FDP51N25 / FDPF51N25
N-Channel UniFET™ MOSFET
250 V, 51 A, 60 mΩ

Features
- $R_{DS(on)} = 48$ mΩ (Typ.) @ $V_{GS} = 10$ V, $I_D = 25.5$ A
- Low Gate Charge (Typ. 55 nC)
- Low $C_{rss}$ (Typ. 63 pF)

Applications
- PDP TV
- Lighting
- Uninterruptible Power Supply
- AC-DC Power Supply

Description
UniFET™ MOSFET is Fairchild Semiconductor’s high voltage MOSFET family based on planar stripe and DMOS technology. This MOSFET is tailored to reduce on-state resistance, and to provide better switching performance and higher avalanche energy strength. This device family is suitable for switching power converter applications such as power factor correction (PFC), flat panel display (FPD) TV power, ATX and electronic lamp ballasts.

Absolute Maximum Ratings $T_C = 25^\circ$C unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>FDP51N25</th>
<th>FDPF51N25</th>
<th>FDPF51N25YDTU</th>
<th>FDPF51N25RDTU</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DSS}$</td>
<td>Drain-Source Voltage</td>
<td>250</td>
<td>250</td>
<td>250*</td>
<td>250*</td>
<td>V</td>
</tr>
<tr>
<td>$I_D$</td>
<td>Drain Current - Continuous ($T_C = 25^\circ$C)</td>
<td>51</td>
<td>51</td>
<td>51*</td>
<td>51*</td>
<td>A</td>
</tr>
<tr>
<td>$I_{DM}$</td>
<td>Drain Current - Continuous ($T_C = 100^\circ$C)</td>
<td>30</td>
<td>30</td>
<td>30*</td>
<td>30*</td>
<td>A</td>
</tr>
<tr>
<td>$V_{GSS}$</td>
<td>Gate-Source voltage</td>
<td>±30</td>
<td>±30</td>
<td>±30</td>
<td>±30</td>
<td>V</td>
</tr>
<tr>
<td>$E_{AS}$</td>
<td>Single Pulsed Avalanche Energy</td>
<td>1111</td>
<td>1111</td>
<td>1111*</td>
<td>1111*</td>
<td>mJ</td>
</tr>
<tr>
<td>$I_{AR}$</td>
<td>Avalanche Current</td>
<td>51</td>
<td>51</td>
<td>51*</td>
<td>51*</td>
<td>A</td>
</tr>
<tr>
<td>$E_{AR}$</td>
<td>Repetitive Avalanche Energy</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>mJ</td>
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<tr>
<td>$dv/dt$</td>
<td>Peak Diode Recovery $dv/dt$</td>
<td>4.5</td>
<td>4.5</td>
<td>4.5</td>
<td>4.5</td>
<td>V/ns</td>
</tr>
<tr>
<td>$P_D$</td>
<td>Power Dissipation ($T_C = 25^\circ$C)</td>
<td>320</td>
<td>320</td>
<td>320*</td>
<td>320*</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>(Derate Above 25°C)</td>
<td>3.7</td>
<td>3.7</td>
<td>3.7</td>
<td>3.7</td>
<td>W/°C</td>
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<td>$T_J, T_{STG}$</td>
<td>Operating and Storage Temperature Range</td>
<td>-55 to +150</td>
<td>-55 to +150</td>
<td>-55 to +150</td>
<td>-55 to +150</td>
<td>°C</td>
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<tr>
<td>$T_L$</td>
<td>Maximum Lead Temperature for Soldering, 1/8” from Case for 5 Seconds</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>°C</td>
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*Drain current limited by maximum junction temperature.

