

# MOSFET – N-Channel, POWERTRENCH®

**30 V, 58 A, 9 mΩ**

## FDD8880, FDD8880-G

### General Description

This N-Channel MOSFET has been designed specifically to improve the overall efficiency of DC/DC converters using either synchronous or conventional switching PWM controllers. It has been optimized for low gate charge, low  $r_{DS(ON)}$  and fast switching speed.

### Features

- $r_{DS(ON)} = 9\text{ m}\Omega$ ,  $V_{GS} = 10\text{ V}$ ,  $I_D = 35\text{ A}$
- $r_{DS(ON)} = 12\text{ m}\Omega$ ,  $V_{GS} = 4.5\text{ V}$ ,  $I_D = 35\text{ A}$
- High Performance Trench Technology for Extremely Low  $r_{DS(ON)}$
- Low Gate Charge
- High Power and Current Handling Capability
- These Devices are Pb-Free and are RoHS Compliant

### Applications

- DC/DC Converters

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

Symbol	Parameter		Ratings	Unit
$V_{DSS}$	Drain to Source Voltage		30	V
$V_{GS}$	Gate to Source Voltage		$\pm 20$	V
$I_D$	Drain Current	Continuous ( $T_A = 25^\circ\text{C}$ , $V_{GS} = 10\text{ V}$ ) (Note 1)	58	A
		Continuous ( $T_A = 25^\circ\text{C}$ , $V_{GS} = 4.5\text{ V}$ ) (Note 1)	51	A
		Continuous ( $T_{amb} = 25^\circ\text{C}$ , $V_{GS} = 10\text{ V}$ , with $R_{\theta JA} = 52^\circ\text{C/W}$ ) (Note 1)	13	A
		Pulsed	Figure 4	A
$E_{AS}$	Single Pulse Avalanche Energy (Note 2)		53	mJ
$P_D$	Power Dissipation		55	W
	Derate above $25^\circ\text{C}$		0.37	mW/ $^\circ\text{C}$
$T_J, T_{STG}$	Operating and Storage Temperature		-55 to 175	$^\circ\text{C}$

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.

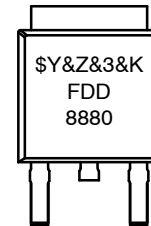
1. Package current limitation is 35A.
2. Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.14\text{ mH}$ ,  $I_{AS} = 28\text{ A}$ ,  $V_{DD} = 27\text{ V}$ ,  $V_{GS} = 10\text{ V}$ .

$V_{DSS}\text{ MAX}$	$r_{DS(ON)}\text{ MAX}$	$I_D\text{ MAX}$
30 V	9 mΩ @ 10 V	58 A
	12 mΩ @ 4.5 V	

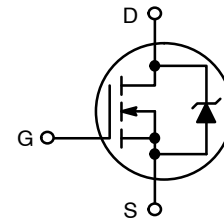


**DPAK3**  
**(TO-252 3 LD)**  
**CASE 369AS**

### MARKING DIAGRAM



$\$Y$  = onsemi Logo  
 $\&Z$  = Assembly Plant Code  
 $\&3$  = 3-Digit Date Code Format  
 $\&K$  = 2-Digits Lot Run Traceability Code  
 FDD8880 = Device Code



**N-Channel**

### ORDERING INFORMATION

See detailed ordering and shipping information on page 12 of this data sheet.

# FDD8880, FDD8880-G

## THERMAL CHARACTERISTICS

Symbol	Parameter	Rated	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case TO-252	2.73	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient TO-252	100	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient TO-252, 1 in <sup>2</sup> Copper Pad Area	52	$^{\circ}\text{C}/\text{W}$

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

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

$B_{VDSS}$	Drain to Source Breakdown Voltage	$I_D = 250 \mu\text{A}, V_{GS} = 0 \text{ V}$	30	–	–	V
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 24 \text{ V}, V_{GS} = 0 \text{ V}$	–	–	1	$\mu\text{A}$
		$V_{DS} = 24 \text{ V}, V_{GS} = 0 \text{ V}, T_C = 150^{\circ}\text{C}$	–	–	250	
$I_{GSS}$	Gate to Source Leakage Current	$V_{GS} = \pm 20 \text{ V}$	–	–	$\pm 100$	nA

### ON CHARACTERISTICS

$V_{GS(TH)}$	Gate to Source Threshold Voltage	$V_{GS} = V_{DS}, I_D = 250 \mu\text{A}$	1.2	–	2.5	V
$r_{DS(ON)}$	Drain to Source On Resistance	$I_D = 35 \text{ A}, V_{GS} = 10 \text{ V}$	–	0.007	0.009	$\Omega$
		$I_D = 35 \text{ A}, V_{GS} = 4.5 \text{ V}$	–	0.009	0.012	
		$I_D = 35 \text{ A}, V_{GS} = 10 \text{ V}, T_J = 175^{\circ}\text{C}$	–	0.013	0.015	

### DYNAMIC CHARACTERISTICS

$C_{ISS}$	Input Capacitance	$V_{DS} = 15 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$	–	1260	–	pF
$C_{OSS}$	Output Capacitance		–	260	–	pF
$C_{RSS}$	Reverse Transfer Capacitance		–	150	–	pF
$R_G$	Gate Resistance	$V_{GS} = 0.5 \text{ V}, f = 1 \text{ MHz}$	–	2.3	–	$\Omega$
$Q_{g(TOT)}$	Total Gate Charge at 10 V	$V_{GS} = 0 \text{ V to } 10 \text{ V}, V_{DD} = 15 \text{ V}, I_D = 35 \text{ A}, I_g = 1.0 \text{ mA}$	–	23	31	nC
$Q_{g(5)}$	Total Gate Charge at 5 V	$V_{GS} = 0 \text{ V to } 5 \text{ V}, V_{DD} = 15 \text{ V}, I_D = 35 \text{ A}, I_g = 1.0 \text{ mA}$	–	13	17	nC
$Q_{g(TH)}$	Threshold Gate Charge	$V_{GS} = 0 \text{ V to } 1 \text{ V}, V_{DD} = 15 \text{ V}, I_D = 35 \text{ A}, I_g = 1.0 \text{ mA}$	–	1.3	1.7	nC
$Q_{gs}$	Gate to Source Gate Charge	$V_{DD} = 15 \text{ V}, I_D = 35 \text{ A}, I_g = 1.0 \text{ mA}$	–	3.8	–	nC
$Q_{gs2}$	Gate Charge Threshold to Plateau		–	2.5	–	nC
$Q_{gd}$	Gate to Drain "Miller" Charge		–	5.0	–	nC

