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FDP8896
N-Channel PowerTrench® MOSFET
30V, 92A, 5.9mΩ

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.

Applications
• DC/DC converters

Features
• $r_{DS(ON)} = 5.9\text{mΩ}$, $V_{GS} = 10\text{V}$, $I_D = 35\text{A}$
• $r_{DS(ON)} = 7.0\text{mΩ}$, $V_{GS} = 4.5\text{V}$, $I_D = 35\text{A}$
• High performance trench technology for extremely low $r_{DS(ON)}$
• Low gate charge
• High power and current handling capability
• RoHS Compliant

MOSFET Maximum Ratings

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Ratings</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DSS}$</td>
<td>Drain to Source Voltage</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GS}$</td>
<td>Gate to Source Voltage</td>
<td>±20</td>
<td>V</td>
</tr>
</tbody>
</table>
| $I_D$ | Drain Current
  Continuous ($T_C = 25^\circ\text{C}$, $V_{GS} = 10\text{V}$) (Note 1) | 92 | A |
  Continuous ($T_C = 25^\circ\text{C}$, $V_{GS} = 4.5\text{V}$) (Note 1) | 85 | A |
  Continuous ($T_{amb} = 25^\circ\text{C}$, $V_{GS} = 10\text{V}$, with $R_{\theta JA} = 62^\circ\text{C/W}$) | 16 | A |
| $E_{AS}$ | Single Pulse Avalanche Energy (Note 2) | 74 | mJ |
| $P_D$ | Power dissipation | 80 | W |
| $T_J, T_{STG}$ | Operating and Storage Temperature | -55 to 175 | °C |

Thermal Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Ratings</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{\theta JC}$</td>
<td>Thermal Resistance Junction to Case TO-220</td>
<td>1.88</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{\theta JA}$</td>
<td>Thermal Resistance Junction to Ambient TO-220 (Note 3)</td>
<td>62</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

Package Marking and Ordering Information

<table>
<thead>
<tr>
<th>Device Marking</th>
<th>Device</th>
<th>Package</th>
<th>Reel Size</th>
<th>Tape Width</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDP8896</td>
<td>FDP8896</td>
<td>TO-220AB</td>
<td>Tube</td>
<td>N/A</td>
<td>50 units</td>
</tr>
</tbody>
</table>
### Electrical Characteristics \( T_C = 25^\circ C \) unless otherwise noted

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( B_{VDSS} )</td>
<td>Drain to Source Breakdown Voltage</td>
<td>( I_D = 250\mu A, V_{GS} = 0V )</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>( I_{DSS} )</td>
<td>Zero Gate Voltage Drain Current</td>
<td>( V_{GS} = 24V )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>( \mu A )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{GS} = 0V )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>( \mu A )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( T_C = 150^\circ C )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>( I_{GS} )</td>
<td>Gate to Source Leakage Current</td>
<td>( V_{GS} = \pm 20V )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>( nA )</td>
</tr>
</tbody>
</table>

### Off Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{GS(TH)} )</td>
<td>Gate to Source Threshold Voltage</td>
<td>( V_{GS} = V_{DS}, I_D = 250\mu A )</td>
<td>1.2</td>
<td>-</td>
<td>2.5</td>
<td>V</td>
</tr>
<tr>
<td>( f_{DS(ON)} )</td>
<td>Drain to Source On Resistance</td>
<td>( I_D = 35A, V_{GS} = 10V )</td>
<td>-</td>
<td>0.0050</td>
<td>0.0059</td>
<td>( \Omega )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_D = 35A, V_{GS} = 4.5V )</td>
<td>-</td>
<td>0.0060</td>
<td>0.0070</td>
<td>( \Omega )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_D = 35A, V_{GS} = 10V, T_J = 175^\circ C )</td>
<td>-</td>
<td>0.0078</td>
<td>0.0094</td>
<td>( \Omega )</td>
</tr>
</tbody>
</table>

