy ( $I_D = 3.5 \text{ A}$ )	EAS	64	mJ
RMS Isolation Voltage ( $t = 0.3 \text{ sec.}$ , R.H. $\leq 30\%$ , $T_A = 25^\circ\text{C}$ ) (Figure 15)	$V_{ISO}$	-	V
Peak Diode Recovery (Note 1)	$dv/dt$	15	V/ns
Lead Temperature for Soldering Leads	$T_L$	260	$^\circ\text{C}$

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1.  $I_{SD} \leq 13 \text{ A}$ ,  $di/dt \leq 400 \text{ A}/\mu\text{s}$ ,  $V_{DS \text{ peak}} \leq V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$

### THERMAL RESISTANCE

Parameter	Symbol	Value	Unit
Junction-to-Case (Drain)	$R_{\theta JC}$	1.1	$^\circ\text{C}/\text{W}$
Junction-to-Ambient Steady State (Note 3)	$R_{\theta JA}$	NDD60N360U1	47
		(Note 2) NDD60N360U1-1	98
		(Note 2) NDD60N360U1-35G	95

2. Insertion mounted
3. Surface mounted on FR4 board using 1" sq. pad size (Cu area = 1.127 in sq [2 oz] including traces)

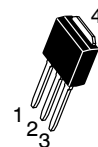
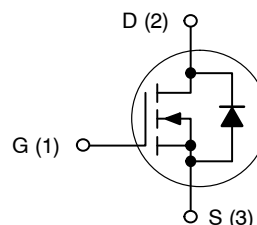


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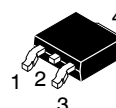
<http://onsemi.com>

$V_{(BR)DSS}$	$R_{DS(ON) \text{ MAX}}$
600 V	360 mΩ @ 10 V

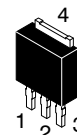
### N-Channel MOSFET



IPAK  
CASE 369D



DPAK  
CASE 369C



IPAK  
CASE 369AD

### MARKING AND ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 3 of this data sheet.

# NDD60N360U1

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	600			V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	Reference to $25^\circ\text{C}$ , $I_D = 1\text{ mA}$		560		mV/ $^\circ\text{C}$
Drain-to-Source Leakage Current	$I_{DSS}$	$V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$	$T_J = 25^\circ\text{C}$		1	$\mu\text{A}$
			$T_J = 125^\circ\text{C}$		100	
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 25\text{ V}$			$\pm 100$	nA

### ON CHARACTERISTICS (Note 4)

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$	2	3.2	4	V
Negative Threshold Temperature Coefficient	$V_{GS(TH)}/T_J$	Reference to $25^\circ\text{C}$ , $I_D = 250\ \mu\text{A}$		8.6		mV/ $^\circ\text{C}$
Static Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}, I_D = 5.5\text{ A}$		320	360	m $\Omega$
Forward Transconductance	$g_{FS}$	$V_{DS} = 15\text{ V}, I_D = 5.5\text{ A}$		10		S

### DYNAMIC CHARACTERISTICS

Input Capacitance	$C_{iss}$	$V_{DS} = 50\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$		790		pF
Output Capacitance	$C_{oss}$			47		
Reverse Transfer Capacitance	$C_{rss}$			3.0		
Effective output capacitance, energy related (Note 6)	$C_{o(er)}$	$V_{GS} = 0\text{ V}, V_{DS} = 0\text{ to }480\text{ V}$		38.9		
Effective output capacitance, time related (Note 7)	$C_{o(tr)}$	$I_D = \text{constant}, V_{GS} = 0\text{ V}, V_{DS} = 0\text{ to }480\text{ V}$		135		
Total Gate Charge	$Q_g$	$V_{DS} = 300\text{ V}, I_D = 13\text{ A}, V_{GS} = 10\text{ V}$		26		nC
Gate-to-Source Charge	$Q_{gs}$			4.7		
Gate-to-Drain Charge	$Q_{gd}$			12.9		
Plateau Voltage	$V_{GP}$			5.6		V
Gate Resistance	$R_g$			4.5		$\Omega$

