

# FDZ209N

## 60V N-Channel PowerTrench® BGA MOSFET

### General Description

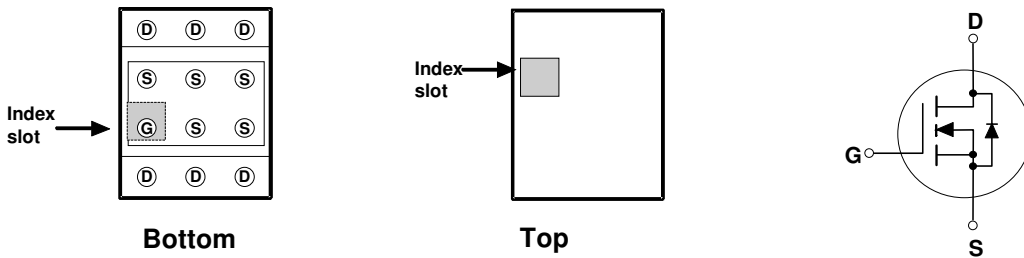
Combining Fairchild's advanced PowerTrench process with state-of-the-art BGA packaging, the FDZ209N minimizes both PCB space and  $R_{DS(ON)}$ . This BGA MOSFET embodies a breakthrough in packaging technology which enables the device to combine excellent thermal transfer characteristics, high current handling capability, ultra-low profile packaging, low gate charge, and low  $R_{DS(ON)}$ .

### Applications

- Solenoid Drivers

### Features

- 4 A, 60 V.  $R_{DS(ON)} = 80 \text{ m}\Omega @ V_{GS} = 5 \text{ V}$
- Occupies only  $5 \text{ mm}^2$  of PCB area: only 55% of the area of SSOT-6
- Ultra-thin package: less than 0.80 mm height when mounted to PCB
- Outstanding thermal transfer characteristics: 4 times better than SSOT-6
- Ultra-low  $Q_g \times R_{DS(ON)}$  figure-of-merit
- High power and current handling capability



### Absolute Maximum Ratings $T_A=25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Rated	Units
$V_{DSS}$	Drain-Source Voltage	60	V
$V_{GSS}$	Gate-Source Voltage	$\pm 20$	V
$I_D$	Drain Current – Continuous (Note 1a)	4	A
	– Pulsed	20	
$P_D$	Power Dissipation (Steady State) (Note 1a)	2	W
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to +150	$^\circ\text{C}$

### Thermal Characteristics

$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (Note 1a)	64	$^\circ\text{C/W}$
$R_{\theta JB}$	Thermal Resistance, Junction-to-Ball (Note 1)	8	
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case (Note 1)	0.7	

### Package Marking and Ordering Information

Device Marking	Device	Reel Size	Tape width	Quantity
209N	FDZ209N	7"	8mm	3000 units

### Electrical Characteristics

$T_A = 25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
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#### Drain-Source Avalanche Ratings (Note 2)

$W_{DSS}$	Drain-Source Avalanche Energy	Single Pulse, $V_{DD} = 30\text{ V}$ ,			90	mJ
$I_{AR}$	Drain-Source Avalanche Current	$I_D = 4\text{ A}$			4	A

#### Off Characteristics

$BV_{DSS}$	Drain-Source Breakdown Voltage	$V_{GS} = 0\text{ V}$ , $I_D = 250\ \mu\text{A}$	60			V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$		59		mV/ $^\circ\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 48\text{ V}$ , $V_{GS} = 0\text{ V}$			1	$\mu\text{A}$
$I_{GSS}$	Gate-Body Leakage	$V_{GS} = \pm 20\text{ V}$ , $V_{DS} = 0\text{ V}$			$\pm 100$	nA

