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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}	± 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	$T_C = 25^\circ\text{C}$	P_D 114 W
Pulsed Drain Current	$t_p = 10 \mu\text{s}$	I_{DM}	44 A
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)

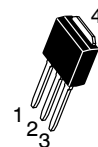
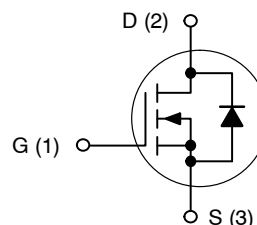


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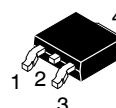
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$V_{(BR)DSS}$	$R_{DS(ON) \text{ MAX}}$
600 V	360 mΩ @ 10 V

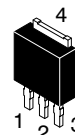
N-Channel MOSFET



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°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	μA
			$T_J = 125^\circ\text{C}$		100	
Gate-to-Source Leakage Current	I_{GSS}	$V_{GS} = \pm 25\text{ V}$			± 100	nA

ON CHARACTERISTICS (Note 4)

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	2	3.2	4	V
Negative Threshold Temperature Coefficient	$V_{GS(TH)}/T_J$	Reference to 25°C , $I_D = 250\text{ }\mu\text{A}$		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 Ω
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		Ω

RESISTIVE SWITCHING CHARACTERISTICS (Note 5)

Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 300\text{ V}, I_D = 13\text{ A}, V_{GS} = 10\text{ V}, R_G = 0\text{ }\Omega$		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			μC

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

5. Switching characteristics are independent of operating junction temperatures.

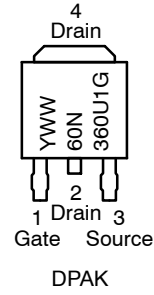
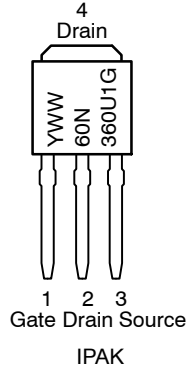
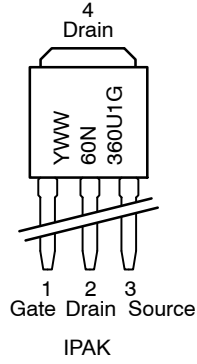
6. $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% $V_{(BR)DSS}$

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 [†]
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

[†]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.