### SWITCHING CHARACTERISTICS ( $V_{GS} = 10 \text{ V}$ )

$t_{ON}$	Turn-On Time	$V_{DD} = 15 \text{ V}, I_D = 35 \text{ A}, V_{GS} = 10 \text{ V}, R_{GS} = 10 \Omega$	–	–	147	ns
$t_{d(ON)}$	Turn-On Delay Time		–	8	–	ns
$t_r$	Rise Time		–	91	–	ns
$t_{d(OFF)}$	Turn-Off Delay Time		–	38	–	ns
$t_f$	Fall Time		–	32	–	ns
$t_{OFF}$	Turn-Off Time		–	–	108	ns

### DRAIN-SOURCE DIODE CHARACTERISTICS

$V_{SD}$	Source to Drain Diode Voltage	$I_{SD} = 35 \text{ A}$	–	–	1.25	V
		$I_{SD} = 15 \text{ A}$	–	–	1.0	V
$t_{rr}$	Reverse Recovery Time	$I_{SD} = 35 \text{ A}, dI_{SD}/dt = 100 \text{ A}/\mu\text{s}$	–	–	27	ns
$Q_{RR}$	Reverse Recovered Charge	$I_{SD} = 35 \text{ A}, dI_{SD}/dt = 100 \text{ A}/\mu\text{s}$	–	–	14	nC

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.

TYPICAL CHARACTERISTICS

(T<sub>J</sub> = 25°C unless otherwise noted)