Thermal Characteristics

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<th>Parameter</th>
<th>FDP51N25</th>
<th>FDPF51N25</th>
<th>FDPF51N25YDTU</th>
<th>FDPF51N25RDTU</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{\text{ujc}}$</td>
<td>Thermal Resistance, Junction-to-Case, Max.</td>
<td>0.39</td>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
<td>°C/W</td>
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<tr>
<td>$R_{\text{uja}}$</td>
<td>Thermal Resistance, Junction-to-Ambient, Max.</td>
<td>62.5</td>
<td>62.5</td>
<td>62.5</td>
<td>62.5</td>
<td>°C/W</td>
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## Package Marking and Ordering Information

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<tr>
<th>Part Number</th>
<th>Top Mark</th>
<th>Package</th>
<th>Packing Method</th>
<th>Reel Size</th>
<th>Tape Width</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>FDP51N25</td>
<td>FDP51N25</td>
<td>TO-220</td>
<td>Tube</td>
<td>N/A</td>
<td>N/A</td>
<td>50 units</td>
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<tr>
<td>FDP51N25</td>
<td>FDP51N25</td>
<td>TO-220F</td>
<td>Tube</td>
<td>N/A</td>
<td>N/A</td>
<td>50 units</td>
</tr>
<tr>
<td>FDPF51N25YDTU</td>
<td>FDPF51N25</td>
<td>TO-220F (Y-formed)</td>
<td>Tube</td>
<td>N/A</td>
<td>N/A</td>
<td>50 units</td>
</tr>
<tr>
<td>FDPF51N25RDTU</td>
<td>FDPF51N25</td>
<td>TO-220F (LG-formed)</td>
<td>Tube</td>
<td>N/A</td>
<td>N/A</td>
<td>50 units</td>
</tr>
</tbody>
</table>

