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October 2013

FDP3652 / FDB3652

N-Channel PowerTrench[®] MOSFET 100 V, 61 A, 16 m Ω

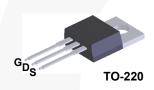
Features

- $r_{DS(on)}$ = 14 m Ω (Typ.), V_{GS} = 10 V, I_D = 61 A
- $Q_{g(tot)}$ = 41 nC (Typ.), V_{GS} = 10 V
- · Low Miller Charge
- · Low Q_{RR} Body Diode
- UIS Capability (Single Pulse and Repetitive Pulse)

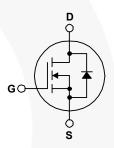
Formerly developmental type 82769

Applications

- Synchronous Rectification for ATX / Server / Telecom PSU
- Battery Protection Circuit
- · Motor drives and Uninterruptible Power Supplies
- · Micro Solar Inverter







MOSFET Maximum Ratings T_C = 25°C unless otherwise noted

Symbol	Parameter	FDP3652 / FDB3652	Unit
V _{DSS}	Drain to Source Voltage	100	V
V_{GS}	Gate to Source Voltage	±20	V
I _D	Drain Current		
	Continuous ($T_C = 25^{\circ}C$, $V_{GS} = 10V$)	61	Α
	Continuous (T _C = 100°C, V _{GS} = 10V)	43	Α
	Continuous ($T_{amb} = 25^{\circ}C$, $V_{GS} = 10V$) with $R_{\theta JA} = 43^{\circ}C/W$)	9	Α
	Pulsed	Figure 4	Α
E _{AS}	Single Pulse Avalanche Energy (Note 1)	182	mJ
P _D	Power dissipation	150	W
	Derate above 25°C	1.0	W/°C
T _J , T _{STG}	Operating and Storage Temperature -55 to 175		

Thermal Characteristics

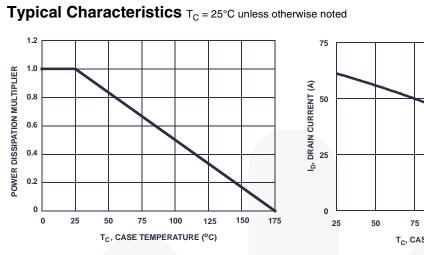
$R_{\theta JC}$	Thermal Resistance Junction to Case TO-220, D2-PAK	1.0	°C/W
$R_{\theta JA}$	Thermal Resistance Junction to Ambient TO-220, D2-PAK (Note 2)	62	°C/W
$R_{\theta JA}$	Thermal Resistance Junction to Ambient D²-PAK, 1in² copper pad area	43	°C/W

Package Marking and Ordering Information						
Device Marking	Device	Package	Reel Size	Tape Width	Quantity	
FDB3652	FDB3652	D²-PAK	330 mm	24 mm	800 units	
FDP3652	FDP3652	TO-220	Tube	N/A	50 units	