### RESISTIVE SWITCHING CHARACTERISTICS (Note 5)

Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 300\text{ V}, I_D = 13\text{ A}, V_{GS} = 10\text{ V}, R_G = 0\ \Omega$		10		ns
Rise Time	$t_r$			20		
Turn-off Delay Time	$t_{d(off)}$			26		
Fall Time	$t_f$			22		

### SOURCE-DRAIN DIODE CHARACTERISTICS

Diode Forward Voltage	$V_{SD}$	$I_S = 13\text{ A}, V_{GS} = 0\text{ V}$	$T_J = 25^\circ\text{C}$		0.93	1.6	V
			$T_J = 100^\circ\text{C}$		0.86		
Reverse Recovery Time	$t_{rr}$	$V_{GS} = 0\text{ V}, V_{DD} = 30\text{ V}, I_S = 13\text{ A}, d_i/d_t = 100\text{ A}/\mu\text{s}$		303		ns	
Charge Time	$t_a$			206			
Discharge Time	$t_b$			97			
Reverse Recovery Charge	$Q_{rr}$			3.6			$\mu\text{C}$

4. Pulse Width  $\leq 300\ \mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

5. Switching characteristics are independent of operating junction temperatures.

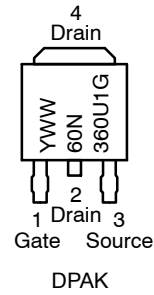
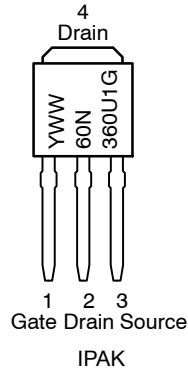
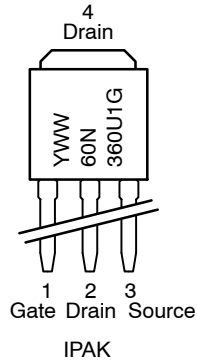
6.  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{(BR)DSS}$

7.  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{(BR)DSS}$

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

# NDD60N360U1

## MARKING DIAGRAMS



Y = Year  
 WW = Work Week  
 G = Pb-Free Package

## ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
NDD60N360U1-1G	IPAK (Pb-Free, Halogen-Free)	75 Units / Rail
NDD60N360U1-35G	IPAK (Pb-Free, Halogen-Free)	75 Units / Rail
NDD60N360U1T4G	DPAK (Pb-Free, Halogen-Free)	2500 / Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