#### On Characteristics (Note 2)

$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}$ , $I_D = 250\ \mu\text{A}$	1	2.5	3	V
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate Threshold Voltage Temperature Coefficient	$I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$		-6		mV/ $^\circ\text{C}$
$R_{DS(on)}$	Static Drain-Source On-Resistance	$V_{GS} = 5\text{ V}$ , $I_D = 4\text{ A}$ $V_{GS} = 5\text{ V}$ , $I_D = 4\text{ A}$ , $T_J = 125^\circ\text{C}$		60 91	80 130	m $\Omega$
$g_{FS}$	Forward Transconductance	$V_{DS} = 5\text{ V}$ , $I_D = 4\text{ A}$		12		S

#### Dynamic Characteristics

$C_{iss}$	Input Capacitance	$V_{DS} = 30\text{ V}$ , $V_{GS} = 0\text{ V}$ ,		657		pF
$C_{oss}$	Output Capacitance	$f = 1.0\text{ MHz}$		76		pF
$C_{riss}$	Reverse Transfer Capacitance			32		pF
$R_G$	Gate Resistance	$V_{GS} = 15\text{ mV}$ , $f = 1.0\text{ MHz}$		1.5		$\Omega$

#### Switching Characteristics (Note 2)

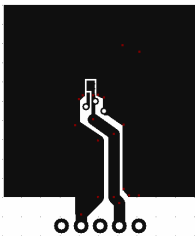
$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 30\text{ V}$ , $I_D = 1\text{ A}$ ,		18	32	ns
$t_r$	Turn-On Rise Time	$V_{GS} = 5\text{ V}$ , $R_{GEN} = 6\ \Omega$		4	8	ns
$t_{d(off)}$	Turn-Off Delay Time			15	27	ns
$t_f$	Turn-Off Fall Time			8	16	ns
$Q_g$	Total Gate Charge	$V_{DS} = 30\text{ V}$ , $I_D = 4\text{ A}$ ,		6.3	9	nC
$Q_{gs}$	Gate-Source Charge	$V_{GS} = 5\text{ V}$		2.5		nC
$Q_{gd}$	Gate-Drain Charge			2.5		nC

#### Drain-Source Diode Characteristics and Maximum Ratings

$I_S$	Maximum Continuous Drain-Source Diode Forward Current				1.7	A
$V_{SD}$	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}$ , $I_S = 1.7\text{ A}$ (Note 2)		0.77	1.2	V
$t_{rr}$	Diode Reverse Recovery Time	$I_F = 4\text{ A}$		27		nS
$Q_{rr}$	Diode Reverse Recovery Charge	$dI_F/dt = 100\text{ A}/\mu\text{s}$ (Note 2)		45		nC

**Notes:**

- $R_{\theta JA}$  is determined with the device mounted on a  $1\text{ in}^2$  2 oz. copper pad on a  $1.5 \times 1.5\text{ in.}$  board of FR-4 material. The thermal resistance from the junction to the circuit board side of the solder ball,  $R_{\theta JB}$ , is defined for reference. For  $R_{\theta JC}$ , the thermal reference point for the case is defined as the top surface of the copper chip carrier.  $R_{\theta JC}$  and  $R_{\theta JB}$  are guaranteed by design while  $R_{\theta JA}$  is determined by the user's board design.



a)  $64^\circ\text{C}/\text{W}$  when mounted on a  $1\text{ in}^2$  pad of 2 oz copper,  $1.5'' \times 1.5'' \times 0.062''$  thick PCB