Electrical Characteristics $T_C = 25^{\circ}C$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Тур	Max	Units
Off Chara	cteristics					
B _{VDSS}	Drain to Source Breakdown Voltage	$I_D = 250 \mu A, V_{GS} = 0 V$	100	-	-	V
I _{DSS}	Zero Gate Voltage Drain Current	V _{DS} = 80V	-	-	1	
		$V_{GS} = 0V$ $T_C = 150^{\circ}C$	-	- 250	250	μΑ
I _{GSS}	Gate to Source Leakage Current	$V_{GS} = \pm 20V$	-	-	±100	nA
On Chara	cteristics					
V _{GS(TH)}	Gate to Source Threshold Voltage	$V_{GS} = V_{DS}, I_{D} = 250 \mu A$	2	-	4	V
		I _D = 61A, V _{GS} = 10V	-	0.014	0.016	
r	Drain to Source On Resistance	I _D = 30A, V _{GS} = 6V	-	0.018	0.026	Ω
r _{DS(ON)}	Drain to Source On Resistance	$I_D = 61A, V_{GS} = 10V,$ $T_J = 175^{\circ}C$	-	0.035	0.043	
Dynamic	Characteristics					
C _{ISS}	Input Capacitance		- \	2880	-	pF
C _{OSS}	Output Capacitance	$V_{DS} = 25V, V_{GS} = 0V,$	-	390	-	pF
C _{RSS}	Reverse Transfer Capacitance	f = 1MHz	-	100	-	pF
Q _{g(TOT)}	Total Gate Charge at 10V	V _{GS} = 0V to 10V		41	53	nC
Q _{g(TH)}	Threshold Gate Charge	$V_{GS} = 0V \text{ to } 2V$ $V_{DD} = 50V$	-	5	6.5	nC
Q _{gs}	Gate to Source Gate Charge	I _D = 61A	-	15	-	nC
Q _{gs2}	Gate Charge Threshold to Plateau	$I_g = 1.0 \text{mA}$	-	10	-	nC
Q _{gd}	Gate to Drain "Miller" Charge		-	10	-	nC
	Characteristics (V _{GS} = 10V)					
t _{ON}	Turn-On Time		-	-	146	ns
t _{d(ON)}	Turn-On Delay Time		-	12	-,/	ns
t _r	Rise Time	$V_{DD} = 50V, I_{D} = 61A$	-	85	-	ns
t _{d(OFF)}	Turn-Off Delay Time	$V_{GS} = 10V$, $R_{GS} = 6.8\Omega$	-	26	7-	ns
t _f	Fall Time		-	45	/ -	ns
t _{OFF}	Turn-Off Time			-	107	ns
Drain-Sou	urce Diode Characteristics					
		I _{SD} = 61A	- /	-	1.25	V
V_{SD}	Source to Drain Diode Voltage	$I_{SD} = 30A$	-	-	1.0	V
t _{rr}	Reverse Recovery Time	$I_{SD} = 61A$, $dI_{SD}/dt = 100A/\mu s$	-	-	62	ns
Q _{RR}	Reverse Recovered Charge	$I_{SD} = 61A$, $dI_{SD}/dt = 100A/\mu s$	-	-	45	nC

- Notes: 1: Starting $T_J = 25^{\circ}C$, L = 0.228 mH, $I_{AS} = 40 A$. 2: Pulse Width = 100s