TYPICAL CHARACTERISTICS

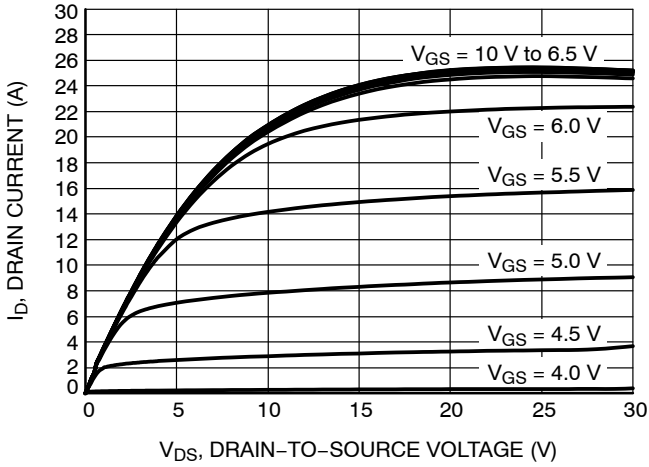


Figure 1. On-Region Characteristics

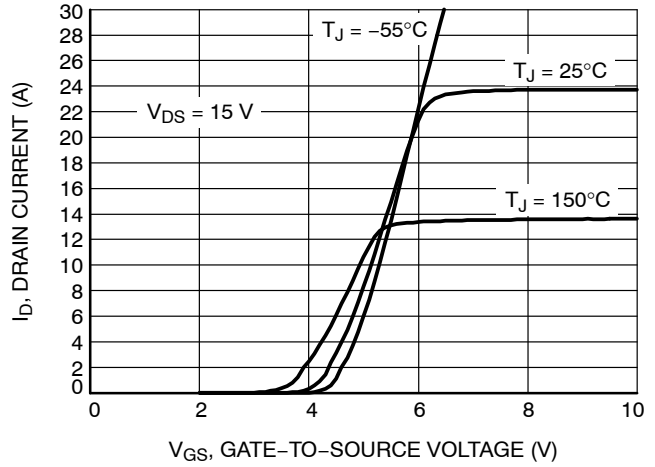


Figure 2. Transfer Characteristics

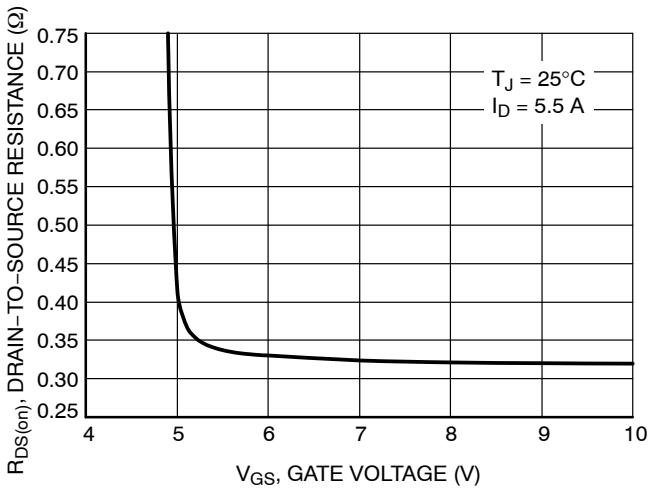


Figure 3. On-Resistance vs. Gate-to-Source Voltage

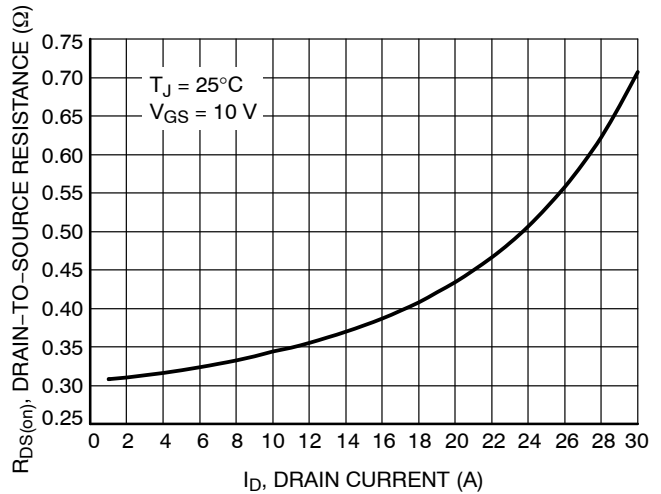