### Dynamic Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C_{ISS} )</td>
<td>Input Capacitance</td>
<td>( V_{DS} = 15V, V_{GS} = 0V )</td>
<td>-</td>
<td>-</td>
<td>2525</td>
<td>( \mu F )</td>
</tr>
<tr>
<td>( C_{DSS} )</td>
<td>Output Capacitance</td>
<td>( f = 1MHz )</td>
<td>-</td>
<td>-</td>
<td>490</td>
<td>( \mu F )</td>
</tr>
<tr>
<td>( C_{RSS} )</td>
<td>Reverse Transfer Capacitance</td>
<td>-</td>
<td>-</td>
<td>300</td>
<td>( \mu F )</td>
<td></td>
</tr>
<tr>
<td>( R_G )</td>
<td>Gate Resistance</td>
<td>( V_{GS} = 0.5V, f = 1MHz )</td>
<td>-</td>
<td>-</td>
<td>2.3</td>
<td>( \Omega )</td>
</tr>
<tr>
<td>( Q_{g(TOT)} )</td>
<td>Total Gate Charge at 10V</td>
<td>( V_{GS} = 0V ) to 10V</td>
<td>-</td>
<td>48</td>
<td>67</td>
<td>( nC )</td>
</tr>
<tr>
<td>( Q_{g(5)} )</td>
<td>Total Gate Charge at 5V</td>
<td>( V_{GS} = 0V ) to 5V</td>
<td>-</td>
<td>25</td>
<td>36</td>
<td>( nC )</td>
</tr>
<tr>
<td>( Q_{g(TH)} )</td>
<td>Threshold Gate Charge</td>
<td>( V_{GS} = 0V ) to 1V</td>
<td>-</td>
<td>2.3</td>
<td>3.0</td>
<td>( nC )</td>
</tr>
<tr>
<td>( Q_{gs} )</td>
<td>Gate to Source Gate Charge</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>( nC )</td>
<td></td>
</tr>
<tr>
<td>( Q_{gs2} )</td>
<td>Gate Charge Threshold to Plateau</td>
<td>-</td>
<td>-</td>
<td>5.7</td>
<td>( nC )</td>
<td></td>
</tr>
<tr>
<td>( Q_{gd} )</td>
<td>Gate to Drain “Miller” Charge</td>
<td>-</td>
<td>-</td>
<td>9.5</td>
<td>( nC )</td>
<td></td>
</tr>
</tbody>
</table>

### Switching Characteristics \( (V_{GS} = 10V) \)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t_{ON} )</td>
<td>Turn-On Time</td>
<td>( V_{DD} = 15V, I_D = 35A )</td>
<td>-</td>
<td>-</td>
<td>168</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{ON} )</td>
<td>Turn-On Delay Time</td>
<td>( V_{DD} = 15V, I_D = 35A )</td>
<td>-</td>
<td>9</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( r )</td>
<td>Rise Time</td>
<td>( V_{GS} = 4.5V, R_{GS} = 6.2\Omega )</td>
<td>-</td>
<td>103</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{OFF} )</td>
<td>Turn-Off Delay Time</td>
<td>( V_{GS} = 4.5V, R_{GS} = 6.2\Omega )</td>
<td>-</td>
<td>56</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( f )</td>
<td>Fall Time</td>
<td>-</td>
<td>-</td>
<td>44</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{OFF} )</td>
<td>Turn-Off Time</td>
<td>-</td>
<td>-</td>
<td>150</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

### Drain-Source Diode Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{SD} )</td>
<td>Source to Drain Diode Voltage</td>
<td>( I_{SD} = 35A )</td>
<td>-</td>
<td>-</td>
<td>1.25</td>
<td>V</td>
</tr>
<tr>
<td>( I_{f} )</td>
<td>Reverse Recovery Time</td>
<td>( I_{SD} = 35A, dI_{SD}/dt = 100A/\mu s )</td>
<td>-</td>
<td>-</td>
<td>27</td>
<td>( \mu C )</td>
</tr>
<tr>
<td>( Q_{RR} )</td>
<td>Reverse Recovered Charge</td>
<td>( I_{SD} = 35A, dI_{SD}/dt = 100A/\mu s )</td>
<td>-</td>
<td>-</td>
<td>12</td>
<td>( \mu C )</td>
</tr>
</tbody>
</table>