NDD60N360U1

TYPICAL CHARACTERISTICS

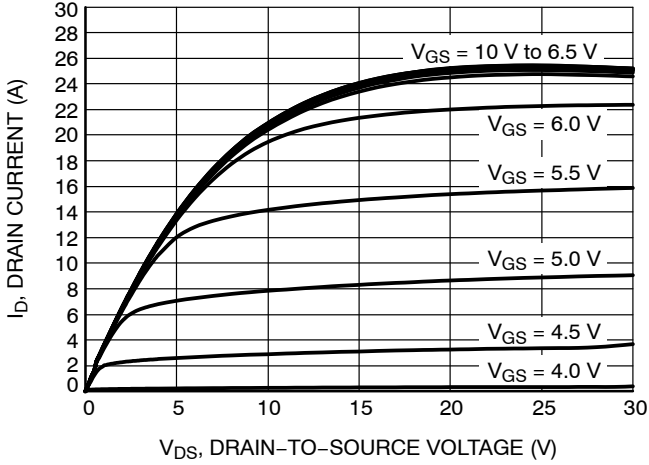


Figure 1. On-Region Characteristics

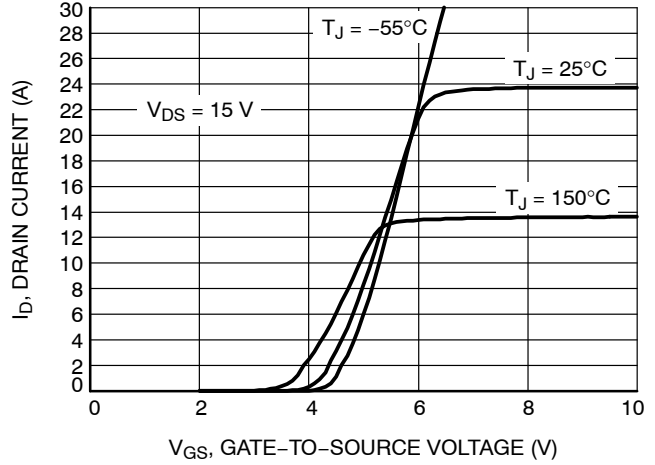


Figure 2. Transfer Characteristics

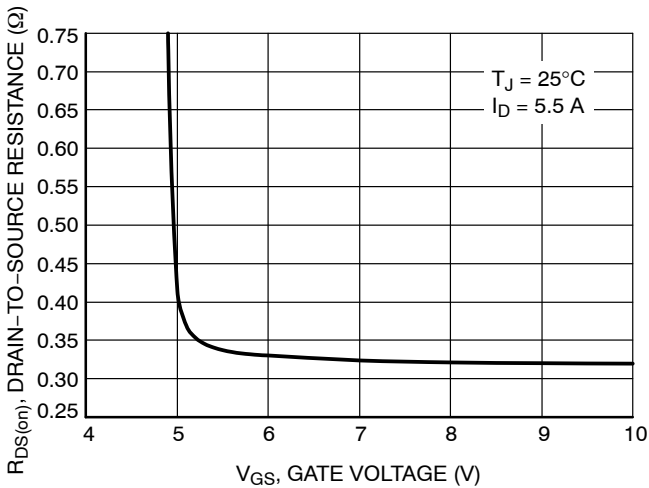


Figure 3. On-Resistance vs. Gate-to-Source Voltage

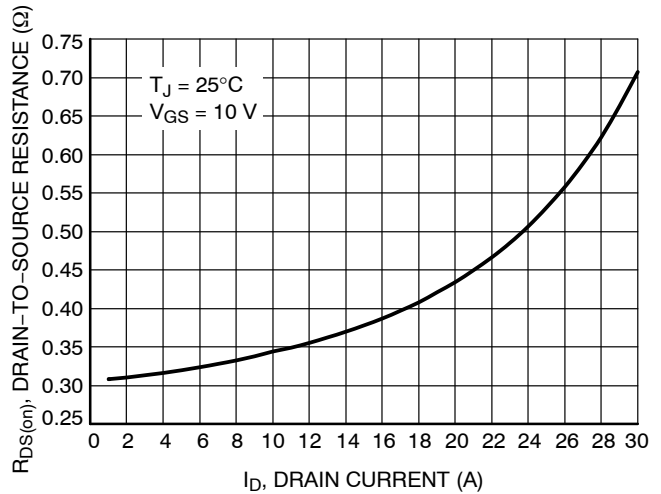


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