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

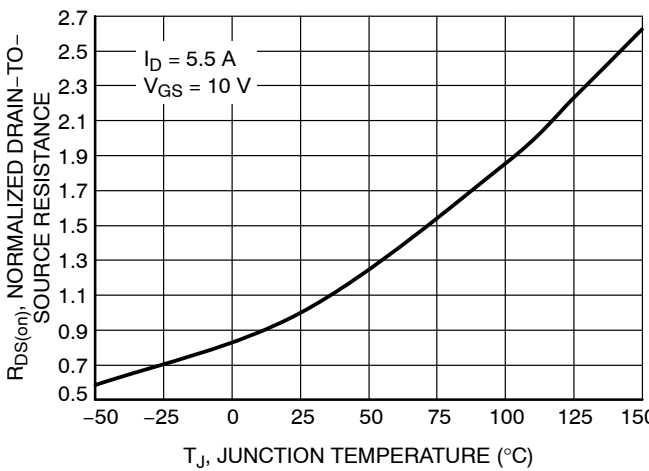


Figure 5. On-Resistance Variation with Temperature

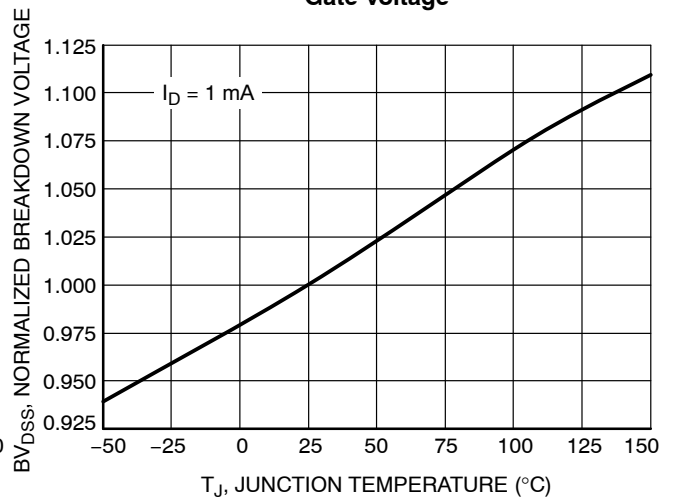
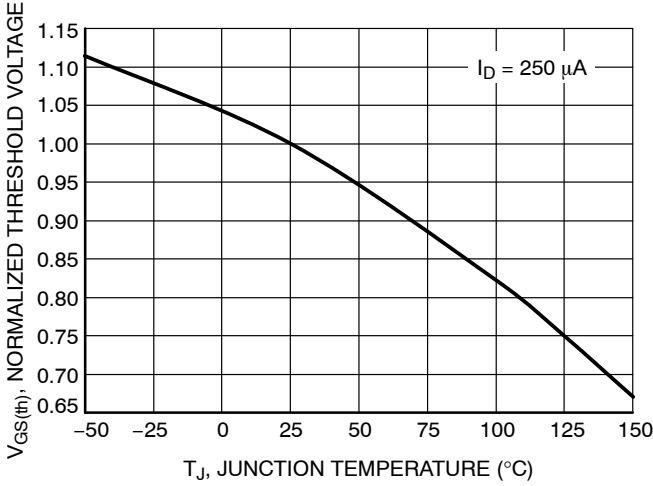


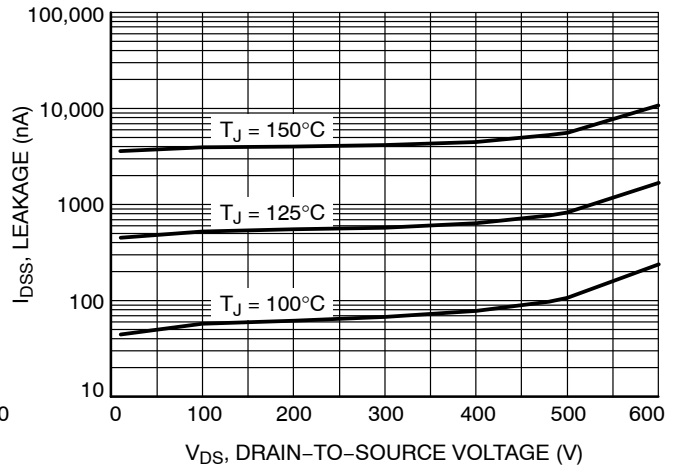
Figure 6. Breakdown Voltage Variation with Temperature