**Notes:**
1. Package current limitation is 80A.
2. Starting \( T_J = 25^\circ C, L = 36\mu H, I_G = 64A, V_{DD} = 27V, V_{GS} = 10V \).
3. Pulse width = 100s.
Typical Characteristics $T_C = 25^\circ C$ unless otherwise noted

![Normalized Power Dissipation vs Case Temperature](image1)

![Maximum Continuous Drain Current vs Case Temperature](image2)

![Normalized Maximum Transient Thermal Impedance](image3)

![Peak Current Capability](image4)

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

Figure 5. Forward Bias Safe Operating Area

NOTE: Refer to Fairchild Application Notes AN7514 and AN7515

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 $T_C = 25^\circ C$ 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 Current
PSPICE Electrical Model

.SUBCKT FDP8896 2 1 3 ; rev November 2003

Ca 12 8 2.3e-9
Cb 15 14 2.3e-9
Cin 6 8 2.3e-9

Dbody 7 5 DbodyMOD
Dbreak 5 11 DbreakMOD
Dplcap 10 5 DplcapMOD

Ebody 11 7 17 18 33
Eds 14 8 5 8 1
Egs 13 8 8 6 1
Evthres 6 21 19 8 1
Evtemp 20 6 18 22 1

It 8 17 1

Lgate 1 9 5.5e-9
Ldrain 2 5 1.0e-9
Lsource 3 7 2.7e-9

RLgate 1 9 55
RLdrain 2 5 10
RLsource 3 7 27

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 2.3e-3
Rgate 9 20 2.3
RSCL 5 51 RSCLMOD 1e-6
RSCL2 5 50 1e-3
Rsource 8 7 RsourceMOD 2e-3
Rvthres 22 18 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 15 14 13 8 S2BMOD

Vbat 22 19 DC 1

ESLC 51 50 VALUE=\{V/(V(5,51)/ABS(V(5,51)))*(PWR(V(5,51)/(1e-6*500),10))\}

.MODEL DbodayMOD D (IS=4E-12 IKF=10 N=1.01 RS=2.6e-3 TRS=8e-4 TRS2=2e-7 + CJO=8.8e-10 M=0.57 TT=1e-16 XTI=2.2)

.MODEL DbreakMOD D (RS=8e-2 TRS=1e-3 TRS2=-8.9e-6)

.MODEL DplcapMOD D (CJO=9.4e-10 IS=1e-30 N=10 M=0.4)

.MODEL MmedMOD NMOS (VTO=1.98 KP=10 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=2.3 T_ABS=25)

.MODEL MstroMOD NMOS (VTO=2.4 KP=350 IS=1e-30 N=10 TOX=1 L=1u W=1u T_ABS=25)

.MODEL MweakMOD NMOS (VTO=1.68 KP=0.05 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=23 RS=0.1 T_ABS=25)

.MODEL RbreakMOD RES (TC=1=8.3e-4 TC2=4e-7)

.MODEL RdrainMOD RES (TC=1=1e-3 TC2=8e-6)

.MODEL RSCLMOD RES (TC=1=9e-4 TC2=1e-6)

.MODEL RsourceMOD RES (TC=1=7.5e-3 TC2=1e-6)

.MODEL RvthresMOD RES (TC=1=2.4e-3 TC2=8.8e-6)

.MODEL RvtempMOD RES (TC=1=2.8e-3 TC2=2e-7)

.MODEL S1AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-4 VOFF=-3)

.MODEL S1BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-3 VOFF=-4)

.MODEL S2AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-2 VOFF=-0.5)

.MODEL S2BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-0.5 VOFF=-2)

