FAIRCHILD SEMICONDUCTOR™

November 2001

# FDD6512A/FDU6512A

## 20V N-Channel PowerTrench® MOSFET

### General Description

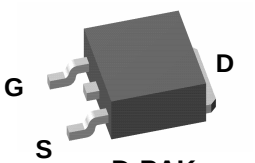
This N-Channel MOSFET has been designed specifically to improve the overall efficiency of DC/DC converters using either synchronous or conventional switching PWM controllers. It has been optimized for low gate charge, low $R_{DS(ON)}$, fast switching speed and extremely low $R_{DS(ON)}$ in a small package.

### Applications

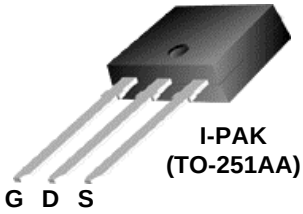
- DC/DC converter
- Motor drives

### Features

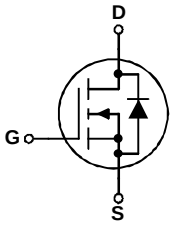
- 36 A, 20 V $R_{DS(ON)}$ = 21 mΩ @ $V_{GS}$ = 4.5 V
  $R_{DS(ON)}$ = 31 mΩ @ $V_{GS}$ = 2.5 V
- Low gate charge (12 nC typical)
- Fast switching
- High performance trench technology for extremely low $R_{DS(ON)}$




D-PAK (TO-252)




I-PAK (TO-251AA)




## Absolute Maximum Ratings

$T_A$=25°C unless otherwise noted

| Symbol | Parameter | | | Ratings | Units |
|---|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source Voltage | | | 20 | V |
| $V_{GSS}$ | Gate-Source Voltage | | | ± 12 | V |
| $I_D$ | Continuous Drain Current | @$T_C$=25°C | (Note 3) | 36 | A |
| | | @$T_A$=25°C | (Note 1a) | 10.7 | |
| | | Pulsed | (Note 1a) | 100 | |
| $P_D$ | Power Dissipation | @$T_C$=25°C | (Note 3) | 43 | W |
| | | @$T_A$=25°C | (Note 1a) | 3.8 | |
| | | @$T_A$=25°C | (Note 1b) | 1.6 | |
| $T_J$, $T_{STG}$ | Operating and Storage Junction Temperature Range | | | –55 to +175 | °C |

## Thermal Characteristics

| | | | | |
|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case | (Note 1) | 3.5 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | (Note 1a) | 40 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | (Note 1b) | 96 | °C/W |

## Package Marking and Ordering Information

| Device Marking | Device | Package | Reel Size | Tape width | Quantity |
|---|---|---|---|---|---|
| FDD6512A | FDD6512A | D-PAK (TO-252) | 13'' | 12mm | 2500 units |
| FDU6512A | FDU6512A | I-PAK (TO-251) | Tube | N/A | 75 |