# NDD60N360U1

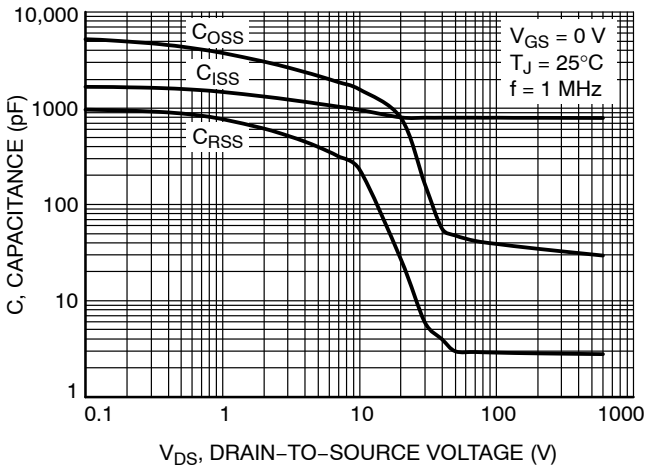
## TYPICAL CHARACTERISTICS



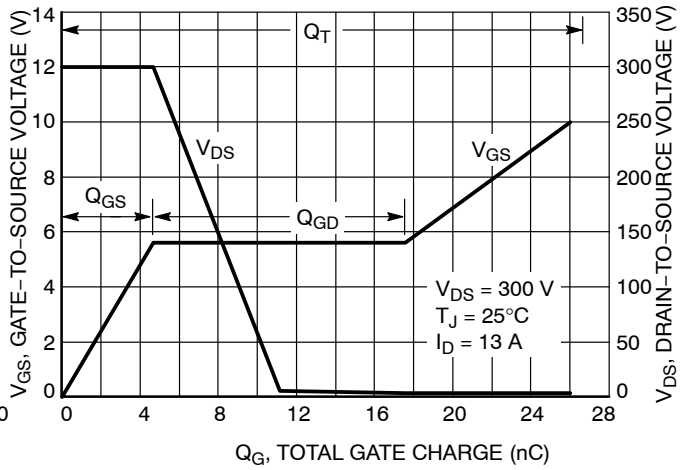
**Figure 7. Threshold Voltage Variation with Temperature**



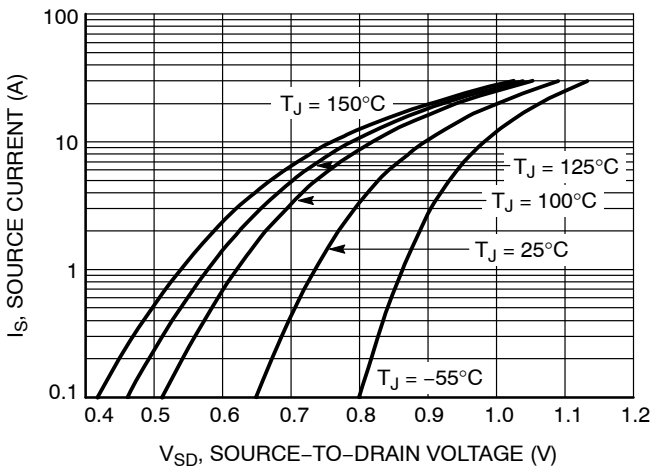
**Figure 8. Drain-to-Source Leakage Current vs. Voltage**