.ENDS


**SABER Electrical Model**

rev November 2003
template FDP8896 n2,n1,n3 = m_temp
electrical n2,n1,n3
number m_temp=25
{
var i iscl
dp..model dbodymod = (isl=4e-12,ikf=10,ni=1.01,rs=2.6e-3,trs1=8e-4,trs2=2e-7,cjo=8.8e-10,m=0.57,tt=1e-16,xti=2.2)
dp..model dbreakmod = (cjo=9.4e-10,isl=10e-30,ni=10,m=0.4)
m..model mmedmod = (type=_n,vto=1.98,kp=10,is=1e-30, tox=1)
m..model mstrongmod = (type=_n,vto=2.4,kp=350,ie=1e-30, tox=1)
m..model mweakmod = (type=_n,vto=1.68,kp=0.05,is=1e-30, tox=1)
sw_vcsps.model s1amod = (ron=1e-5,roff=0.1, von=3, voff=-4)
sw_vcsps.model s2amod = (ron=1e-5,roff=0.1, von=2, voff=-0.5)
sw_vcsps.model s2bmod = (ron=1e-5,roff=0.1, von=0.5, voff=-2)
c.ca n12 n8 = 2.3e-9
c.cb n15 n14 = 2.3e-9
c.cin n6 n8 = 2.3e-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
spe.eds n14 n8 n5 = 1
spe.egs n3 n8 n6 = 1
spe.evthres n6 n21 n19 n8 = 1
spe.evtemp n20 n6 n18 n22 = 1
i.it n8 n17 = 1
l.lgate n1 n9 = 5.5e-9
l.ldrain n2 n5 = 1.0e-9
l.lsouce n3 n7 = 2.7e-9
res.rigate n1 n9 = 55
res.rldrain n2 n5 = 10
res.rlsource n3 n7 = 27
m.mmed n16 n6 n8 n8 = model=mmedmod, l=1u, w=1u, temp=m_temp
m.mstrong n16 n6 n8 n8 = model=mstrongmod, l=1u, w=1u, temp=m_temp
m.mweak n16 n21 n8 n8 = model=mweakmod, l=1u, w=1u, temp=m_temp
res.rbreak n17 n18 = 1, tc1=8.3e-4,tc2=4e-7
res.rdrain n50 n16 = 2.3e-3,tc1=1e-3,tc2=8e-6
res.rigate n9 n20 = 2.3
res.rslc1 n5 n51 = 1e-6,tc1=9e-4,tc2=1e-6
res.rslc2 n50 n51 = 1e6
res.rlsource n8 n7 = 2e-3,tc1=7.5e-3,tc2=2e-6
res.rvthres n18 n19 = 1, tc1=2.4e-3,tc2=8.8e-6
res.rvtemp n18 n19 = 1, tc1=2.6e-3,tc2=2e-7
sw_vcsps.model s1a n6 n12 n13 n8 = model=s1amod
sw_vcsps.model s1b n13 n12 n13 n8 = model=s1bmod
sw_vcsps.model s2a n15 n14 n13 = model=s2amod
sw_vcsps.model s2b 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)*1e6/500))** 10))
}
}
**PSPICE Thermal Model**

REV 23 November 2003

FDP8896T

CTHERM1 TH 6 9e-4
CTHERM2 6 5 1e-3
CTHERM3 5 4 2e-3
CTHERM4 4 3 3e-3
CTHERM5 3 2 7e-3
CTHERM6 2 TL 8e-2

RTHERM1 TH 6 3.0e-2
RTHERM2 6 5 1.0e-1
RTHERM3 5 4 1.8e-1
RTHERM4 4 3 2.8e-1
RTHERM5 3 2 4.5e-1
RTHERM6 2 TL 4.6e-1

**SABER Thermal Model**

SABER thermal model FDP8896T
template thermal_model th tl
thermal_c th, tl
{
  ctherm.ctherm1 th 6 =9e-4
ctherm.ctherm2 6 5 =1e-3
ctherm.ctherm3 5 4 =2e-3
ctherm.ctherm4 4 3 =3e-3
ctherm.ctherm5 3 2 =7e-3
ctherm.ctherm6 2 tl =8e-2
  rtherm.rtherm1 th 6 =3.0e-2
  rtherm.rtherm2 6 5 =1.0e-1
  rtherm.rtherm3 5 4 =1.8e-1
  rtherm.rtherm4 4 3 =2.8e-1
  rtherm.rtherm5 3 2 =4.5e-1
  rtherm.rtherm6 2 tl =4.6e-1
}
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<td>Advance Information</td>
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