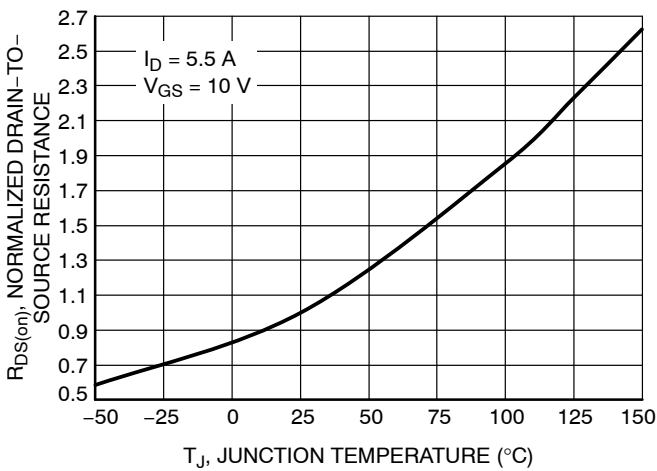


Figure 5. On-Resistance Variation with Temperature

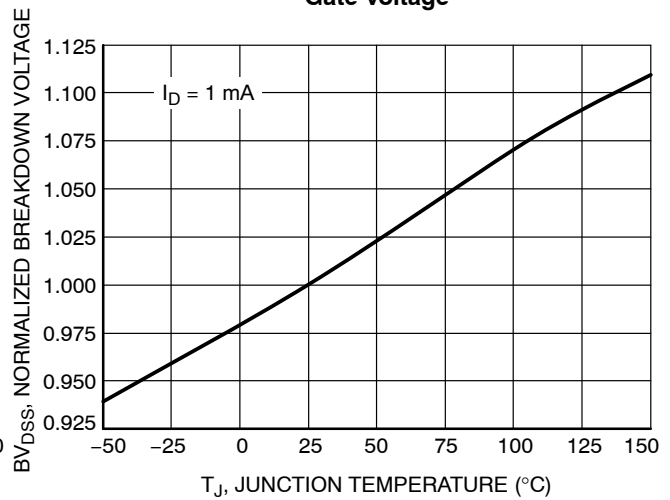


Figure 6. Breakdown Voltage Variation with Temperature

NDD60N360U1

TYPICAL CHARACTERISTICS

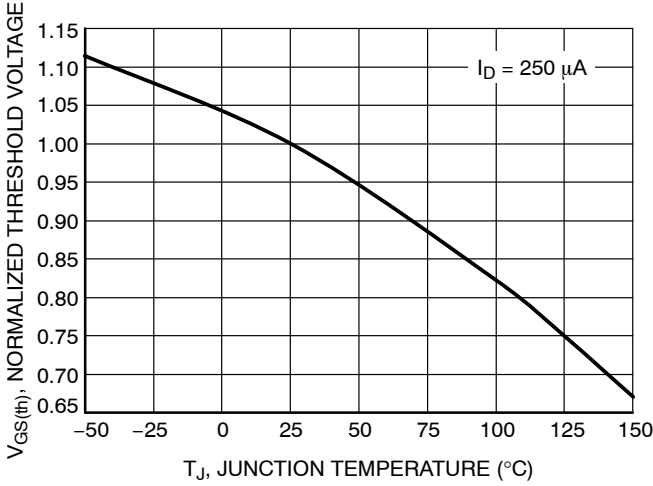


Figure 7. Threshold Voltage Variation with Temperature

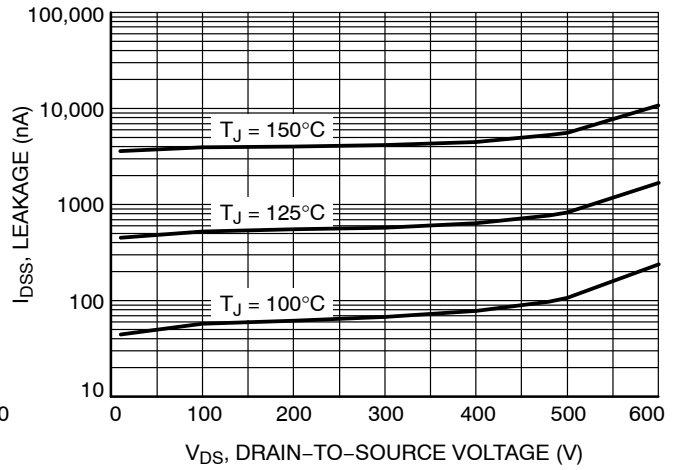