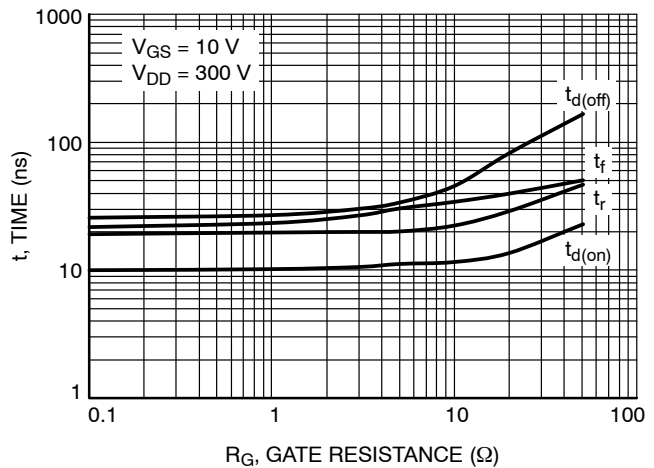
**Figure 9. Capacitance Variation**



**Figure 10. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge**



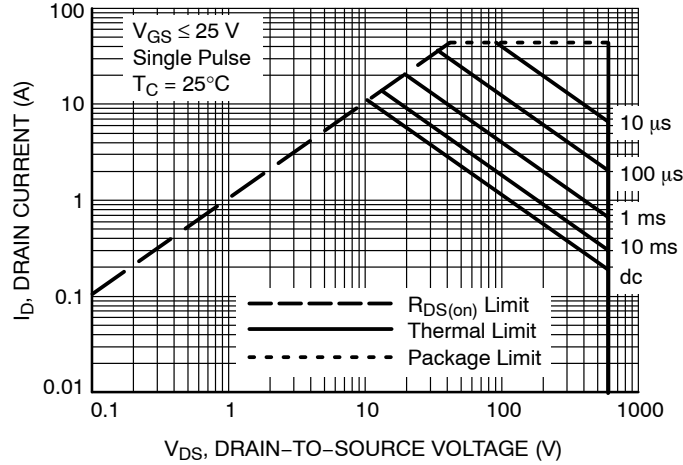
**Figure 11. Diode Forward Voltage vs. Current**



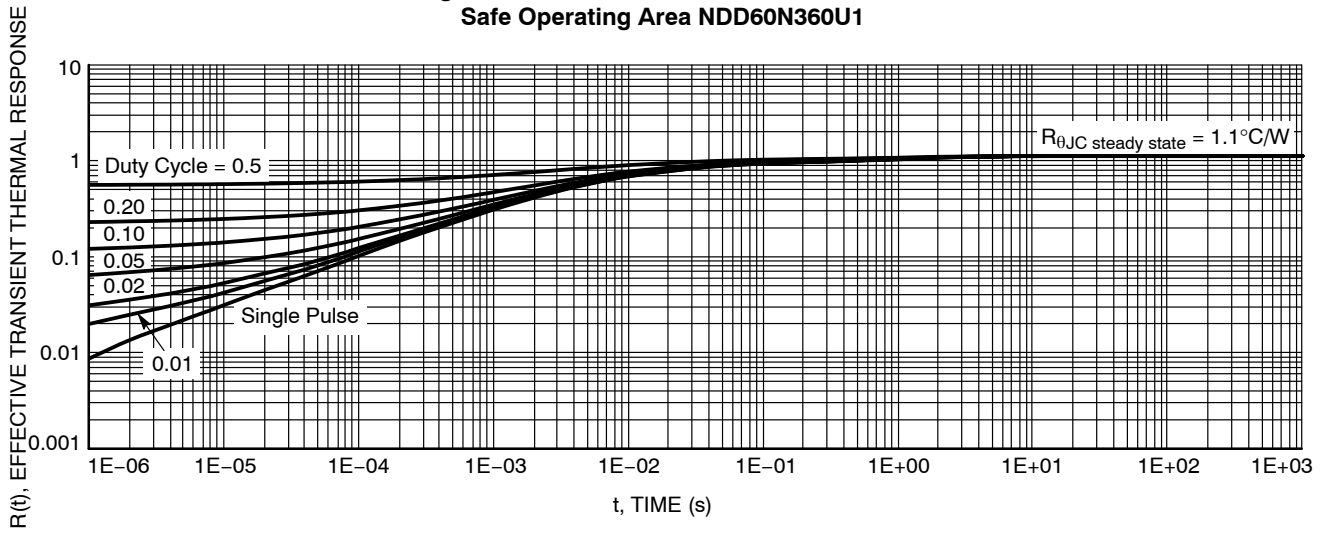
**Figure 12. Resistive Switching Time Variation vs. Gate Resistance**