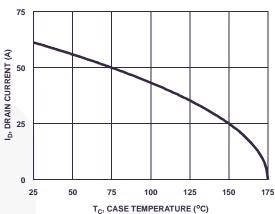


Figure 1. Normalized Power Dissipation vs Ambient Temperature

Figure 2. Maximum Continuous Drain Current vs Case Temperature

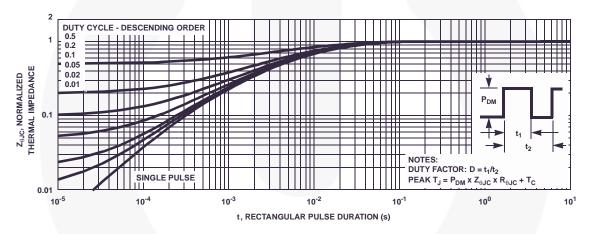


Figure 3. Normalized Maximum Transient Thermal Impedance

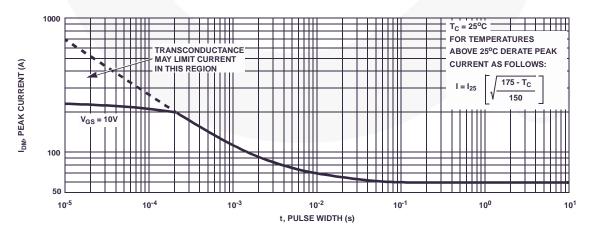
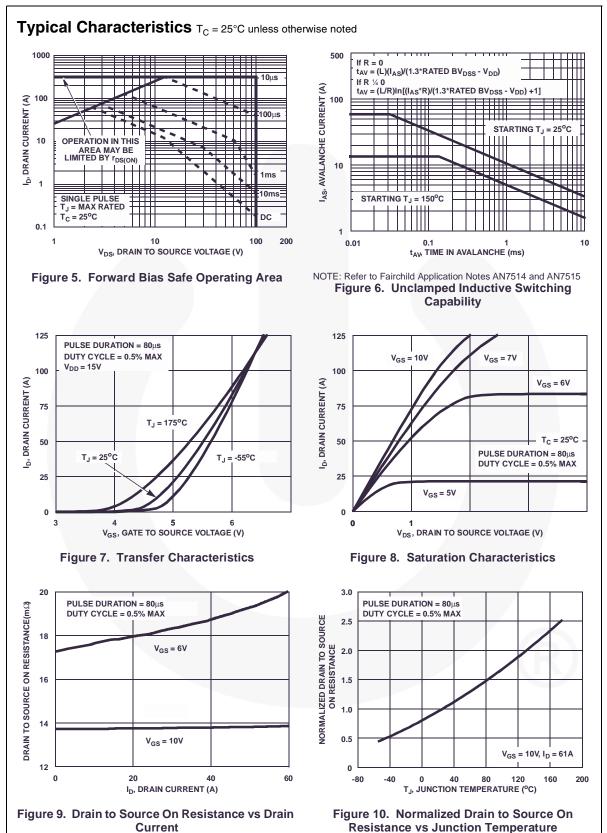


