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July 2007

## FDS9958 Dual P-Channel PowerTrench<sup>®</sup> MOSFET -60V, -2.9A, 105mΩ

## Features

- Max  $r_{DS(on)} = 105 m\Omega$  at  $V_{GS} = -10V$ ,  $I_D = -2.9A$
- Max  $r_{DS(on)}$  =135m $\Omega$  at V<sub>GS</sub> = -4.5V, I<sub>D</sub> = -2.5A
- RoHS Compliant



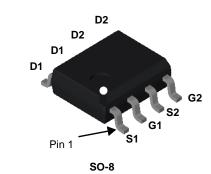
## **General Description**

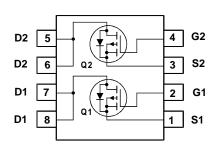
These P-channel logic level specified MOSFETs are produced using Fairchild Semiconductor's advanced PowerTrench<sup>®</sup> process that has been especially tailored to minimize the on-state resistance and yet maintain low gate charge for superior switching performance.

These devices are well suited for portable electronics applications: load switching and power management, battery charging and protection circuits.

### Applications

- Load Switch
- Power Management





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

Symbol	Parameter		Ratings	Units	
V <sub>DS</sub>	Drain to Source Voltage		-60	V	
V <sub>GS</sub>	Gate to Source Voltage		±20	V	
	Drain Current -Continuous	(Note 1a)	-2.9	•	
D	-Pulsed		-12	— A	
E <sub>AS</sub>	Single Pulse Avalanche Energy	(Note 3)	54	mJ	
	Power Dissipation for Dual Operation		2		
P <sub>D</sub>	Power Dissipation (Note 1a		1.6	W	
	Power Dissipation	(Note 1b)	0.9		
T <sub>J</sub> , T <sub>STG</sub>	Operating and Storage Junction Temperature Range		-55 to +150	°C	

## **Thermal Characteristics**

$R_{ ext{ heta}JC}$	Thermal Resistance, Junction to Case	40	°C/W
$R_{\thetaJA}$	Thermal Resistance, Junction to Ambient (Note 1a)	78	C/W

## Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
FDS9958	FDS9958	SO-8	330mm	12mm	2500units