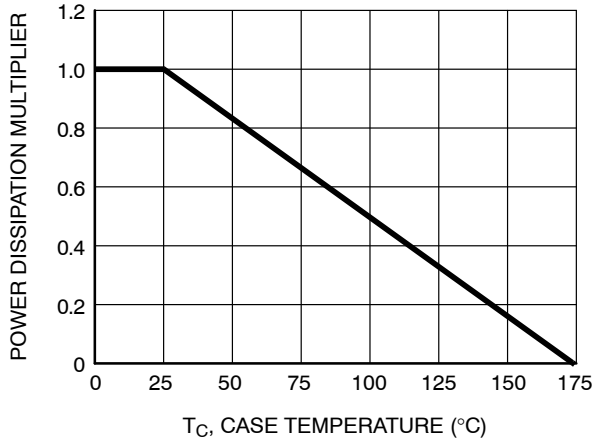


Figure 1. Normalized Power Dissipation vs. Case Temperature

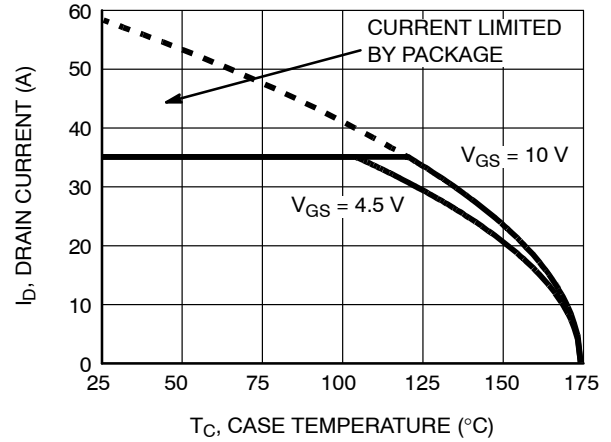


Figure 2. Maximum Continuous Drain Current vs. Case Temperature

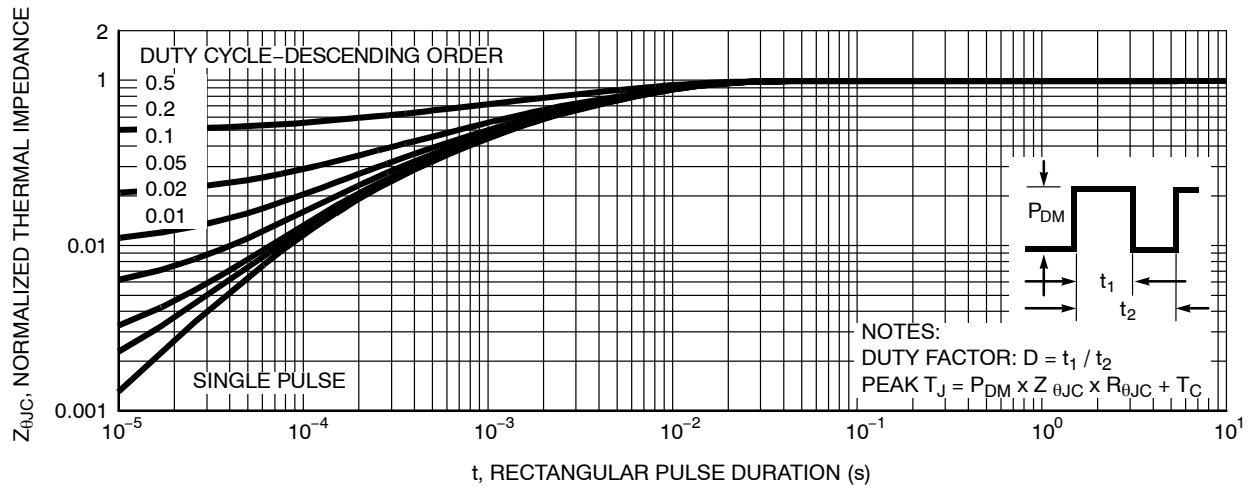


Figure 3. Normalized Maximum Transient Thermal Impedance

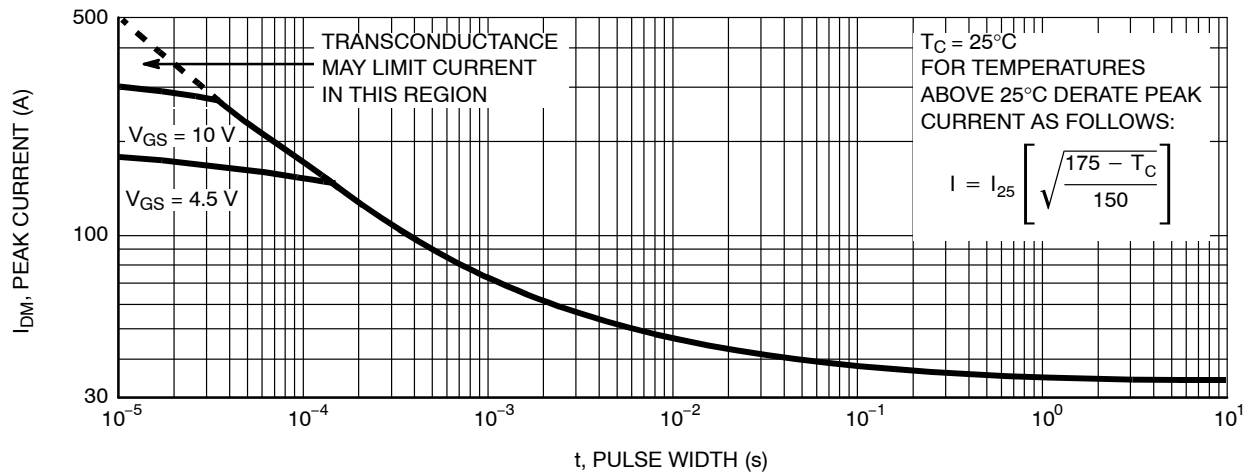


Figure 4. Peak Current Capability

TYPICAL CHARACTERISTICS

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

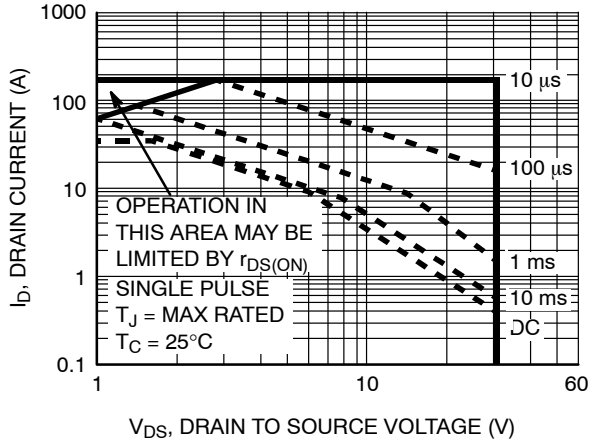
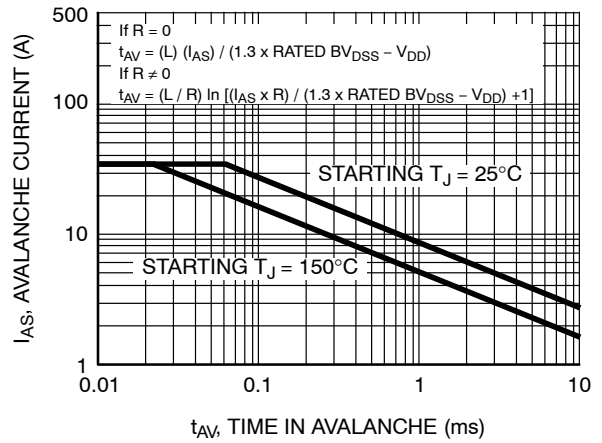


Figure 5. Forward Bias Safe Operating Area



NOTE: Refer to onsemi Application Notes [AN-7514](#) and [AN-7515](#)  
 Figure 6. Unclamped Inductive Switching Capability