## Electrical Characteristics  \( T_C = 25^\circ C \) unless otherwise noted.

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<tr>
<th>Symbol</th>
<th>Parameter</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>( V_{BDSS} )</td>
<td>Drain-Source Breakdown Voltage ( V_{GS} = 0 , V, , I_D = 250 , \mu A, , T_J = 25 ^\circ C )</td>
<td>250</td>
<td>--</td>
<td>--</td>
<td>250</td>
<td>V</td>
</tr>
<tr>
<td>( \Delta V_{BDSS} / \Delta T_J )</td>
<td>Breakdown Voltage Temperature Coefficient ( I_D = 250 , \mu A, ) Referenced to 25(^\circ)C ( V_{DD} = 250 , V, , V_{GS} = 0 , V )</td>
<td>--</td>
<td>0.25</td>
<td>--</td>
<td>V/°C</td>
<td></td>
</tr>
<tr>
<td>( I_{DSS} )</td>
<td>Zero Gate Voltage Drain Current ( V_{DS} = 250 , V, , V_{GS} = 0 , V )</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>μA</td>
<td></td>
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<tr>
<td>( I_{GS} )</td>
<td>Gate-Body Leakage Current, Forward ( V_{GS} = 30 , V, , V_{DS} = 0 , V )</td>
<td>--</td>
<td>--</td>
<td>100</td>
<td>nA</td>
<td></td>
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<tr>
<td>( I_{GSR} )</td>
<td>Gate-Body Leakage Current, Reverse ( V_{GS} = -30 , V, , V_{DS} = 0 , V )</td>
<td>--</td>
<td>--</td>
<td>-100</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>( V_{GS(th)} )</td>
<td>Gate Threshold Voltage ( V_{DS} = V_{GS}, , I_D = 250 , \mu A )</td>
<td>3.0</td>
<td>--</td>
<td>5.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>( R_{ON} )</td>
<td>Static Drain-Source On-Resistance ( V_{GS} = 10 , V, , I_P = 25.5 , A )</td>
<td>--</td>
<td>0.048</td>
<td>0.060</td>
<td>Ω</td>
<td></td>
</tr>
<tr>
<td>( g_{FS} )</td>
<td>Forward Transconductance ( V_{DS} = 40 , V, , I_P = 25.5 , A )</td>
<td>--</td>
<td>43</td>
<td>--</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>( C_{iss} )</td>
<td>Input Capacitance ( V_{DS} = 25 , V, , V_{GS} = 0 , V, , f = 1 , MHz )</td>
<td>--</td>
<td>2620</td>
<td>3410</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>( C_{oss} )</td>
<td>Output Capacitance ( V_{GS} = 0 , V, , V_{DS} = 0 , V )</td>
<td>--</td>
<td>530</td>
<td>690</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>( C_{rss} )</td>
<td>Reverse Transfer Capacitance ( V_{GS} = 0 , V, , V_{DS} = 0 , V )</td>
<td>--</td>
<td>63</td>
<td>90</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>( t_{d(on)} )</td>
<td>Turn-On Delay Time ( V_{DD} = 125 , V, , I_D = 51 , A, , V_{GS} = 10 , V, , R_O = 25 , \Omega )</td>
<td>--</td>
<td>62</td>
<td>135</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>( t_{r} )</td>
<td>Turn-On Rise Time ( V_{DD} = 125 , V, , I_D = 51 , A, , V_{GS} = 10 , V, , R_O = 25 , \Omega )</td>
<td>--</td>
<td>465</td>
<td>940</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>( t_{d(off)} )</td>
<td>Turn-Off Delay Time ( V_{DD} = 125 , V, , I_D = 51 , A, , V_{GS} = 10 , V, , R_O = 25 , \Omega )</td>
<td>--</td>
<td>98</td>
<td>205</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>( t_{f} )</td>
<td>Turn-Off Fall Time ( V_{DD} = 125 , V, , I_D = 51 , A, , V_{GS} = 10 , V, , R_O = 25 , \Omega )</td>
<td>--</td>
<td>130</td>
<td>270</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>( Q_{g} )</td>
<td>Total Gate Charge ( V_{DD} = 200 , V, , I_D = 51 , A, , V_{GS} = 0 , V ) ( (Note 4) )</td>
<td>--</td>
<td>55</td>
<td>70</td>
<td>nC</td>
<td></td>
</tr>
<tr>
<td>( Q_{gs} )</td>
<td>Gate-Source Charge ( V_{DD} = 200 , V, , I_D = 51 , A, , V_{GS} = 0 , V ) ( (Note 4) )</td>
<td>--</td>
<td>16</td>
<td>--</td>
<td>nC</td>
<td></td>
</tr>
<tr>
<td>( Q_{gd} )</td>
<td>Gate-Drain Charge ( V_{DD} = 200 , V, , I_D = 51 , A, , V_{GS} = 0 , V ) ( (Note 4) )</td>
<td>--</td>
<td>27</td>
<td>--</td>
<td>nC</td>
<td></td>
</tr>
</tbody>
</table>

### Notes:
1. Repetitive rating: pulse-width limited by maximum junction temperature.
2. \( L = 0.68 \, mH, \, I_D = 51 \, A, \, V_{DD} = 50 \, V, \, R_O = 25 \, \Omega \), starting \( T_J = 25 ^\circ C \).
3. \( I_D = 51 \, A, \, \frac{dI}{dt} = 200 \, A/\mu s \), \( V_{DD} \leq V_{BDSS} \), starting \( T_J = 25 ^\circ C \).
4. Essentially independent of operating temperature typical characteristics.

## Drain-Source Diode Characteristics and Maximum Ratings

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_S )</td>
<td>Maximum Continuous Drain-Source Diode Forward Current</td>
<td>--</td>
<td>--</td>
<td>51</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>( I_{SM} )</td>
<td>Maximum Pulsed Drain-Source Diode Forward Current</td>
<td>--</td>
<td>--</td>
<td>204</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>( V_{SD} )</td>
<td>Drain-Source Diode Forward Voltage ( V_{GS} = 0 , V, , I_S = 51 , A )</td>
<td>--</td>
<td>--</td>
<td>1.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>( t_{rr} )</td>
<td>Reverse Recovery Time ( V_{GS} = 0 , V, , I_S = 51 , A, , \frac{dI}{dt} = 100 , A/\mu s )</td>
<td>--</td>
<td>178</td>
<td>--</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>( Q_{tr} )</td>
<td>Reverse Recovery Charge ( V_{GS} = 0 , V, , I_S = 51 , A, , \frac{dI}{dt} = 100 , A/\mu s )</td>
<td>--</td>
<td>4.0</td>
<td>--</td>
<td>μC</td>
<td></td>
</tr>
</tbody>
</table>
Typical Performance Characteristics