Figure 4. Peak Current Capability



Typical Characteristics $T_C = 25^{\circ}C$ unless otherwise noted

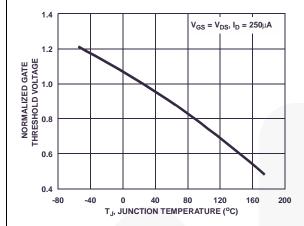


Figure 11. Normalized Gate Threshold Voltage vs Junction Temperature

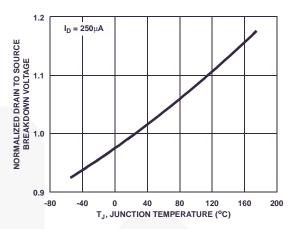


Figure 12. Normalized Drain to Source Breakdown Voltage vs Junction Temperature

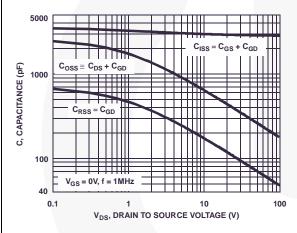


Figure 13. Capacitance vs Drain to Source Voltage

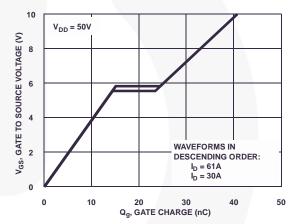


Figure 14. Gate Charge Waveforms for Constant Gate Currents

Test Circuits and Waveforms

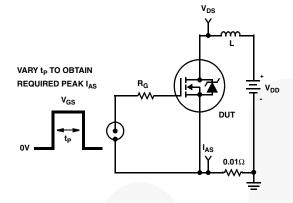


Figure 15. Unclamped Energy Test Circuit

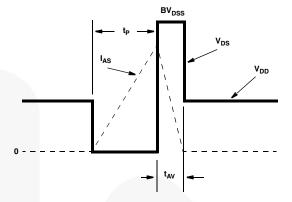


Figure 16. Unclamped Energy Waveforms

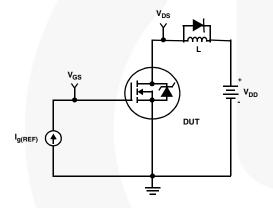


Figure 17. Gate Charge Test Circuit

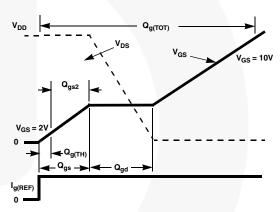


Figure 18. Gate Charge Waveforms

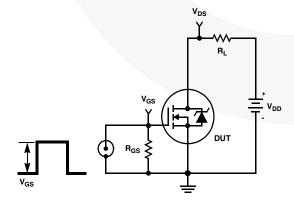


Figure 19. Switching Time Test Circuit

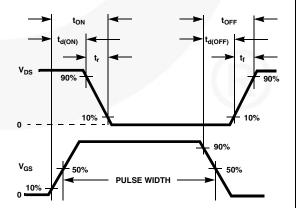


Figure 20. Switching Time Waveforms

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.

$$P_{DM} = \frac{(T_{JM} - T_A)}{R_{\theta JA}} \tag{EQ. 1}$$

In using surface mount devices such as the TO-263 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:

- Mounting pad area onto which the device is attached and whether there is copper on one side or both sides of the board.
- 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.
- 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.

Fairchild 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 Fairchild 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 centimeter square. The area, in square inches or square centimeters is the top copper area including the gate and source pads.

$$R_{\theta JA} = 26.51 + \frac{19.84}{(0.262 + Area)}$$
 (EQ. 2)

Area in Iches Squared

$$R_{\theta JA} = 26.51 + \frac{128}{(1.69 + Area)}$$
 (EQ. 3)

Area in Centimeter Squared

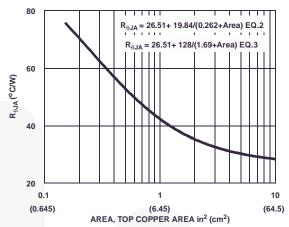
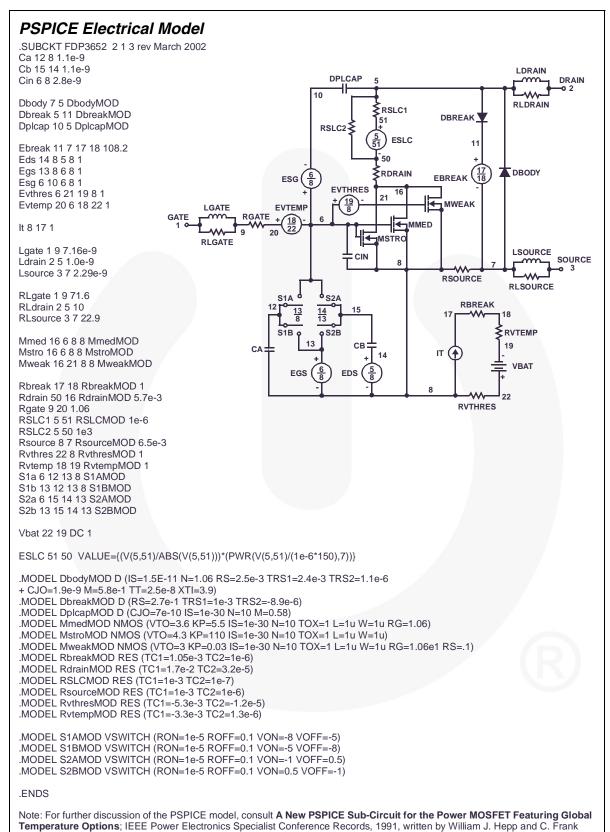


Figure 21. Thermal Resistance vs Mounting
Pad Area



Wheatley.