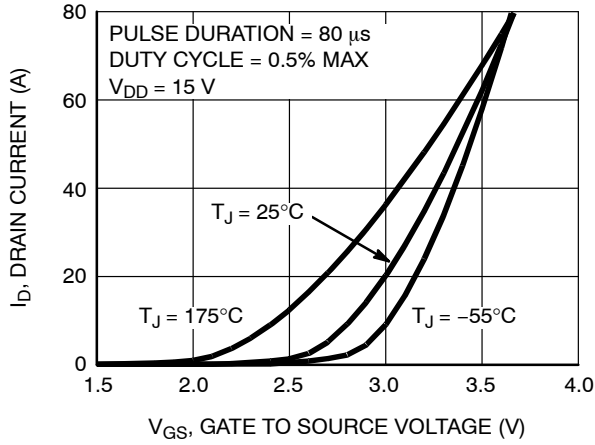


Figure 7. Transfer Characteristics

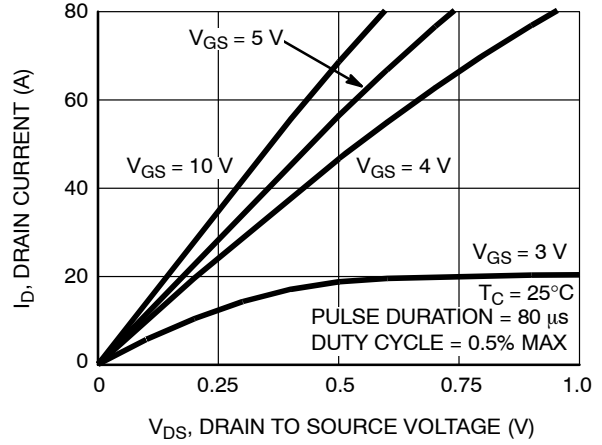


Figure 8. Saturation Characteristics

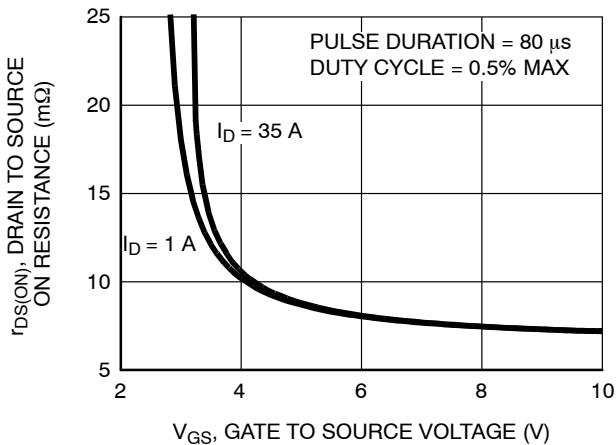


Figure 9. Drain to Source On Resistance vs. Gate Voltage and Drain Current

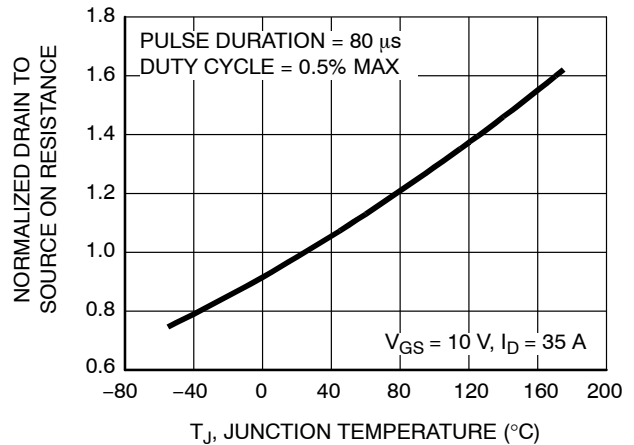


Figure 10. Normalized Drain to Source On Resistance vs. Junction Temperature

TYPICAL CHARACTERISTICS

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

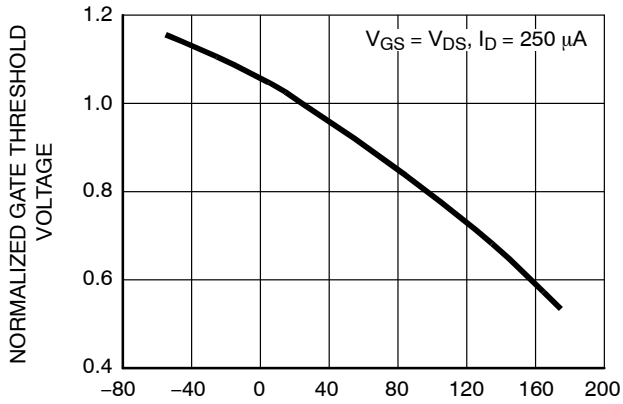


Figure 11. Normalized Gate Threshold Voltage vs. Junction Temperature

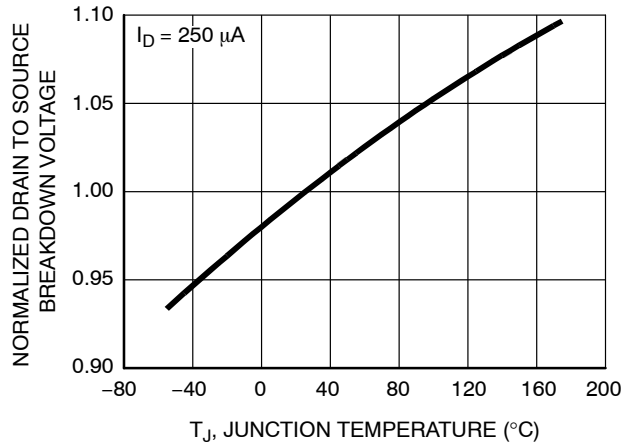


Figure 12. Normalized Drain to Source Breakdown Voltage vs. Junction Temperature

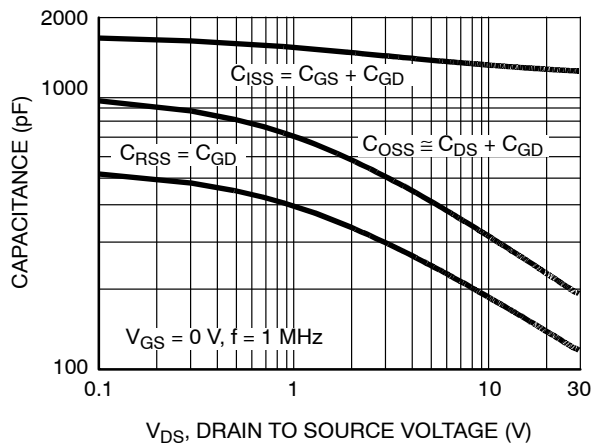


Figure 13. Capacitance vs. Drain to Source Voltage

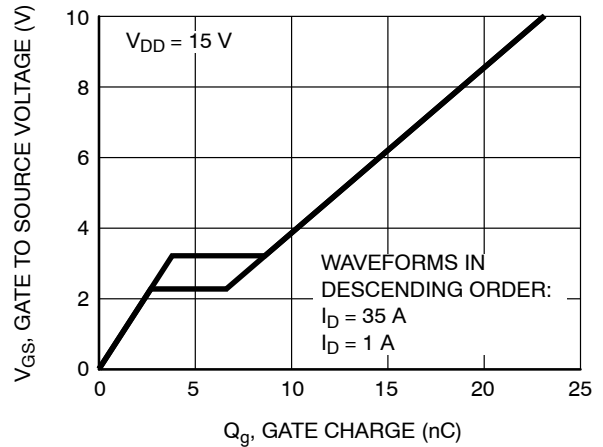


Figure 14. Gate Charge Waveforms for Constant Gate Current

TEST CIRCUITS AND WAVEFORMS

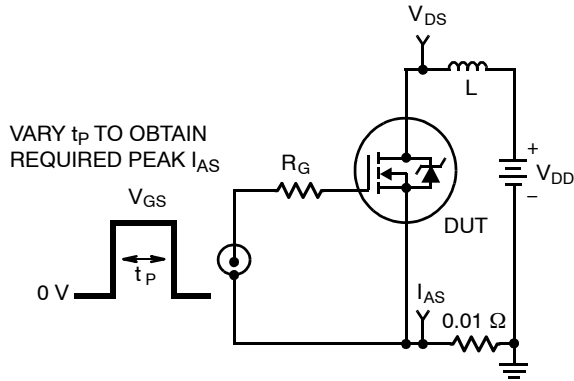


Figure 15. Unclamped Energy Test Circuit

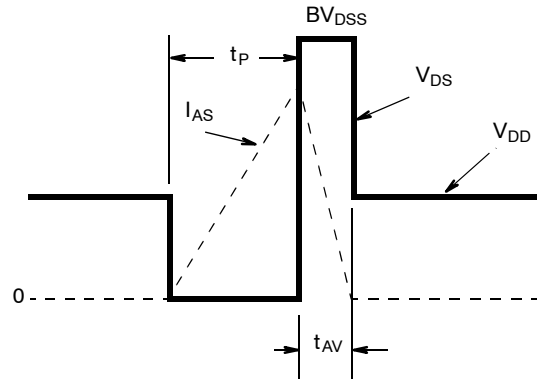


Figure 16. Unclamped Energy Waveforms

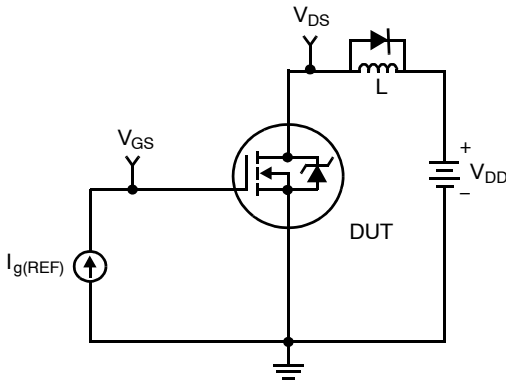


Figure 17. Gate Charge Test Circuit

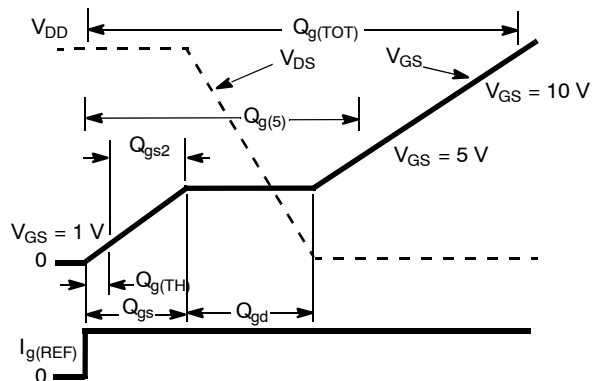


Figure 18. Gate Charge Waveforms

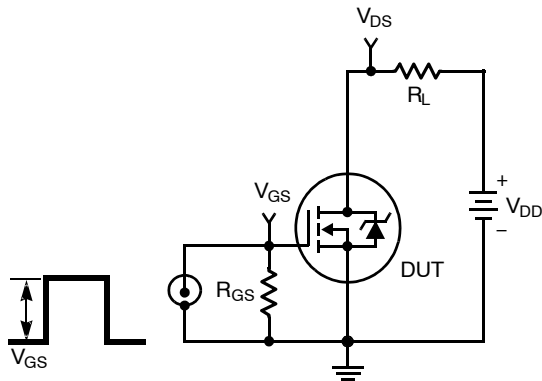


Figure 19. Switching Time Test Circuit

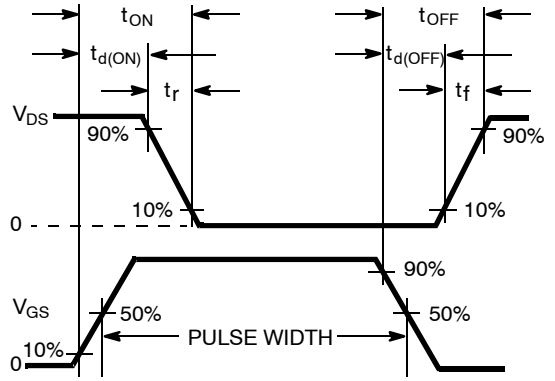


Figure 20. Switching Time Waveforms

**THERMAL RESISTANCE VS. MOUNTING PAD AREA**

The maximum rated junction temperature,  $T_{JM}$ , and the thermal resistance of the heat dissipating path determines the maximum allowable device power dissipation,  $P_{DM}$ , in an application. Therefore the application’s ambient temperature,  $T_A$  (°C), and thermal resistance  $R_{\theta JA}$  (°C/W) must be reviewed to ensure that  $T_{JM}$  is never exceeded. Equation 1 mathematically represents the relationship and serves as the basis for establishing the rating of the part.

$$P_{DM} = \frac{(T_{JM} - T_A)}{R_{\theta JA}} \quad \text{(eq. 1)}$$

In using surface mount devices such as the TO-252 package, the environment in which it is applied will have a significant influence on the part’s current and maximum power dissipation ratings. Precise determination of  $P_{DM}$  is complex and influenced by many factors:

1. Mounting pad area onto which the device is attached and whether there is copper on one side or both sides of the board.
2. The number of copper layers and the thickness of the board.
3. The use of external heat sinks.