Figure 1. On-Region Characteristics

Figure 2. Transfer Characteristics

Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

Figure 5. Capacitance Characteristics

Figure 6. Gate Charge Characteristics
Typical Performance Characteristics (Continued)

**Figure 7. Breakdown Voltage Variation**

- **Breakdown Voltage Variation** vs. Temperature
- Graph showing breakdown voltage variation vs. temperature.
- Notes: 1. $V_{GS} = 0$ V
   2. $I_D = 250$ μA

**Figure 8. On-Resistance Variation**

- **On-Resistance Variation** vs. Temperature
- Graph showing on-resistance variation vs. temperature.
- Notes: 1. $V_{GS} = 10$ V
   2. $I_D = 25.5$ A

**Figure 9-1. Maximum Safe Operating Area**

- Maximum Safe Operating Area for FDP51N25
- Graph showing maximum safe operating area.
- Notes: 1. $T_J = 25$ °C
   2. $T_J = 150$ °C
   3. Single Pulse

**Figure 9-2. Maximum Safe Operating Area**

- Maximum Safe Operating Area for FDPF51N25 / FDPF51N25YDTU
- Graph showing minimum safe operating area.
- Notes: 1. $T_J = 25$ °C
   2. $T_J = 150$ °C
   3. Single Pulse

**Figure 10. Maximum Drain Current**

- Maximum Drain Current vs. Case Temperature
- Graph showing maximum drain current vs. case temperature.
- Notes: 1. $T_C = 25$ °C
   2. $T_C = 150$ °C
   3. Single Pulse
Typical Performance Characteristics (Continued)

Figure 11-1. Transient Thermal Response Curve for FDP51N25

![Graph showing transient thermal response curve for FDP51N25](image)

- Notes:
  1. \( Z_{\theta JC(t)} \) = 0.39 °C/W Max.
  2. Duty Factor, \( D = \frac{t_1}{t_2} \)
  3. \( T_{JM} - T_C = P_{DM} * Z_{\theta JC(t)} \)

- \( Z_{\theta JC(t)} \), Thermal Response 
- \( t_1 \), Square Wave Pulse Duration [sec]

Figure 11-2. Transient Thermal Response Curve for FDPF51N25 / FDPF51N25YDTU

![Graph showing transient thermal response curve for FDPF51N25](image)

- Notes:
  1. \( Z_{\theta JC(t)} \) = 3.3 °C/W Max.
  2. Duty Factor, \( D = \frac{t_1}{t_2} \)
  3. \( T_{JM} - T_C = P_{DM} * Z_{\theta JC(t)} \)

- \( Z_{\theta JC(t)} \), Thermal Response 
- \( t_1 \), Square Wave Pulse Duration [sec]
Figure 12. Gate Charge Test Circuit & Waveform

Figure 13. Resistive Switching Test Circuit & Waveforms

Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms
Figure 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms

- DUT
- V_DS
- I_SD
- L
- R_G
- V_GS
- V_DD

- Driver
- Same Type as DUT
- • dv/dt controlled by R_G
- • I_SD controlled by pulse period

- V_GS (Driver)
- D = Gate Pulse Width
- Gate Pulse Period
- → 10V

- I_SD (DUT)
- I_FM, Body Diode Forward Current
- I_RM, Body Diode Reverse Current
- dl/dt
- Body Diode Recovery dv/dt

- V_DS (DUT)
- V_SD
- V_DD

Body Diode Forward Voltage Drop

Body Diode Forward Voltage Drop
NOTES:

A. EXCEPT WHERE NOTED CONFORMS TO EIAJ SC91A.

B. DOES NOT COMPLY EIAJ STD. VALUE.

C. ALL DIMENSIONS ARE IN MILLIMETERS.

D. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.