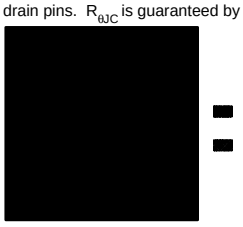
## Electrical Characteristics

$T_A$ = 25°C unless otherwise noted

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Drain-Source Avalanche Ratings (Note 2)** | | | | | | |
| $E_{AS}$ | Drain-Source Avalanche Energy | Single Pulse, $V_{DD}$ = 10 V, $I_D$=10A | | | 90 | mJ |
| $I_{AS}$ | Drain-Source Avalanche Current | | | | 10 | A |
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain–Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 250 µA | 20 | | | V |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 250 µA,Referenced to 25°C | | 14 | | mV/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 16 V, $V_{GS}$ = 0 V | | | 10 | µA |
| $I_{GSSF}$ | Gate–Body Leakage, Forward | $V_{GS}$ = 12 V, $V_{DS}$ = 0 V | | | 100 | nA |
| $I_{GSSR}$ | Gate–Body Leakage, Reverse | $V_{GS}$ = –12 V, $V_{DS}$ = 0 V | | | –100 | nA |
| **On Characteristics (Note 2)** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 0.6 | 0.8 | 1.5 | V |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | $I_D$ = 250 µA, Referenced to 25°C | | –3.2 | | mV/°C |
| $R_{DS(on)}$ | Static Drain–Source On–Resistance | $V_{GS}$ = 4.5 V, $I_D$ = 10.7 A<br>$V_{GS}$ = 2.5 V, $I_D$ = 9.1 A<br>$V_{GS}$ = 4.5 V, $I_D$ = 10.7 A, $T_J$=125°C | | 16<br>21<br>22 | 21<br>31<br>29 | mΩ |
| $I_{D(on)}$ | On–State Drain Current | $V_{GS}$ = 4.5 V, $V_{DS}$ = 5 V | 50 | | | A |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 5 V, $I_D$ = 10.7 A | | 50 | | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 10 V, $V_{GS}$ = 0 V, f = 1.0 MHz | | 1082 | | pF |
| $C_{oss}$ | Output Capacitance | | | 277 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 130 | | pF |
| **Switching Characteristics (Note 2)** | | | | | | |
| $t_{d(on)}$ | Turn–On Delay Time | $V_{DD}$ = 10 V, $I_D$ = 1 A, $V_{GS}$ = 4.5 V, $R_{GEN}$ = 6 Ω | | 8 | 16 | ns |
| $t_r$ | Turn–On Rise Time | | | 8 | 16 | ns |
| $t_{d(off)}$ | Turn–Off Delay Time | | | 24 | 38 | ns |
| $t_f$ | Turn–Off Fall Time | | | 8 | 16 | ns |
| $Q_g$ | Total Gate Charge | $V_{DS}$ = 10V, $I_D$ = 10.7 A, $V_{GS}$ = 4.5 V | | 12 | 19 | nC |
| $Q_{gs}$ | Gate–Source Charge | | | 2 | | nC |
| $Q_{gd}$ | Gate–Drain Charge | | | 3 | | nC |
| **Drain–Source Diode Characteristics and Maximum Ratings** | | | | | | |
| $I_S$ | Maximum Continuous Drain–Source Diode Forward Current | | | | 2.3 | A |
| $V_{SD}$ | Drain–Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_S$ = 2.3 A (Note 2) | | 0.72 | 1.2 | V |

**Notes:**

**1.** $R_{\theta JA}$ is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins. $R_{\theta JC}$ is guaranteed by design while $R_{\theta CA}$ is determined by the user's board design.



a) $R_{\theta JA}$ = 40°C/W when mounted on a 1in$^2$ pad of 2 oz copper

b) $R_{\theta JA}$ = 96°C/W when mounted on a minimum pad.

Scale 1 : 1 on letter size paper

**2.** Pulse Test: Pulse Width < 300µs, Duty Cycle < 2.0%

**3.** Maximum current is calculated as: $\sqrt{\frac{P_D}{R_{DS(ON)}}}$

where $P_D$ is maximum power dissipation at $T_C$ = 25°C and $R_{DS(on)}$ is at $T_{J(max)}$ and $V_{GS}$ = 10V. Package current limitation is 21A