4. The use of thermal vias.
5. Air flow and board orientation.
6. For non steady state applications, the pulse width, the duty cycle and the transient thermal response of the part, the board and the environment they are in.

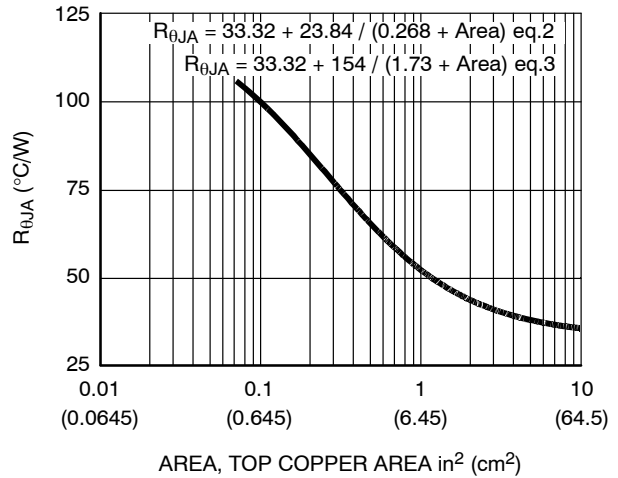
**onsemi** provides thermal information to assist the designer’s preliminary application evaluation. Figure 21 defines the  $R_{\theta JA}$  for the device as a function of the top copper (component side) area. This is for a horizontally positioned FR-4 board with 1oz copper after 1000 seconds of steady state power with no air flow. This graph provides the necessary information for calculation of the steady state junction temperature or power dissipation. Pulse

applications can be evaluated using the **onsemi** device Spice thermal model or manually utilizing the normalized maximum transient thermal impedance curve.

Thermal resistances corresponding to other copper areas can be obtained from Figure 21 or by calculation using Equation 2 or 3. Equation 2 is used for copper area defined in inches square and Equation 3 is for area in centimeters square. The area, in square inches or square centimeters is the top copper area including the gate and source pads.

$$R_{\theta JA} = 33.32 + \frac{23.84}{(0.268 + \text{Area})} \quad \text{Area in Inches Squared} \quad \text{(eq. 2)}$$

$$R_{\theta JA} = 33.32 + \frac{154}{(1.73 + \text{Area})} \quad \text{Area in Inches Squared} \quad \text{(eq. 3)}$$



**Figure 21. Thermal Resistance vs. Mounting Pad Area**

# FDD8880, FDD8880-G

## PSPICE ELECTRICAL MODEL

.SUBCKT FDD8880 2 1 3 ; rev April 2004

Ca 12 8 9.5e-10

Cb 15 14 9.5e-10

Cin 6 8 1.15e-9

Dbody 7 5 DbodyMOD

Dbreak 5 11 DbreakMOD

Dplcap 10 5 DplcapMOD

Ebreak 11 7 17 18 33.15

Eds 14 8 5 8 1

Egs 13 8 6 8 1

Esg 6 10 6 8 1

Evthres 6 21 19 8 1

Etemp 20 6 18 22 1

It 8 17 1

Lgate 1 9 5.3e-9

Ldrain 2 5 1.0e-9

Lsource 3 7 1.7e-9

RLgate 1 9 53

RLdrain 2 5 10

RLsource 3 7 17

Mmed 16 6 8 8 MmedMOD

Mstro 16 6 8 8 MstroMOD

Mweak 16 21 8 8 MweakMOD

Rbreak 17 18 RbreakMOD 1

Rdrain 50 16 RdrainMOD 3.2e-3

Rgate 9 20 2.2

RSLC1 5 51 RSLCMOD 1e-6

RSLC2 5 50 1e3

Rsource 8 7 RsourceMOD 3.2e-3

Rvthres 22 8 RvthresMOD 1

Rvtemp 18 19 RvtempMOD 1

S1a 6 12 13 8 S1AMOD

S1b 13 12 13 8 S1BMOD

S2a 6 15 14 13 S2AMOD

S2b 13 15 14 13 S2BMOD

Vbat 22 19 DC 1

ESLC 51 50 VALUE={ (V(5,51)/ABS(V(5,51))) \* (PWR(V(5,51)/(1e-6\*170),5)) }

.MODEL DbodyMOD D (IS=2E-12 IKF=10 N=1.01 RS=3.76e-3 TRS1=8e-4 TRS2=2e-7  
+ CJO=4.8e-10 M=0.55 TT=1e-17 XTI=2)