Figure 8. Drain-to-Source Leakage Current vs. Voltage

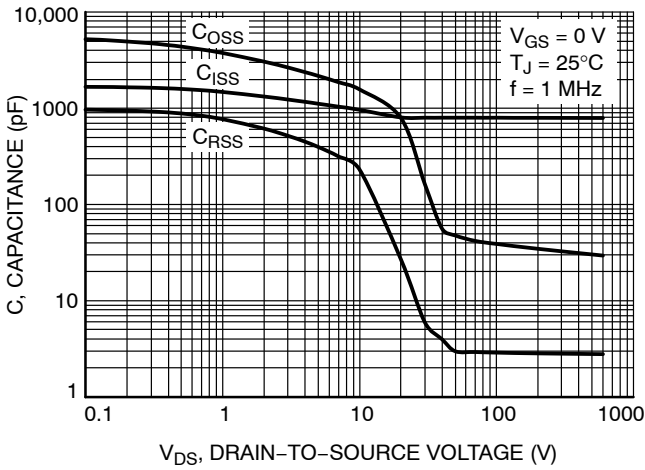


Figure 9. Capacitance Variation

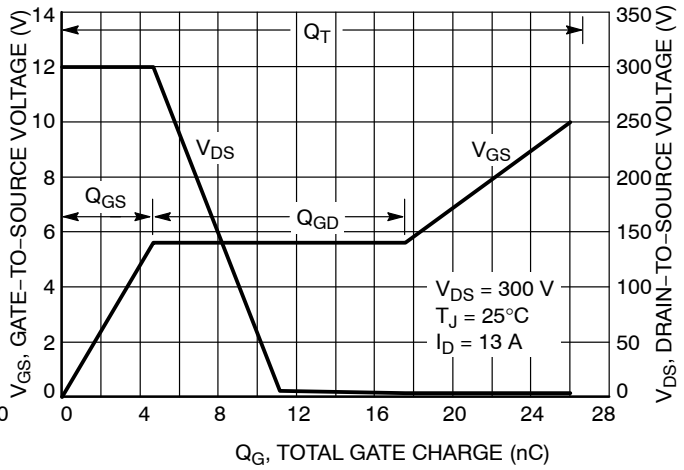


Figure 10. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

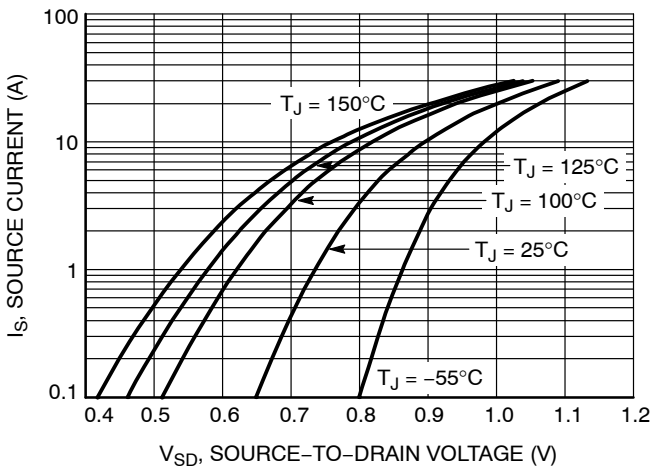


Figure 11. Diode Forward Voltage vs. Current

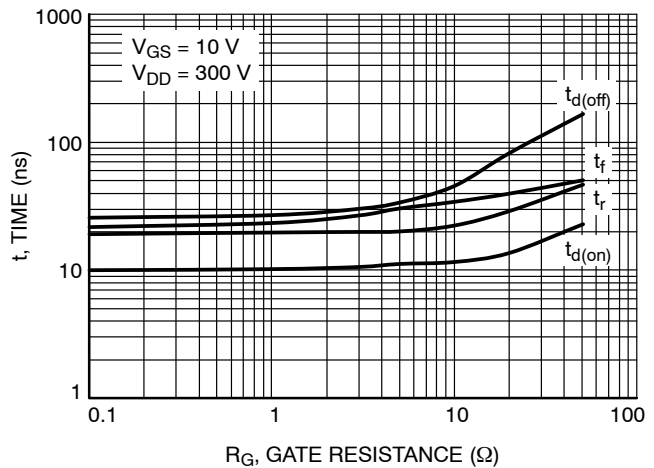


Figure 12. Resistive Switching Time Variation vs. Gate Resistance