$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	BV <sub>DSS</sub> ΔBV <sub>DSS</sub> ΔT <sub>J</sub> I <sub>DSS</sub> I <sub>GSS</sub>	Drain to Source Breakdown Voltage Breakdown Voltage Temperature Coefficient Zero Gate Voltage Drain Current	$I_D = -250\mu$ A, referenced to 25°C $V_{DS} = -48V$ , $V_{GS} = 0V$ $T_J = 125$ °C	-60	-52		V mV/°C
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	ΔΒV <sub>DSS</sub> ΔΤ <sub>J</sub> I <sub>DSS</sub> I <sub>GSS</sub>	Breakdown Voltage Temperature Coefficient Zero Gate Voltage Drain Current	$I_D = -250\mu$ A, referenced to 25°C $V_{DS} = -48V$ , $V_{GS} = 0V$ $T_J = 125$ °C	-60	-52		-
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	ΔΒV <sub>DSS</sub> ΔT <sub>J</sub> I <sub>DSS</sub> I <sub>GSS</sub>	Breakdown Voltage Temperature Coefficient Zero Gate Voltage Drain Current	$I_D = -250\mu$ A, referenced to 25°C $V_{DS} = -48V$ , $V_{GS} = 0V$ $T_J = 125$ °C		-52		mV/°C
$\begin{array}{c c c c c c c } \hline \mbox{Desc} & \mbox{Zero Gate Voltage Drain Current} & \mbox{V}_{GS} = 0V & \mbox{T}_J = 125^\circ C & & -100 & \mbox{ID} \\ \hline \mbox{M}_{GSS} & \mbox{Gate to Source Leakage Current} & \mbox{V}_{GS} = \pm 20V, \mbox{V}_{DS} = 0V & & \pm 100 & \mbox{nA} \\ \hline \mbox{Dn Characteristics} \\ \hline \mbox{V}_{GS(th)} & \mbox{Gate to Source Threshold Voltage} & \mbox{V}_{GS} = \frac{100}{V_{GS} = -250\mu A} & \mbox{-1.0} & \mbox{-1.6} & -3.0 & V \\ \hline \mbox{A}_{VS(th)} & \mbox{Gate to Source Threshold Voltage} & \mbox{I}_D = -250\mu A, \mbox{referenced to } 25^\circ C & \mbox{A} & \mbox{m} & \mbox{m} \\ \hline \mbox{M}_{CS(th)} & \mbox{Gate to Source Threshold Voltage} & \mbox{I}_D = -2.50\mu A, \mbox{referenced to } 25^\circ C & \mbox{A} & \mbox{m} & \mbox{m} \\ \hline \mbox{M}_{CS(th)} & \mbox{Static Drain to Source On Resistance} & \mbox{V}_{GS} = -10V, \mbox{I}_D = -2.9A & \mbox{82} & 105 & \mbox{M} \\ \hline \mbox{V}_{GS} = -10V, \mbox{I}_D = -2.9A, \mbox{J}_J = 125^\circ C & \mbox{131} & 190 & \mbox{M} \\ \hline \mbox{M}_{GS} = -10V, \mbox{I}_D = -2.9A & \mbox{7.7} & \mbox{S} \\ \hline \mbox{M}_{GS} = -10V, \mbox{I}_D = -2.9A & \mbox{7.7} & \mbox{S} \\ \hline \mbox{M}_{GS} = -10V, \mbox{I}_D = -2.9A & \mbox{7.7} & \mbox{S} \\ \hline \mbox{M}_{GS} = -10V, \mbox{I}_D = -2.9A & \mbox{7.7} & \mbox{S} \\ \hline \mbox{M}_{GS} = -10V, \mbox{I}_D = -2.9A & \mbox{7.7} & \mbox{S} \\ \hline \mbox{M}_{GS} = -10V, \mbox{I}_D = -2.9A & \mbox{7.7} & \mbox{S} \\ \hline \mbox{M}_{GS} = -10V, \mbox{I}_D = -2.9A & \mbox{7.7} & \mbox{S} \\ \hline \mbox{M}_{GS} = -10V, \mbox{I}_D = -2.9A & \mbox{7.7} & \mbox{S} \\ \hline \mbox{M}_{GS} = -10V, \mbox{I}_D = -2.9A & \mbox{7.7} & \mbox{S} \\ \hline \mbox{M}_{GS} = -10V, \mbox{I}_D = -2.9A & \mbox{7.8} & 7.8$	I <sub>GSS</sub>	-	$V_{GS} = 0V$ $T_J = 125^{\circ}C$				
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		Gate to Source Leakage Current					μA
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	On Chara		$V_{GS} = \pm 20V, V_{DS} = 0V$			±100	nA
$ \begin{array}{c c c c c c c c c c } \hline \Delta V_{GS}(m) \\ \hline \Delta T_J \\ \hline \Delta$		cteristics			•		
$ \begin{array}{c c c c c c c c c } \hline \Delta T_J & Gate to Source Threshold Voltage Temperature Coefficient & I_D = -250 \mu A, referenced to 25°C & 4 & mV/\% \\ \hline \Delta T_J & I_D = representation for the second sec$	V <sub>GS(th)</sub>	Gate to Source Threshold Voltage	$V_{GS} = V_{DS}, I_D = -250 \mu A$	-1.0	-1.6	-3.0	V
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\Delta V_{GS(th)}$ $\Delta T_J$	5	$I_D = -250\mu A$ , referenced to $25^{\circ}C$		4		mV/°C
$\begin{tabular}{ c c c c c c c } \hline $V_{GS} = -10V, \ I_D = -2.9A, \ T_J = 125^\circ C & 131 & 190 \\ \hline $V_{DD} = -5V, \ I_D = -2.9A & 7.7 & S \\ \hline $V_{DD} = -5V, \ I_D = -2.9A & 7.7 & S \\ \hline $Oynamic Characteristics \\ \hline $C_{iss} & Input Capacitance & $V_{DS} = -30V, \ V_{GS} = 0V, $f = 1MHz$ & $765 & 1020 & pF \\ \hline $C_{oss} & Output Capacitance & $V_{DS} = -30V, \ V_{GS} = 0V, $f = 1MHz$ & $90 & 120 & pF \\ \hline $V_{Trss} & Reverse Transfer Capacitance & $V_{DS} = -30V, \ V_{GS} = 0V, $f = 1MHz$ & $40 & 65 & pF \\ \hline $Switching Characteristics \\ \hline $t_{d(on)} & $Turn-On Delay Time $ \\ $t_{r} & $Rise Time $ \\ $t_{d(off)} & $Turn-Off Delay Time $ \\ $t_{d} & $Fall Time $ \\ \hline $Q_{g} & $Total Gate Charge $ \\ \hline $Q_{g} & $Total Gate Charge $ \\ \hline $Q_{g} & $Gate to Source Charge $ \\ \hline $Q_{gs} & $Gate to Source Charge $ \\ \hline $Q_{gs} & $Gate to Source Charge $ \\ \hline $V_{CS} = 0V to -4.5V $ \\ \hline $V_{DD} = -2.9A $ \\ \hline $V_{DD} = -2.9A$			$V_{GS} = -10V, I_D = -2.9A$		82	105	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	r <sub>DS(on)</sub>	Static Drain to Source On Resistance	$V_{GS} = -4.5V, I_D = -2.5A$		103	135	mΩ