# NDD60N360U1

## TYPICAL CHARACTERISTICS



**Figure 13. Maximum Rated Forward Biased Safe Operating Area NDD60N360U1**

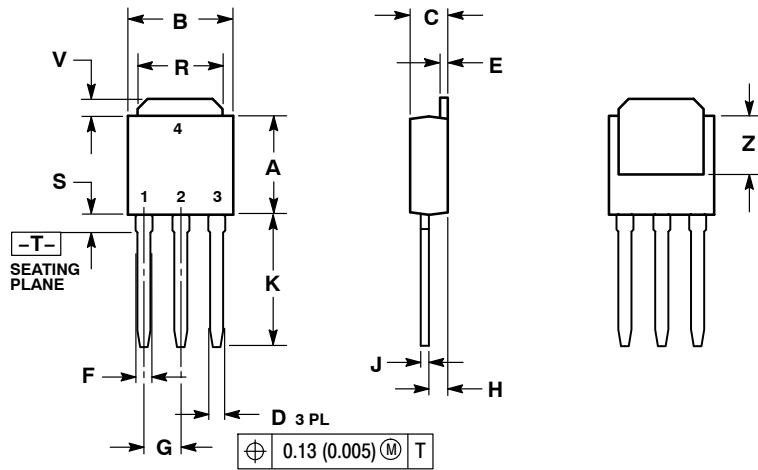


**Figure 14. Thermal Impedance (Junction-to-Case) for NDD60N360U1**

# NDD60N360U1

## PACKAGE DIMENSIONS

### IPAK CASE 369D-01 ISSUE C

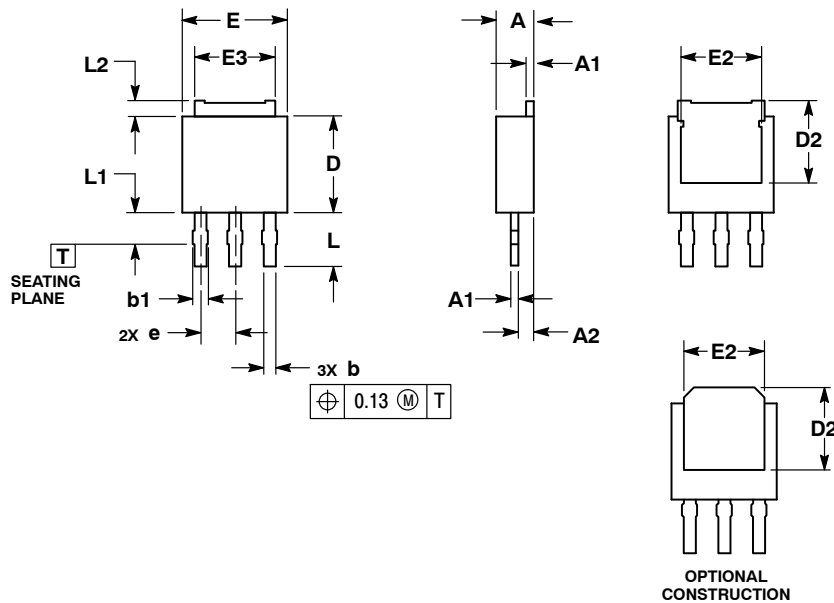


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.235	0.245	5.97	6.35
B	0.250	0.265	6.35	6.73
C	0.086	0.094	2.19	2.38
D	0.027	0.035	0.69	0.88
E	0.018	0.023	0.46	0.58
F	0.037	0.045	0.94	1.14
G	0.090 BSC	2.29 BSC		
H	0.034	0.040	0.87	1.01
J	0.018	0.023	0.46	0.58
K	0.350	0.380	8.89	9.65
R	0.180	0.215	4.45	5.45
S	0.025	0.040	0.63	1.01
V	0.035	0.050	0.89	1.27
Z	0.155	---	3.93	---

- STYLE 2:
- PIN 1. GATE  
2. DRAIN  
3. SOURCE  
4. DRAIN

### 3.5 MM IPAK, STRAIGHT LEAD CASE 369AD ISSUE B



- NOTES:
- 1.. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  - 2.. CONTROLLING DIMENSION: MILLIMETERS.
  3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30mm FROM TERMINAL TIP.
  4. DIMENSIONS D AND E DO NOT INCLUDE MOLD GATE OR MOLD FLASH.