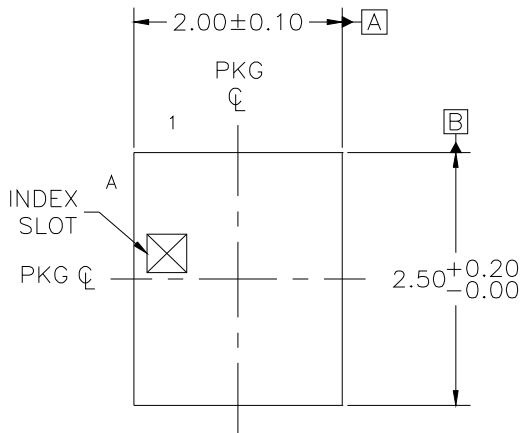


b)  $128^\circ\text{C}/\text{W}$  when mounted on a minimum pad of 2 oz copper

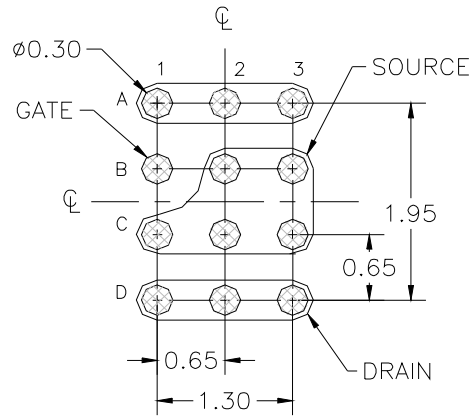
Scale 1 : 1 on letter size paper

- Pulse Test: Pulse Width <  $300\ \mu\text{s}$ , Duty Cycle < 2.0%

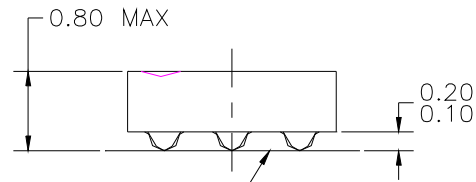
**Dimensional Outline and Pad Layout**



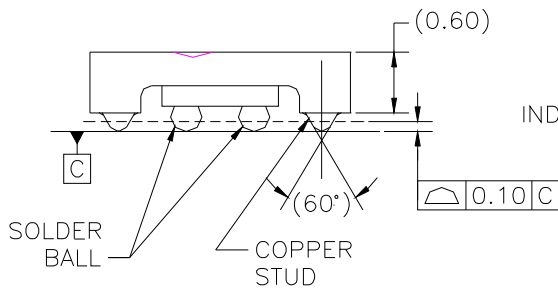
TOP VIEW



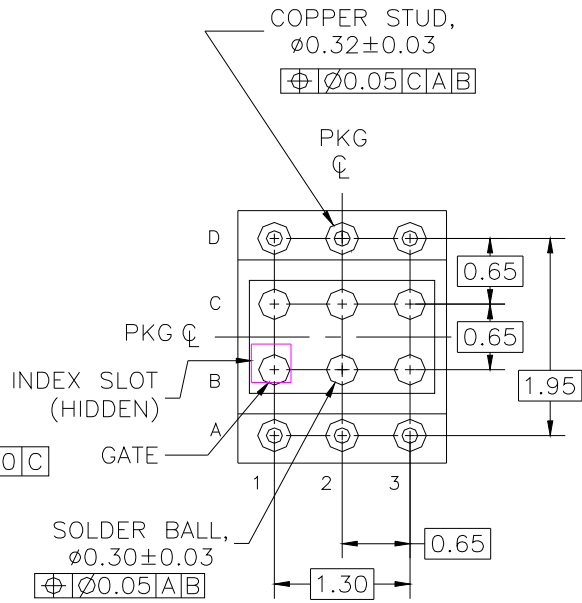
LAND PATTERN RECOMMENDATION



FRONT VIEW



SIDE VIEW



BOTTOM VIEW

NOTES: UNLESS OTHERWISE SPECIFIED

- A) ALL DIMENSIONS ARE IN MILLIMETERS.
- B) NO JEDEC REGISTRATION REFERENCE AS OF JULY 1999.
- C) TERMINAL CONFIGURATION TABLE.

POSITION	DESIGNATION	TYPE
A1,A2,A3, D1,D2,D3	DRAIN	COPPER STUD
B1	GATE	SOLDER BALL
B2,B3,C1,C2,C3	SOURCE	SOLDER BALL

Typical Characteristics

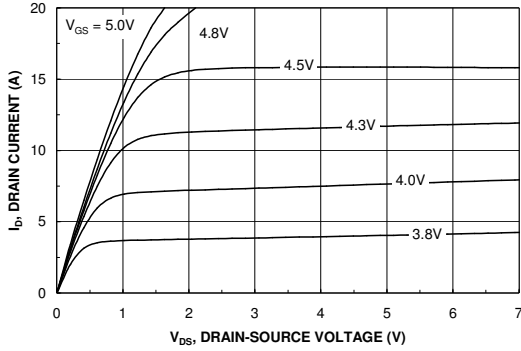


Figure 1. On-Region Characteristics.