Dynamic CharacteristicsCissInput Capacitance $V_{DS} = -30V, V_{GS} = 0V,$ 7651020pFCossOutput Capacitance $V_{DS} = -30V, V_{GS} = 0V,$ 90120pFCrssReverse Transfer Capacitance $f = 1MHz$ 4065pFSwitching Characteristics $t_r$ Rise Time $V_{DD} = -30V, I_D = -2.9A,$ $t_d(off)$ Turn-On Delay Time $V_{GS} = -10V, R_{GEN} = 6\Omega$ 612ns $t_d(off)$ Turn-Off Delay Time $V_{GS} = 0V \text{ to } -10V,$ $V_{DD} = -30V,$ 1623nC $Q_g$ Total Gate Charge $V_{GS} = 0V \text{ to } -4.5V$ $V_{DD} = -30V,$ 1623nC $Q_{gs}$ Gate to Source Charge $V_{GS} = 0V \text{ to } -4.5V$ $V_{DD} = -30V,$ 1623nC $Q_{gs}$ Gate to Source Charge $V_{GS} = 0V \text{ to } -4.5V$ $V_{DD} = -2.9A$ 312nC			$V_{GS}$ = -10V, $I_D$ = -2.9A, $T_J$ = 125°C		131	190	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	9fs	Forward Transconductance	$V_{DD} = -5V, I_D = -2.9A$		7.7		S
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Dynamic	Characteristics					
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	C <sub>iss</sub>	Input Capacitance			765	1020	pF
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		Output Capacitance			90	120	pF
Switching Characteristics $t_{d(on)}$ Turn-On Delay Time $V_{DD} = -30V, I_D = -2.9A,$ $6$ $12$ ns $t_r$ Rise Time $V_{GS} = -10V, R_{GEN} = 6\Omega$ $3$ $10$ ns $t_{d(off)}$ Turn-Off Delay Time $27$ $43$ ns $t_f$ Fall Time $6$ $12$ ns $Q_g$ Total Gate Charge $V_{GS} = 0V$ to $-10V$ $V_{DD} = -30V,$ $16$ $23$ $Q_g$ Total Gate Charge $V_{GS} = 0V$ to $-4.5V$ $V_{DD} = -30V,$ $16$ $23$ nC $Q_{gs}$ Gate to Source Charge $V_{GS} = 0V$ to $-4.5V$ $I_D = -2.9A$ $2$ nC	C <sub>rss</sub>	Reverse Transfer Capacitance	T = TMHZ		40	65	pF
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		Characteristics				I.	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $					6	12	ns
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	t <sub>r</sub>	Rise Time			3	10	ns
$t_f$ Fall Time612ns $Q_g$ Total Gate Charge $V_{GS} = 0V \text{ to } -10V$ $V_{DD} = -30V$ ,1623nC $Q_g$ Total Gate Charge $V_{GS} = 0V \text{ to } -4.5V$ $V_{DD} = -30V$ ,812nC $Q_{gs}$ Gate to Source Charge $2$ nC2nC	t <sub>d(off)</sub>	Turn-Off Delay Time	$-V_{GS} = -10V, R_{GEN} = 6\Omega$		27	43	ns
	t <sub>f</sub>	Fall Time			6	12	ns
	Q <sub>g</sub>	Total Gate Charge	$V_{GS} = 0V \text{ to } -10V$		16	23	nC
		Total Gate Charge	$V_{GS} = 0V \text{ to } -4.5V$ $V_{DD} = -30V$ ,		8	12	nC
	Qg	5	ID = -2.9A		2		nC
JgdGate to Drain "Miller" Charge3nC							
	Q <sub>gs</sub>				3		nC
)rain-Source Diode Characteristics	Q <sub>gs</sub> Q <sub>gd</sub>	Gate to Source Charge Gate to Drain "Miller" Charge			3		nC
Orain-Source Diode Characteristics   V <sub>SD</sub> Source to Drain Diode Forward Voltage V <sub>GS</sub> = 0V, I <sub>S</sub> = -1.3A (Note 2) -0.8 -1.2 V	Q <sub>gs</sub> Q <sub>gd</sub>	Gate to Source Charge Gate to Drain "Miller" Charge urce Diode Characteristics	-			-1.2	
$V_{SD}$ Source to Drain Diode Forward Voltage $V_{GS} = 0V$ , $I_S = -1.3A$ (Note 2)-0.8-1.2VReverse Recovery Time2642ns	Q <sub>gs</sub> Q <sub>gd</sub> Drain-Sou	Gate to Source Charge Gate to Drain "Miller" Charge urce Diode Characteristics Source to Drain Diode Forward Voltage	V <sub>GS</sub> = 0V, I <sub>S</sub> = -1.3A (Note 2)		-0.8		V
agd Gate to Drain "Miller" Charge 3	t <sub>f</sub> Q <sub>g</sub>	Fall Time Total Gate Charge	$V_{GS} = 0V \text{ to } -10V$ $V_{GS} = 0V \text{ to } -4.5V$ $V_{DD} = -30V,$ $V_{DD} = -2.9A$		6 16 8	12 23	
	Q <sub>g</sub> Q <sub>gs</sub> Q <sub>gd</sub>	Gate to Source Charge Gate to Drain "Miller" Charge			3		nC
	Q <sub>gs</sub> Q <sub>gd</sub>	Gate to Source Charge Gate to Drain "Miller" Charge urce Diode Characteristics	-		3		nC
	Q <sub>gs</sub> Q <sub>gd</sub> Drain-Sou	Gate to Source Charge Gate to Drain "Miller" Charge urce Diode Characteristics	-			-1.2	
$V_{SD}$ Source to Drain Diode Forward Voltage $V_{GS} = 0V$ , $I_S = -1.3A$ (Note 2) -0.8 -1.2 V	Q <sub>gs</sub> Q <sub>gd</sub> Drain-Sou V <sub>SD</sub>	Gate to Source Charge Gate to Drain "Miller" Charge urce Diode Characteristics Source to Drain Diode Forward Voltage	V <sub>GS</sub> = 0V, I <sub>S</sub> = -1.3A (Note 2)		-0.8		V