## Typical Characteristics

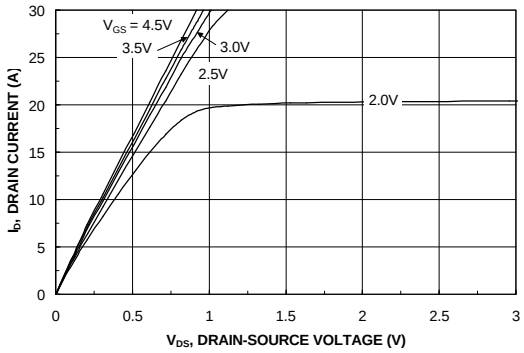



**Figure 1. On-Region Characteristics**

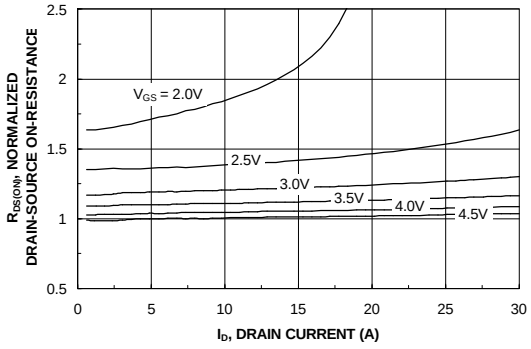



**Figure 2. On-Resistance Variation with Drain Current and Gate Voltage**

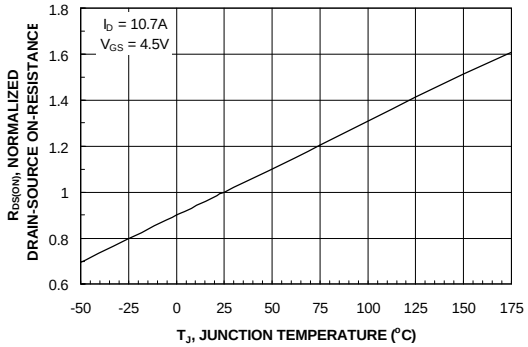



**Figure 3. On-Resistance Variation withTemperature**

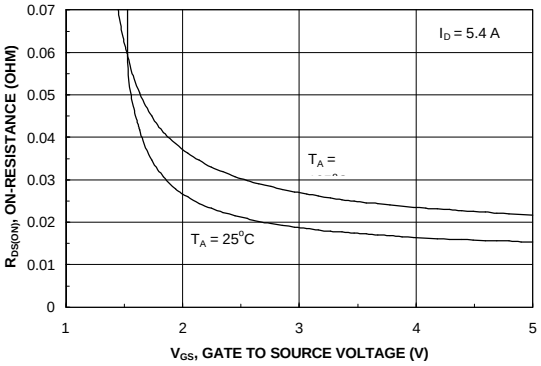



**Figure 4. On-Resistance Variation with Gate-to-Source Voltage**

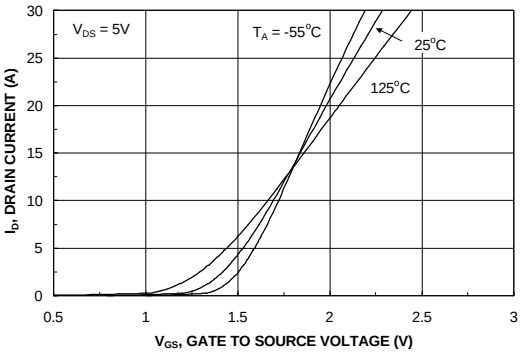



**Figure 5. Transfer Characteristics**

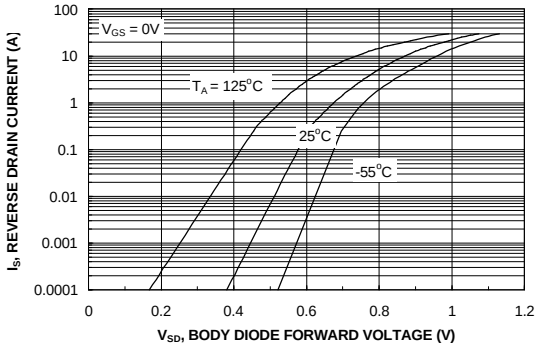



**Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature**

## Typical Characteristics

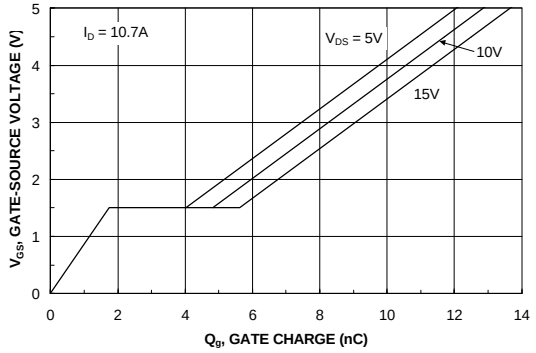



**Figure 7. Gate Charge Characteristics**

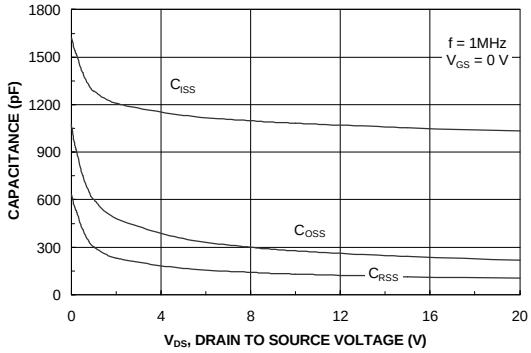



**Figure 8. Capacitance Characteristics**

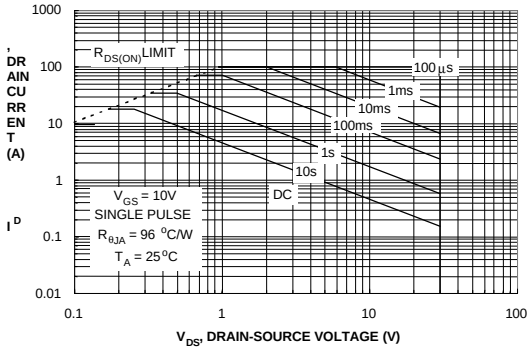



**Figure 9. Maximum Safe Operating Area**

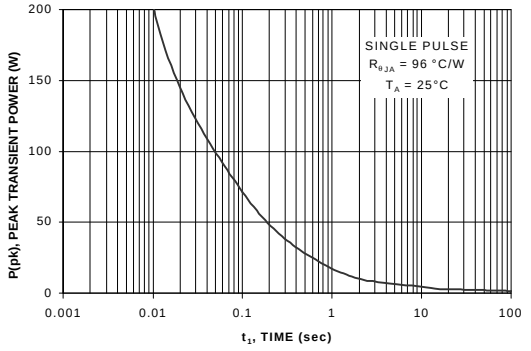



**Figure 10. Single Pulse Maximum Power Dissipation**

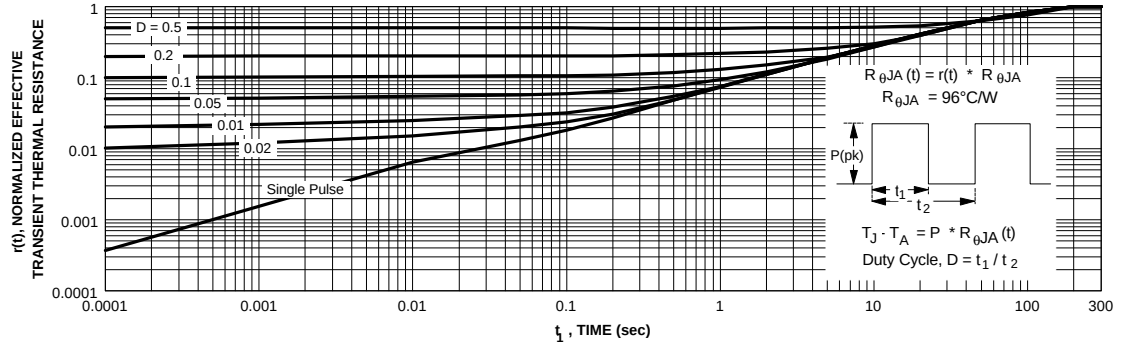



**Figure 11. Transient Thermal Response Curve**

**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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