.MODEL DbreakMOD D (RS=0.2 TRS1=1e-3 TRS2=-8.9e-6)

.MODEL DplcapMOD D (CJO=5.5e-10 IS=1e-30 N=10 M=0.45)

.MODEL MmedMOD NMOS (VTO=2.0 KP=10 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=2.2)

.MODEL MstroMOD NMOS (VTO=2.5 KP=170 IS=1e-30 N=10 TOX=1 L=1u W=1u)

.MODEL MweakMOD NMOS (VTO=1.69 KP=0.05 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=22 RS=0.1)



## FDD8880, FDD8880-G

```

.MODEL RbreakMOD RES (TC1=8.3e-4 TC2=-8e-7)
.MODEL RdrainMOD RES (TC1=1.8e-3 TC2=8e-6)
.MODEL RSLCMOD RES (TC1=9e-4 TC2=1e-6)
.MODEL RsourceMOD RES (TC1=5e-3 TC2=1e-6)
.MODEL RvthresMOD RES (TC1=-1e-3 TC2=-8.2e-6)
.MODEL RvtempMOD RES (TC1=-2.6e-3 TC2=2e-7)

.MODEL S1AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-4 VOFF=-3.5)
.MODEL S1BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-3.5 VOFF=-4)
.MODEL S2AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-1.3 VOFF=-0.8)
.MODEL S2BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-0.8 VOFF=-1.3)
.ENDS

```

NOTE: For further discussion of the PSPICE model, consult **A New PSPICE Sub-Circuit for the Power MOSFET Featuring Global Temperature Options**; IEEE Power Electronics Specialist Conference Records, 1991, written by William J. Hepp and C. Frank Wheatley.

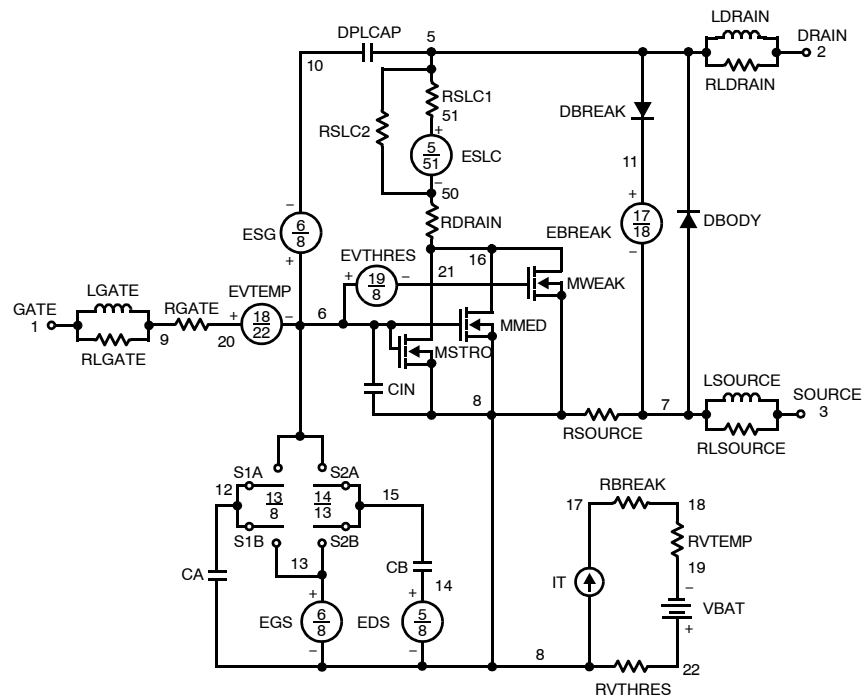


Figure 22.

**SABER ELECTRICAL MODEL**

rev April 2004

template FDD8880 n2,n1,n3

electrical n2,n1,n3

```
{
var i iscl
dp..model dbodymod = (isl=2e-12,ikf=10,nl=1.01,rs=3.76e-3,trs1=8e-4,trs2=2e-7,cjo=4.8e-10,m=0.55,tt=1e-17,xti=2)
dp..model dbreakmod = (rs=0.2,trs1=1e-3,trs2=-8.9e-6)
dp..model dplcapmod = (cjo=5.5e-10,isl=10e-30,nl=10,m=0.45)
m..model mmedmod = (type=_n,vto=2.0,kp=10,is=1e-30, tox=1)
m..model mstrongmod = (type=_n,vto=2.5,kp=170,is=1e-30, tox=1)
m..model mweakmod = (type=_n,vto=1.69,kp=0.05,is=1e-30, tox=1,rs=0.1)
sw_vcsp..model s1amod = (ron=1e-5,roff=0.1,von=-4,voff=-3.5)
sw_vcsp..model s1bmod = (ron=1e-5,roff=0.1,von=-3.5,voff=-4)
sw_vcsp..model s2amod = (ron=1e-5,roff=0.1,von=-1.3,voff=-0.8)
sw_vcsp..model s2bmod = (ron=1e-5,roff=0.1,von=-0.8,voff=-1.3)
c.ca n12 n8 = 9.5e-10
c.cb n15 n14 = 9.5e-10
c.cin n6 n8 = 1.15e-9

dp.dbody n7 n5 = model=dbodymod
dp.dbreak n5 n11 = model=dbreakmod
dp.dplcap n10 n5 = model=dplcapmod

spe.ebreak n11 n7 n17 n18 = 33.15
spe.eds n14 n8 n5 n8 = 1
spe.egs n13 n8 n6 n8 = 1
spe.esg n6 n10 n6 n8 = 1
spe.evthres n6 n21 n19 n8 = 1
spe.evtemp n20 n6 n18 n22 = 1

i.it n8 n17 = 1

l.lgate n1 n9 = 5.3e-9
l.l drain n2 n5 = 1.0e-9
l.l source n3 n7 = 1.7e-9

res.rlgate n1 n9 = 53
res.rl drain n2 n5 = 10
res.rl source n3 n7 = 17

m.mmed n16 n6 n8 n8 = model=mmedmod, l=1u, w=1u
m.mstrong n16 n6 n8 n8 = model=mstrongmod, l=1u, w=1u
m.mweak n16 n21 n8 n8 = model=mweakmod, l=1u, w=1u

res.rbreak n17 n18 = 1, tc1=8.3e-4,tc2=-8e-7
res.r drain n50 n16 = 3.2e-3, tc1=1.8e-3,tc2=8e-6
res.rgate n9 n20 = 2.2
res.rslc1 n5 n51 = 1e-6, tc1=9e-4,tc2=1e-6
res.rslc2 n5 n50 = 1e3
res.rsource n8 n7 = 3.2e-3, tc1=5e-3,tc2=1e-6
res.rvthres n22 n8 = 1, tc1=-1e-3,tc2=-8.2e-6
res.rvtemp n18 n19 = 1, tc1=-2.6e-3,tc2=2e-7
sw_vcsp.s1a n6 n12 n13 n8 = model=s1amod
sw_vcsp.s1b n13 n12 n13 n8 = model=s1bmod
sw_vcsp.s2a n6 n15 n14 n13 = model=s2amod
sw_vcsp.s2b n13 n15 n14 n13 = model=s2bmod
```