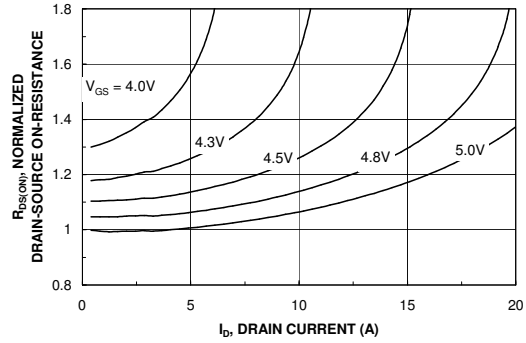


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.

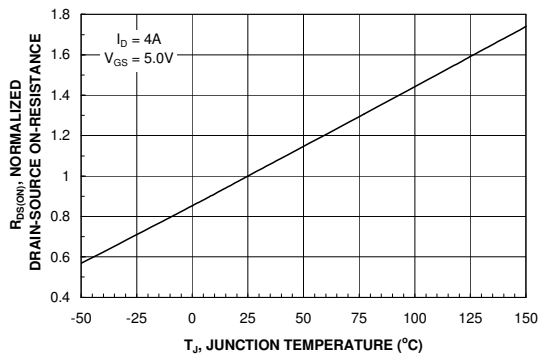


Figure 3. On-Resistance Variation with Temperature.

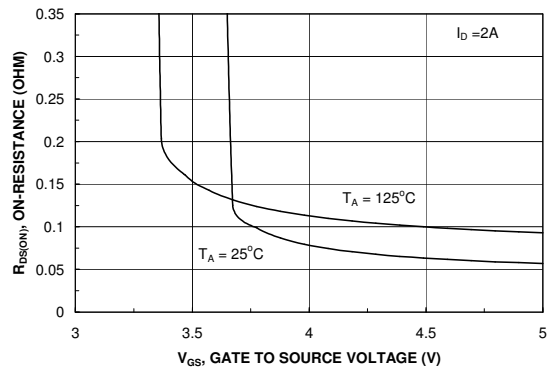


Figure 4. On-Resistance Variation with Gate-to-Source Voltage.

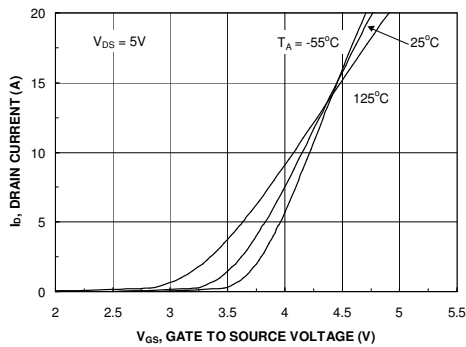


Figure 5. Transfer Characteristics.

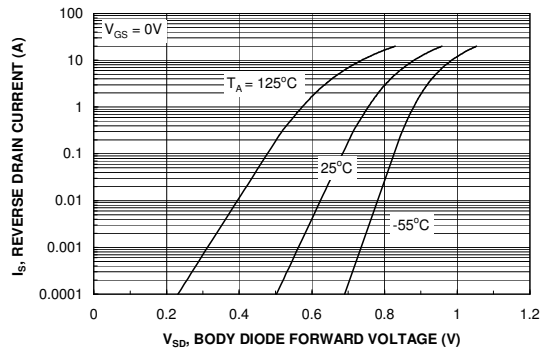


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature.