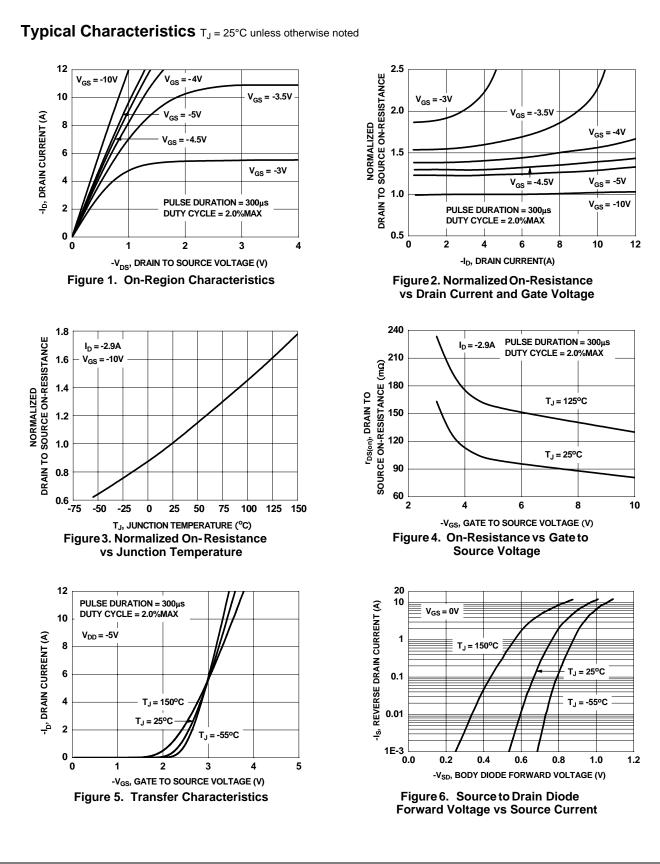
2. Pulse Test: Pulse Width < 300 $\mu$ s, Duty cycle < 2.0%.