# FDD8880, FDD8880-G

v.vbat n22 n19 = dc=1

equations {

i (n51->n50) +=iscl

iscl: v(n51,n50) = ((v(n5,n51)/(1e-9+abs(v(n5,n51))))\*((abs(v(n5,n51)\*1e6/170))\*5))

}

}

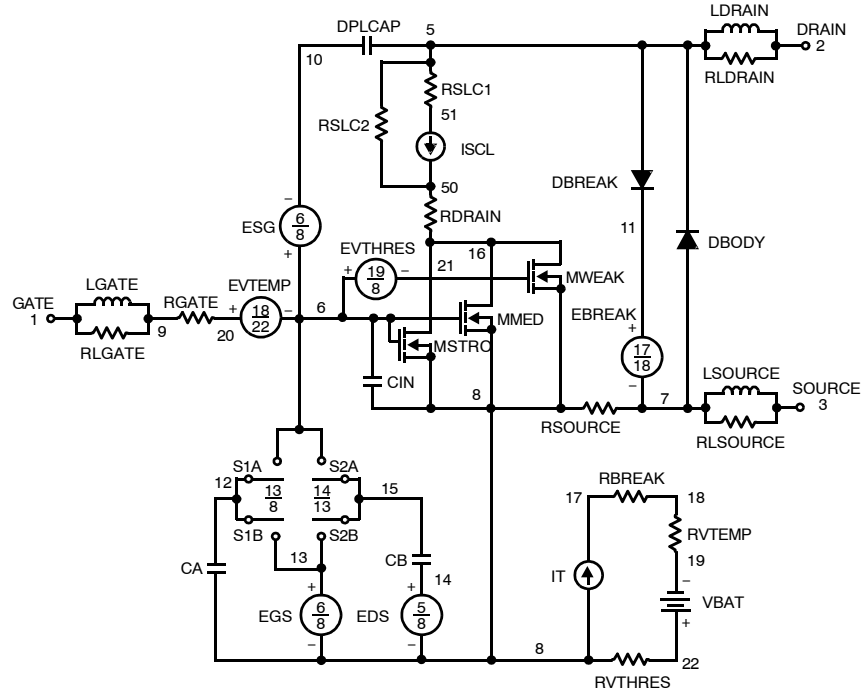


Figure 23.

# FDD8880, FDD8880-G

## SPICE THERMAL MODEL

REV 23 April 2004

FDD8880T

CTHERM1 TH 6 8e-4  
 CTHERM2 6 5 1e-3  
 CTHERM3 5 4 2.5e-3  
 CTHERM4 4 3 2.6e-3  
 CTHERM5 3 2 8e-3  
 CTHERM6 2 TL 1.5e-2

RTHERM1 TH 6 1.44e-1  
 RTHERM2 6 5 1.9e-1  
 RTHERM3 5 4 3.0e-1  
 RTHERM4 4 3 4.0e-1  
 RTHERM5 3 2 5.7e-1  
 RTHERM6 2 TL 5.8e-1

## SABER THERMAL MODEL

SABER thermal model FDD8880T

template thermal\_model th tl  
 thermal\_c th, tl

```
{
ctherm.ctherm1 th 6 =8e-4
ctherm.ctherm2 6 5 =1e-3
ctherm.ctherm3 5 4 =2.5e-3
ctherm.ctherm4 4 3 =2.6e-3
ctherm.ctherm5 3 2 =8e-3
ctherm.ctherm6 2 tl =1.5e-2
```

```
rtherm.rtherm1 th 6 =1.44e-1
rtherm.rtherm2 6 5 =1.9e-1
rtherm.rtherm3 5 4 =3.0e-1
rtherm.rtherm4 4 3 =4.0e-1
rtherm.rtherm5 3 2 =5.7e-1
rtherm.rtherm6 2 tl =5.8e-1
```

```
}
```

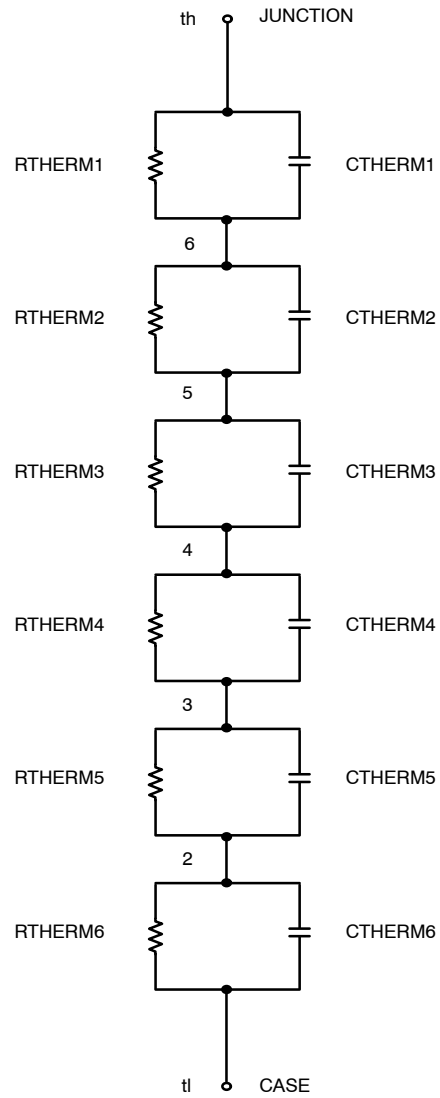


Figure 24.