SABER Electrical Model REV March 2002 template FDP3652 n2.n1.n3 electrical n2,n1,n3 dp..model dbodymod = (isl=1.5e-11,nl=1.06,rs=2.5e-3,trs1=2.4e-3,trs2=1.1e-6,cjo=1.9e-9,m=5.8e-1,tt=2.5e-8,xti=3.9) dp..model dbreakmod = (rs=2.7e-1,trs1=1e-3,trs2=-8.9e-6) dp..model dplcapmod = (cjo=7e-10,isl=10e-30,nl=10,m=0.58) m..model mmedmod = (type=_n,vto=3.6,kp=5.5,is=1e-30, tox=1) m..model mstrongmod = $(type=_n, vto=4.3, kp=110, is=1e-30, tox=1)$ m..model mweakmod = (type=_n,vto=3,kp=0.03,is=1e-30, tox=1,rs=.1) sw_vcsp..model s1amod = (ron=1e-5,roff=0.1,von=-8,voff=-5) I DRAIN sw_vcsp..model s1bmod = (ron=1e-5,roff=0.1,von=-5,voff=-8) DPI CAP DRAIN sw_vcsp..model s2amod = (ron=1e-5,roff=0.1,von=-1,voff=0.5) 10 sw_vcsp..model s2bmod = (ron=1e-5,roff=0.1,von=0.5,voff=-1) RLDRAIN **≨**RSLC1 c.ca n12 n8 = 1.1e-951 c.cb n15 n14 = 1.1e-9RSLC2 c.cin n6 n8 = 2.8e-9ISCL DBREAK dp.dbody n7 n5 = model=dbodymod 50 dp.dbreak n5 n11 = model=dbreakmod ≶rdrain 8 ESG (dp.dplcap n10 n5 = model=dplcapmod 11 **DBODY EVTHRES** 19 spe.ebreak n11 n7 n17 n18 = 108.2 MWEAK EVTEMP **LGATE** spe.eds n14 n8 n5 n8 = 1 **RGATE** (18 22 MMED **EBREAK** spe.egs n13 n8 n6 n8 = 1 20 spe.esg n6 n10 n6 n8 = 1 ← MSTRO RLGATE spe.evthres n6 n21 n19 n8 = 1 LSOURCE CIN SOURCE spe.evtemp n20 n6 n18 n22 = 1 **RSOURCE** i.it n8 n17 = 1RLSOURCE I.lgate n1 n9 = 7.16e-9RBREAK 17 18 I.ldrain n2 n5 = 1.0e-9I.lsource n3 n7 = 2.29e-9**≷**RVTEMP CB 19 res.rlgate n1 n9 = 71.6 CA IT res.rldrain n2 n5 = 10 VBAT 8 res.rlsource n3 n7 = 22.9 EGS EDS m.mmed n16 n6 n8 n8 = model=mmedmod, l=1u, w=1u m.mstrong n16 n6 n8 n8 = model=mstrongmod, l=1u, w=1u **RVTHRES** m.mweak n16 n21 n8 n8 = model=mweakmod, l=1u, w=1u res.rbreak n17 n18 = 1, tc1=1.05e-3,tc2=1e-6 res.rdrain n50 n16 = 5.7e-3, tc1=1.7e-2,tc2=3.2e-5 res.rgate n9 n20 = 1.06 res.rslc1 n5 n51 = 1e-6, tc1=1e-3,tc2=1e-7 res.rslc2 n5 n50 = 1e3 res.rsource n8 n7 = 6.5e-3, tc1=1e-3,tc2=1e-6 res.rvthres n22 n8 = 1, tc1=-5.3e-3,tc2=-1.2e-5 res.rvtemp n18 n19 = 1, tc1=-3.3e-3,tc2=1.3e-6sw 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 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)*1e6/150))**7))