3. UIL condition: Starting  $T_J$  = 25°C, L = 3mH,  $I_{AS}$  = 6A,  $V_{DD}$  = 60V,  $V_{GS}$  = 10V.

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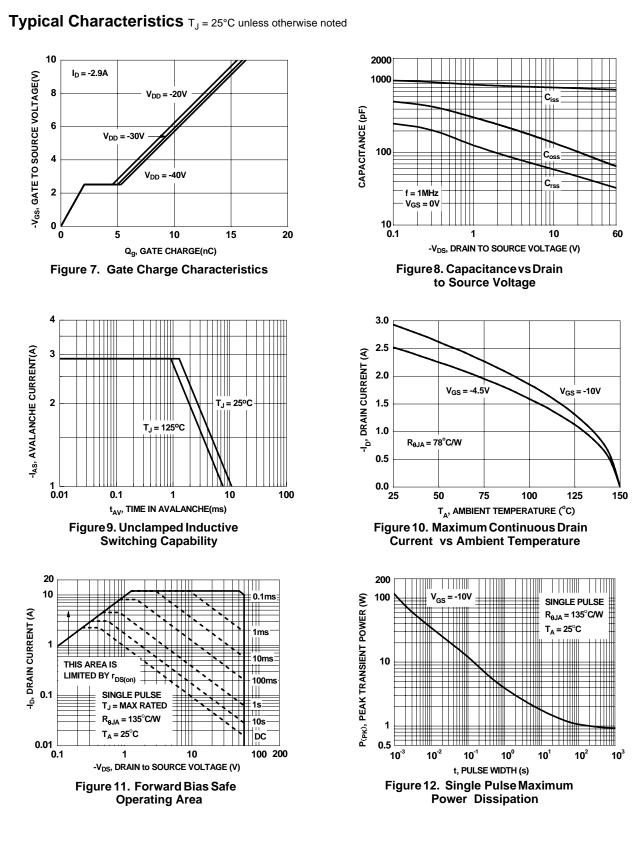
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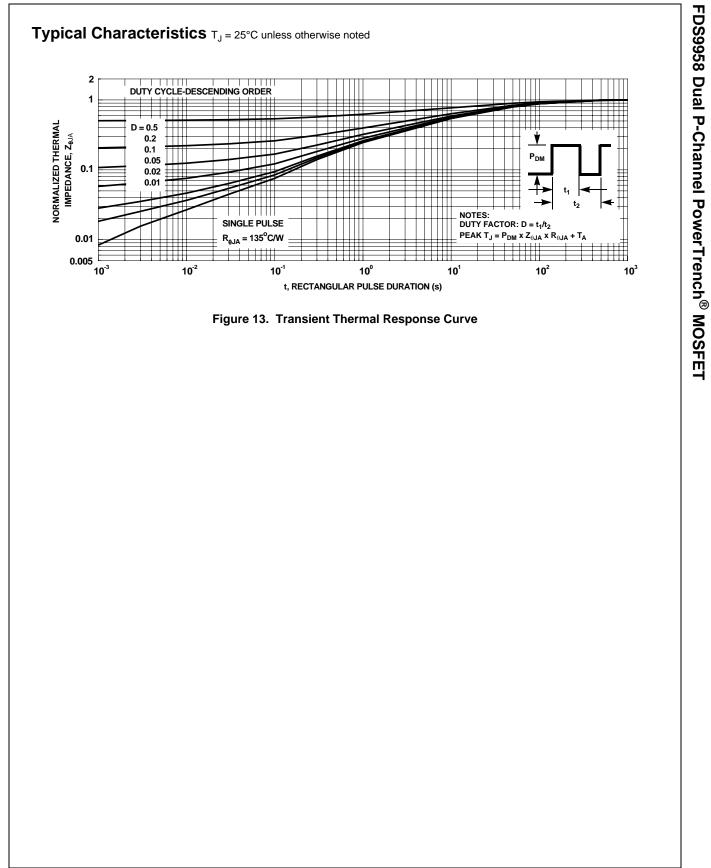
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