F. DRAWING FILE NAME: TO220N03REV1
NOTES:
A) REFERENCE JEDEC, TO-220, VARIATION AB
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DIMENSIONS COMMON TO ALL PACKAGE SUPPLIERS EXCEPT WHERE NOTED [ ].
D) LOCATION OF MOLDED FEATURE MAY VARY (LOWER LEFT CORNER, LOWER CENTER AND CENTER OF THE PACKAGE)
E) DOES NOT COMPLY JEDEC STANDARD VALUE.
F) "A1" DIMENSIONS AS BELOW:
   SINGLE GAUGE = 0.51 - 0.61
   DUAL GAUGE  = 1.10 - 1.45
G) DRAWING FILE NAME: TO220B03REV8
H) PRESENCE IS SUPPLIER DEPENDENT
I) SUPPLIER DEPENDENT MOLD LOCKING HOLES IN HEATSINK.
J) FAIRCHILD SEMICONDUCTOR
NOTES:

A. EXCEPT WHERE NOTED CONFORMS TO EIAJ SC91A.
B. DOES NOT COMPLY EIAJ STD. VALUE.
C. ALL DIMENSIONS ARE IN MILLIMETERS.
D. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.
F. OPTION 1 - WITH SUPPORT PIN HOLE.
   OPTION 2 - NO SUPPORT PIN HOLE.
G. DRAWING FILE NAME: TO220M03REV3
NOTES:

A. EXCEPT WHERE NOTED CONFORMS TO EIAJ SC91A.
B. DOES NOT COMPLY EIAJ STD. VALUE.
C. ALL DIMENSIONS ARE IN MILLIMETERS.
D. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.
F. DRAWING FILE NAME: TO220Q03REV1
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<th>Product Status</th>
<th>Definition</th>
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<td>Advance Information</td>
<td>Formative / In Design</td>
<td>Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.</td>
</tr>
<tr>
<td>Preliminary</td>
<td>First Production</td>
<td>Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.</td>
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<tr>
<td>Active</td>
<td>Full Production</td>
<td>Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.</td>
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<tr>
<td>Obsolete</td>
<td>Not In Production</td>
<td>Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.</td>
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- **CorePOWER™**
- **CROSSVOLT™**
- **CTL™**
- **Current Transfer Logic™**
- **DEUXPEED™**
- **Dual Cool™**
- **EcoSpark®**
- **EfficientMax™**
- **ESBC™**
- **Fairchild®**
- **Fairchild Semiconductor®**
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- **FACT™**
- **FAST™**
- **FastvCore™**
- **FETBench™**
- **FPS™**
- **F-PFS™**
- **FRFET™**
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- **Green FPS™**
- **Green FPS™ e-Series™**
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- **QFET™**
- **QS™**
- **Quiet Series™**
- **RapidConfigure™**
- **Saving our world, 1mW/W/kW at a time™**
- **SignalWise™**
- **SmartMax™**
- **SMART START™**
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- **SPM®**
- **STEALTH™**
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- **SuperSOT™-6**
- **SuperSOT™-8**
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- **TINYOPTO™**
- **TinyPower™**
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- **TriFault Detect™**
- **TRUECURRENT™**
- **µSerDes™**
- **UHC™**
- **Ultra FRFET™**
- **UniFET™**
- **VCX™**
- **VisualMax™**
- **VoltagePlus™**
- **XS™**
- **Xsens™**
- **仙童™**

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**PRODUCT STATUS DEFINITIONS**

**Definition of Terms**

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<tr>
<th>Datasheet Identification</th>
<th>Product Status</th>
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<td>Advance Information</td>
<td>Formative / In Design</td>
<td>Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.</td>
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<tr>
<td>Preliminary</td>
<td>First Production</td>
<td>Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.</td>
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<td>Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.</td>
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