## PACKAGE MARKING AND ORDERING INFORMATION

Device	Device Marking	Package Type	Reel Size	Tape Width	Shipping <sup>†</sup>
FDD8880	FDD8880	DPAK3 (TO-252 3 LD) (TO-252AA) (Pb-Free)	13"	16 mm	2500 / Tape & Reel
FDD8880-G	FDD8880	DPAK3 (TO-252 3 LD) (TO-252AA) (Pb-Free)	13"	16 mm	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.

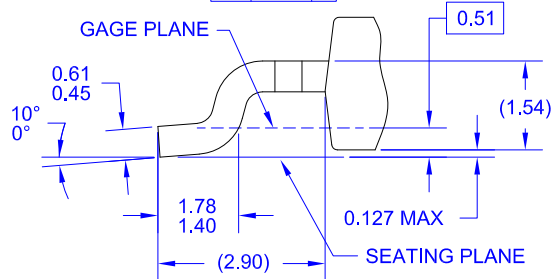
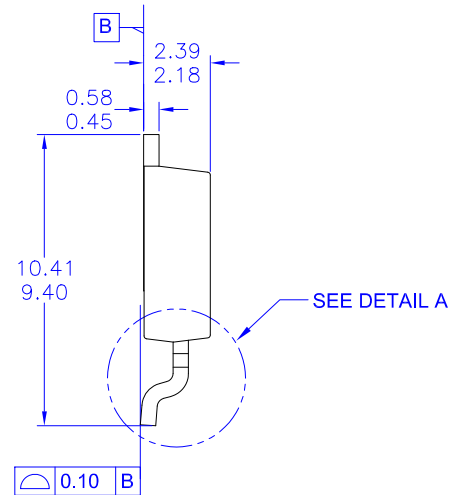
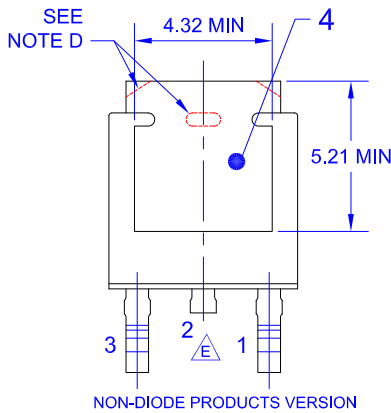
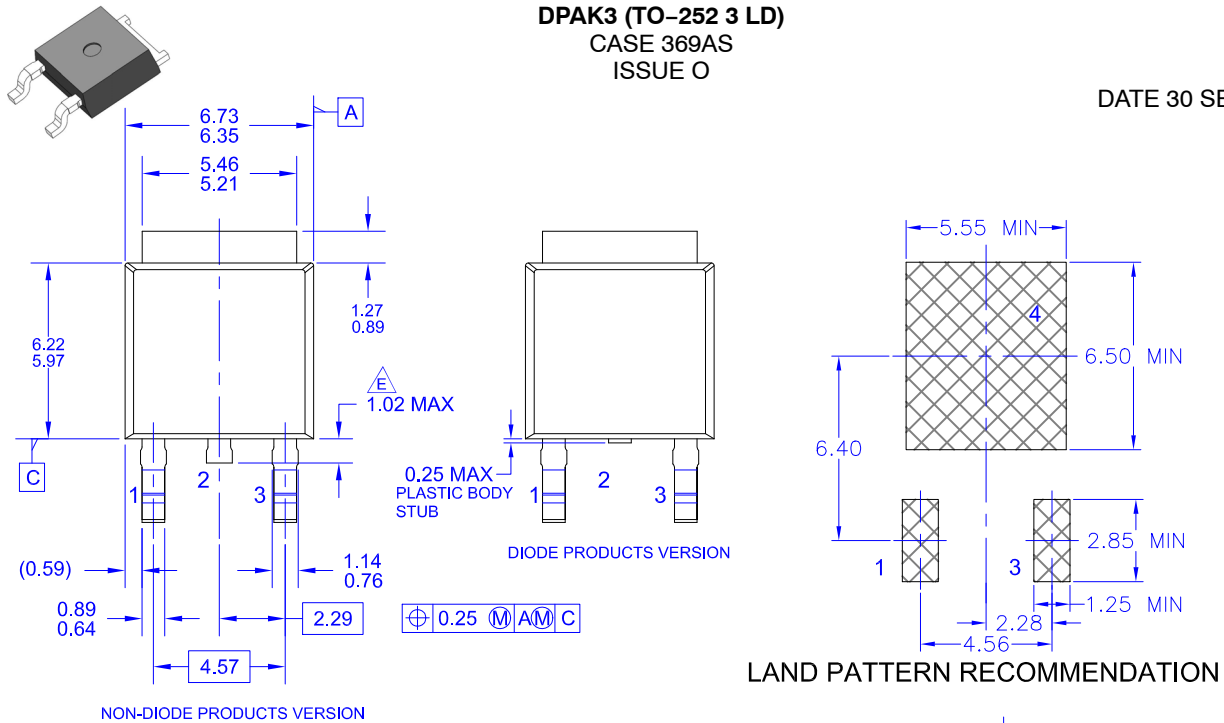
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# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



## DPAK3 (TO-252 3 LD) CASE 369AS ISSUE O

DATE 30 SEP 2016



- NOTES: UNLESS OTHERWISE SPECIFIED
- A) THIS PACKAGE CONFORMS TO JEDEC, TO-252, ISSUE C, VARIATION AA.
  - B) ALL DIMENSIONS ARE IN MILLIMETERS.
  - C) DIMENSIONING AND TOLERANCING PER ASME Y14.5M-2009.
  - D) SUPPLIER DEPENDENT MOLD LOCKING HOLES OR CHAMFERED CORNERS OR EDGE PROTRUSION.
  - E) TRIMMED CENTER LEAD IS PRESENT ONLY FOR DIODE PRODUCTS
  - F) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR EXTRUSIONS.
  - G) LAND PATTERN RECOMMENDATION IS BASED ON IPC7351A STD TO228P991X239-3N.

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<b>DESCRIPTION:</b>	<b>DPAK3 (TO-252 3 LD)</b>	<b>PAGE 1 OF 1</b>

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