Typical Characteristics

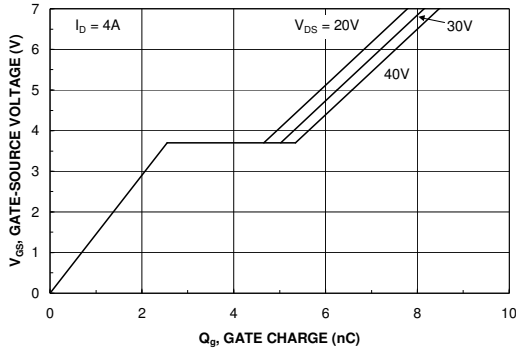


Figure 7. Gate Charge Characteristics.

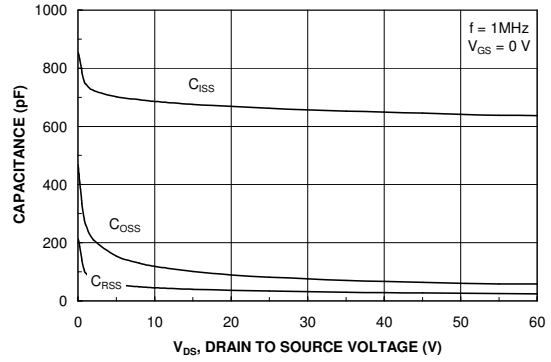


Figure 8. Capacitance Characteristics.

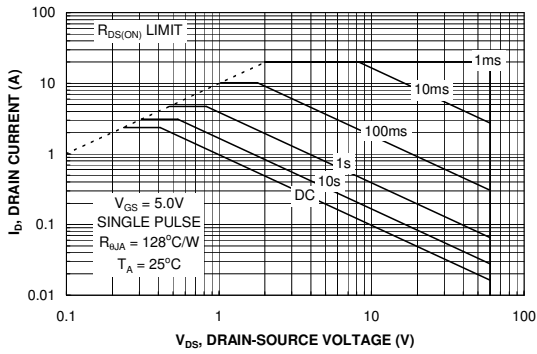


Figure 9. Maximum Safe Operating Area.

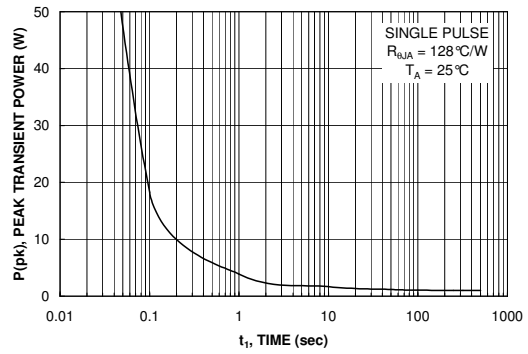


Figure 10. Single Pulse Maximum Power Dissipation.

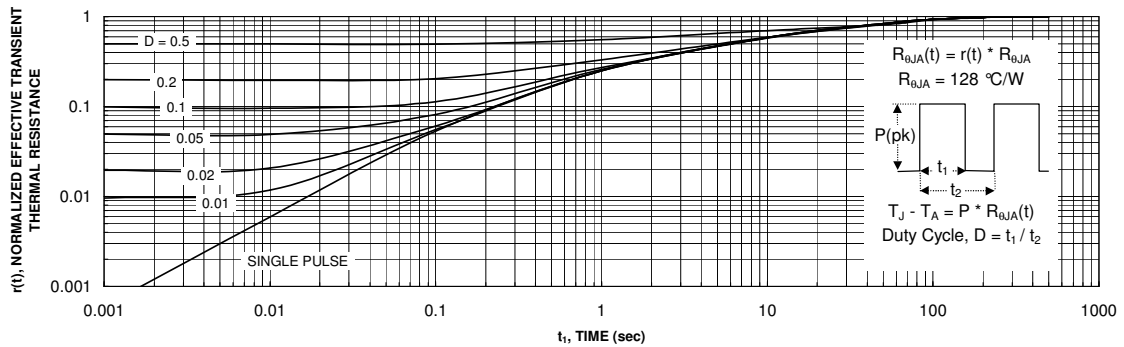


Figure 11. Transient Thermal Response Curve.

Thermal characterization performed using the conditions described in Note 1b. Transient thermal response will change depending on the circuit board design.

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