NDD60N360U1

TYPICAL CHARACTERISTICS

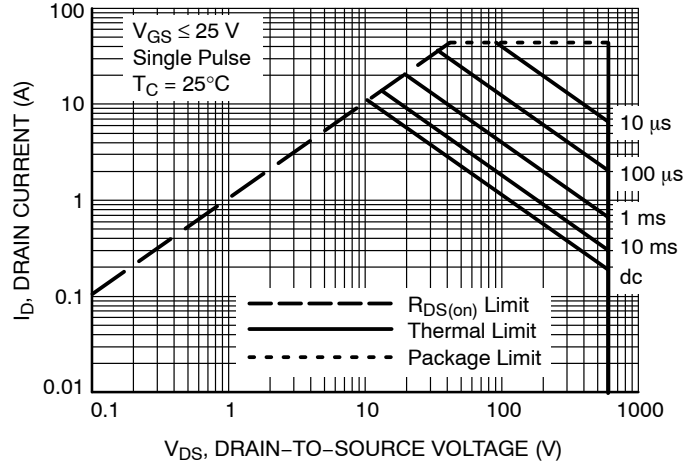


Figure 13. Maximum Rated Forward Biased Safe Operating Area NDD60N360U1

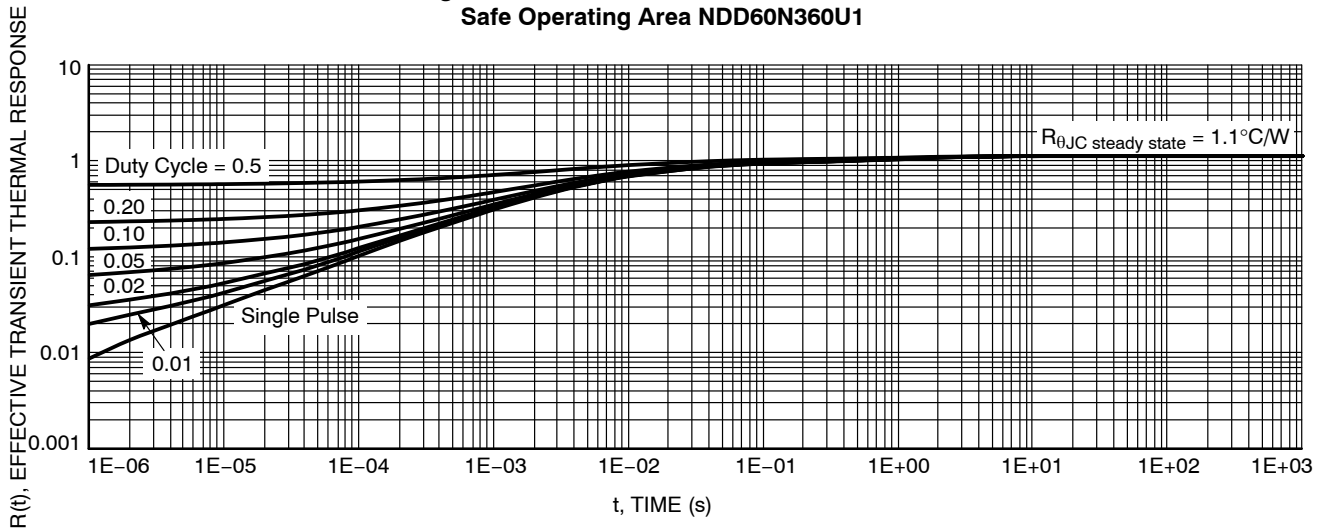
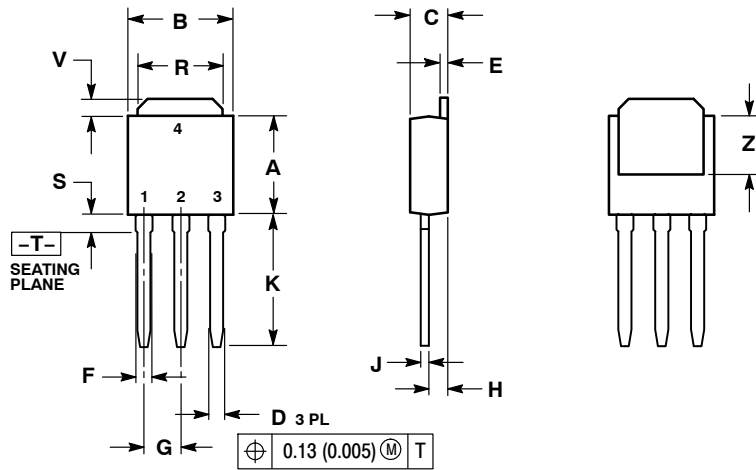


Figure 14. Thermal Impedance (Junction-to-Case) for NDD60N360U1

NDD60N360U1

PACKAGE DIMENSIONS

IPAK CASE 369D-01 ISSUE C



NOTES:

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

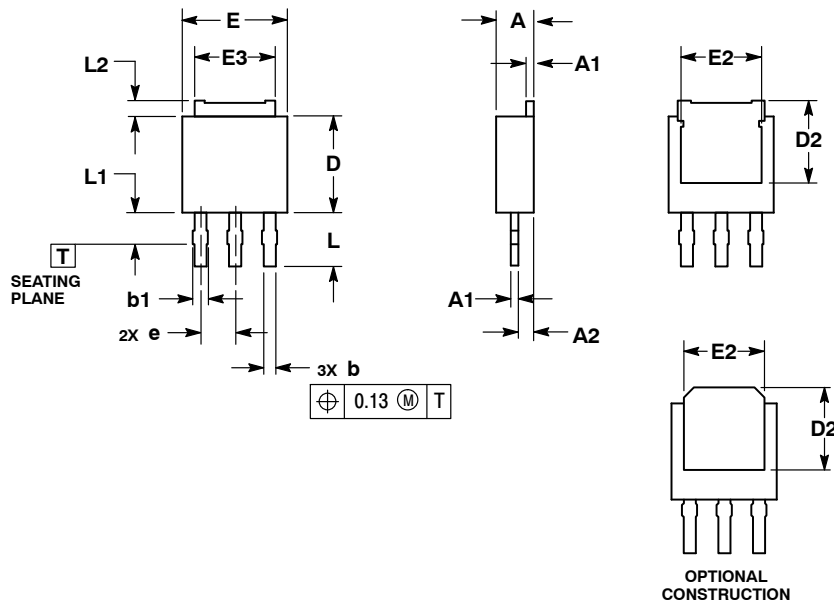
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.235	0.245	5.97	6.35
B	0.250	0.265	6.35	6.73
C	0.086	0.094	2.19	2.38
D	0.027	0.035	0.69	0.88
E	0.018	0.023	0.46	0.58
F	0.037	0.045	0.94	1.14
G	0.090 BSC		2.29 BSC	
H	0.034	0.040	0.87	1.01
J	0.018	0.023	0.46	0.58
K	0.350	0.380	8.89	9.65
R	0.180	0.215	4.45	5.45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

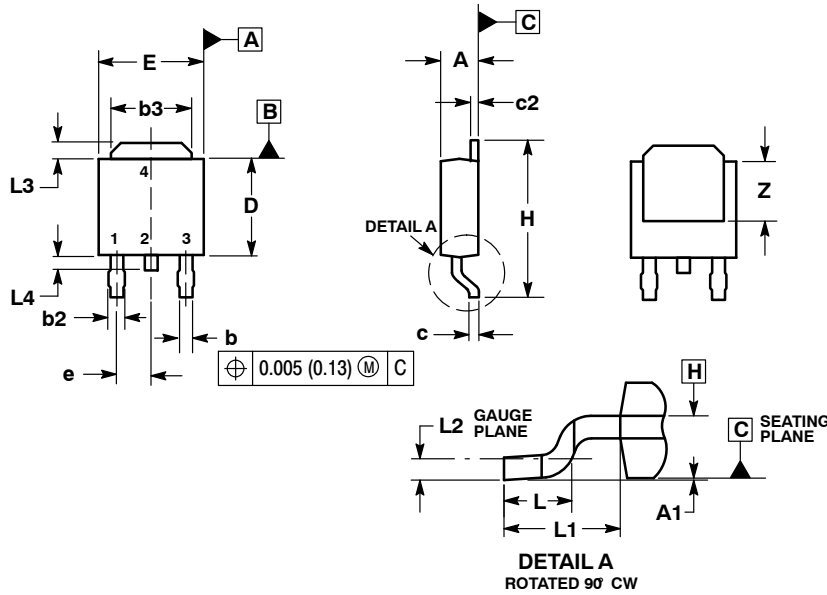
STYLE 2:

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

NDD60N360U1

PACKAGE DIMENSIONS

DPAK (SINGLE GAUGE) CASE 369C-01 ISSUE D



NOTES:

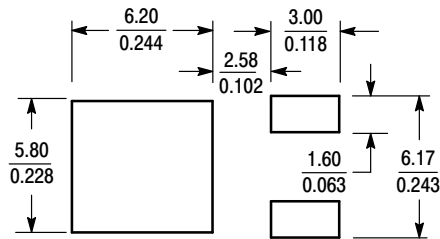
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
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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