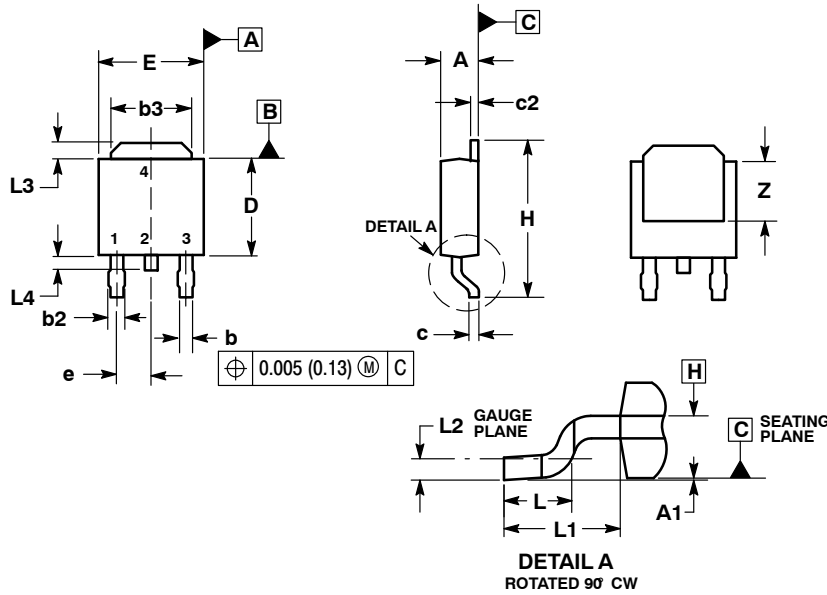
DIM	MILLIMETERS	
	MIN	MAX
A	2.19	2.38
A1	0.46	0.60
A2	0.87	1.10
b	0.69	0.89
b1	0.77	1.10
D	5.97	6.22
D2	4.80	---
E	6.35	6.73
E2	4.57	5.45
E3	4.45	5.46
e	2.28 BSC	
L	3.40	3.60
L1	---	2.10
L2	0.89	1.27

- STYLE 2:
- PIN 1. GATE  
2. DRAIN  
3. SOURCE  
4. DRAIN

# NDD60N360U1

## PACKAGE DIMENSIONS

### DKPAK (SINGLE GAUGE) CASE 369C-01 ISSUE D



#### NOTES:

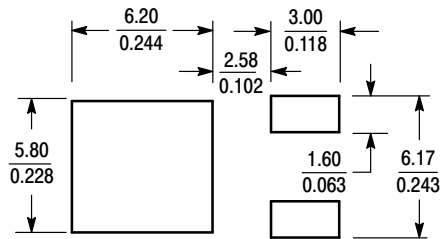
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
5. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
6. DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.086	0.094	2.18	2.38
A1	0.000	0.005	0.00	0.13
b	0.025	0.035	0.63	0.89
b2	0.030	0.045	0.76	1.14
b3	0.180	0.215	4.57	5.46
c	0.018	0.024	0.46	0.61
c2	0.018	0.024	0.46	0.61
D	0.235	0.245	5.97	6.22
E	0.250	0.265	6.35	6.73
e	0.090 BSC		2.29 BSC	
H	0.370	0.410	9.40	10.41
L	0.055	0.070	1.40	1.78
L1	0.108 REF		2.74 REF	
L2	0.020 BSC		0.51 BSC	
L3	0.035	0.050	0.89	1.27
L4	---	0.040	---	1.01
Z	0.155	---	3.93	---

#### STYLE 2:


1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

#### SOLDERING FOOTPRINT\*



SCALE 3:1  $\left(\frac{\text{mm}}{\text{inches}}\right)$

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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