SPICE Thermal Model JUNCTION th REV 23 March 2002 FDP3652 CTHERM1 TH 6 1e-2 CTHERM2 6 5 1.5e-2 CTHERM3 5 4 2e-2 RTHERM1 CTHERM1 CTHERM4 4 3 2.1e-2 CTHERM5 3 2 2.2e-2 CTHERM6 2 TL 9e-2 6 RTHERM1 TH 6 2.7e-2 RTHERM2 6 5 2.8e-2 RTHERM2 CTHERM2 RTHERM3 5 4 7.8e-2 RTHERM4 4 3 9e-2 RTHERM5 3 2 2.7e-1 RTHERM6 2 TL 2.87e-1 SABER Thermal Model SABER thermal model FDP3652 RTHERM3 CTHERM3 template thermal_model th tl thermal_c th, tl ctherm.ctherm1 th 6 =1e-2 ctherm.ctherm2 6 5 = 1.5e-2 ctherm.ctherm3 5 4 =2e-2 ctherm.ctherm4 4 3 =2.1e-2 RTHERM4 CTHERM4 ctherm.ctherm5 3 2 =2.2e-2 ctherm.ctherm6 2 tl =9e-2 rtherm.rtherm1 th 6 = 2.7e-2 rtherm.rtherm2 6 5 = 2.8e-2 rtherm.rtherm3 5 4 = 7.8e-2 RTHERM5 CTHERM5 rtherm.rtherm4 4 3 =9e-2 rtherm.rtherm5 3 2 =2.7e-1 rtherm.rtherm6 2 tl =2.87e-1 2 RTHERM6 CTHERM6 CASE

Mechanical Dimensions

TO-220 3L

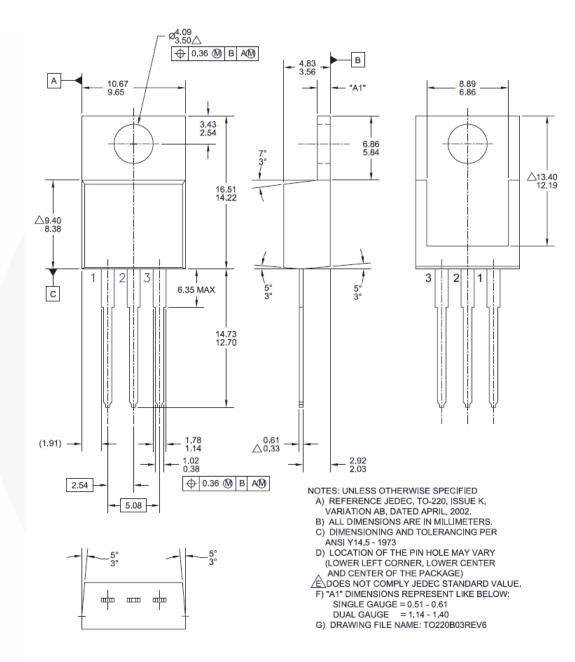


Figure 22. TO-220, Molded, 3Lead, Jedec Variation AB

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Dimension in Millimeters

Mechanical Dimensions

TO-263 2L (D²PAK)

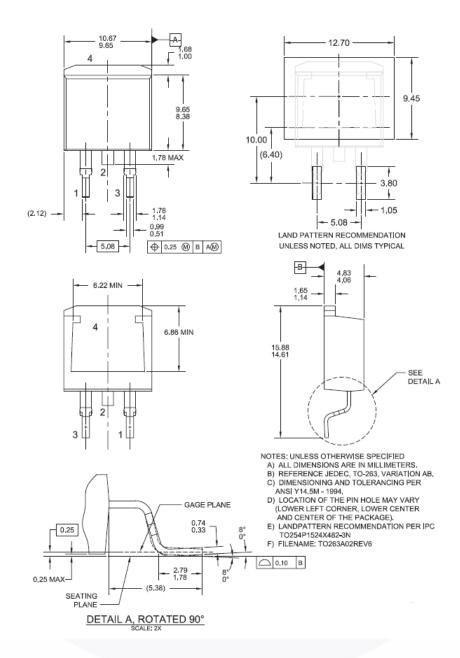


Figure 23. 2LD, TO263, Surface Mount

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Dimension in Millimeters





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