

# FDD3706/FDU3706

## 20V N-Channel PowerTrench® MOSFET

### General Description

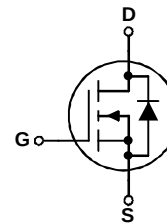
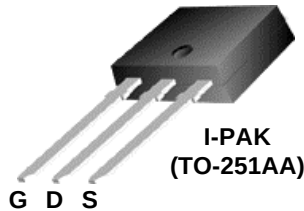
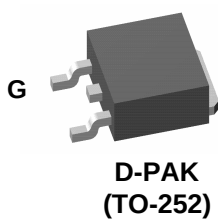
This N-Channel MOSFET has been designed specifically to improve the overall efficiency of DC/DC converters using either synchronous or conventional switching PWM controllers. It has been optimized for low gate charge, low  $R_{DS(ON)}$ , fast switching speed and extremely low  $R_{DS(ON)}$  in a small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

### Applications

- DC/DC converter
- Motor Drives

### Features

- 50 A, 20 V  $R_{DS(ON)} = 9\text{ m}\Omega @ V_{GS} = 10\text{ V}$   
 $R_{DS(ON)} = 11\text{ m}\Omega @ V_{GS} = 4.5\text{ V}$   
 $R_{DS(ON)} = 16\text{ m}\Omega @ V_{GS} = 2.5\text{ V}$
- Low gate charge (16 nC)
- Fast Switching
- High performance trench technology for extremely low  $R_{DS(ON)}$



### Absolute Maximum Ratings

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

| Symbol         | Parameter                                                    | Ratings     | Units            |
|----------------|--------------------------------------------------------------|-------------|------------------|
| $V_{DSS}$      | Drain-Source Voltage                                         | 20          | V                |
| $V_{GSS}$      | Gate-Source Voltage                                          | $\pm 12$    | V                |
| $I_D$          | Continuous Drain Current @ $T_C = 25^\circ\text{C}$ (Note 3) | 50          | A                |
|                | @ $T_A = 25^\circ\text{C}$ (Note 1a)                         | 14.7        |                  |
|                | Pulsed (Note 1a)                                             | 60          |                  |
| $P_D$          | Power Dissipation @ $T_C = 25^\circ\text{C}$ (Note 3)        | 44          | W                |
|                | @ $T_A = 25^\circ\text{C}$ (Note 1a)                         | 3.8         |                  |
|                | @ $T_A = 25^\circ\text{C}$ (Note 1b)                         | 1.6         |                  |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range             | -55 to +175 | $^\circ\text{C}$ |

### Thermal Characteristics

|                 |                                                   |     |                    |
|-----------------|---------------------------------------------------|-----|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case (Note 1)     | 3.4 | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (Note 1a) | 45  | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (Note 1b) | 96  | $^\circ\text{C/W}$ |

### Package Marking and Ordering Information

| Device Marking | Device  | Package        | Reel Size | Tape width | Quantity   |
|----------------|---------|----------------|-----------|------------|------------|
| FDD3706        | FDD3706 | D-PAK (TO-252) | 13"       | 12mm       | 2500 units |
| FDU3706        | FDU3706 | I-PAK (TO-251) | Tube      | N/A        | 75         |

**Electrical Characteristics** $T_A = 25^\circ\text{C}$  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, $V_{DD} = 10\text{V}$ , $I_D = 7\text{A}$ |  |  | 60 | mJ |
| $I_{AS}$ | Drain-Source Avalanche Current |                                                         |  |  | 7  | A  |

**Off Characteristics**

|                                      |                                           |                                                                   |    |    |      |                      |
|--------------------------------------|-------------------------------------------|-------------------------------------------------------------------|----|----|------|----------------------|
| $BV_{DSS}$                           | Drain-Source Breakdown Voltage            | $V_{GS} = 0\text{V}$ , $I_D = 250\text{ }\mu\text{A}$             | 20 |    |      | V                    |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$ |    | 13 |      | mV/ $^\circ\text{C}$ |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{DS} = 16\text{V}$ , $V_{GS} = 0\text{V}$                      |    |    | 1    | $\mu\text{A}$        |
| $I_{GSSF}$                           | Gate-Body Leakage, Forward                | $V_{GS} = 12\text{V}$ , $V_{DS} = 0\text{V}$                      |    |    | 100  | nA                   |
| $I_{GSSR}$                           | Gate-Body Leakage, Reverse                | $V_{GS} = -12\text{V}$ , $V_{DS} = 0\text{V}$                     |    |    | -100 | nA                   |

**On Characteristics** (Note 2)

|                                        |                                                |                                                                                                                                                                                                                             |     |                        |                     |                      |
|----------------------------------------|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------------------|---------------------|----------------------|
| $V_{GS(th)}$                           | Gate Threshold Voltage                         | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                                                                                          | 0.5 | 1                      | 1.5                 | V                    |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$                                                                                                                                                           |     | -3.5                   |                     | mV/ $^\circ\text{C}$ |
| $R_{DS(on)}$                           | Static Drain-Source On-Resistance              | $V_{GS} = 10\text{V}$ , $I_D = 16.2\text{A}$<br>$V_{GS} = 4.5\text{V}$ , $I_D = 14.7\text{A}$<br>$V_{GS} = 2.5\text{V}$ , $I_D = 12.2\text{A}$<br>$V_{GS} = 4.5\text{V}$ , $I_D = 14.7\text{A}$ , $T_J = 125^\circ\text{C}$ |     | 7.5<br>8<br>11<br>12.6 | 9<br>11<br>16<br>19 | m $\Omega$           |
| $I_{D(on)}$                            | On-State Drain Current                         | $V_{GS} = 4.5\text{V}$ , $V_{DS} = 5\text{V}$                                                                                                                                                                               | 30  |                        |                     | A                    |
| $g_{FS}$                               | Forward Transconductance                       | $V_{DS} = 5\text{V}$ , $I_D = 14.7\text{A}$                                                                                                                                                                                 |     | 65                     |                     | S                    |

**Dynamic Characteristics**

|           |                              |                                                                       |  |      |  |    |
|-----------|------------------------------|-----------------------------------------------------------------------|--|------|--|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 10\text{V}$ , $V_{GS} = 0\text{V}$ ,<br>$f = 1.0\text{MHz}$ |  | 1882 |  | pF |
| $C_{oss}$ | Output Capacitance           |                                                                       |  | 430  |  | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                       |  | 201  |  | pF |

**Switching Characteristics** (Note 2)

|              |                     |                                                                                                     |  |     |    |    |
|--------------|---------------------|-----------------------------------------------------------------------------------------------------|--|-----|----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 10\text{V}$ , $I_D = 1\text{A}$ ,<br>$V_{GS} = 4.5\text{V}$ , $R_{GEN} = 6\text{ }\Omega$ |  | 11  | 20 | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                                     |  | 15  | 27 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                                     |  | 35  | 56 | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                                     |  | 16  | 29 | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = 10\text{V}$ , $I_D = 14.7\text{A}$ ,<br>$V_{GS} = 4.5\text{V}$                            |  | 16  | 23 | nC |
| $Q_{gs}$     | Gate-Source Charge  |                                                                                                     |  | 3.7 |    | nC |
| $Q_{gd}$     | Gate-Drain Charge   |                                                                                                     |  | 4   |    | nC |

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

|                 |                                                       |                                                        |  |     |     |   |
|-----------------|-------------------------------------------------------|--------------------------------------------------------|--|-----|-----|---|
| I <sub>S</sub>  | Maximum Continuous Drain–Source Diode Forward Current |                                                        |  |     | 3.2 | A |
| V <sub>SD</sub> | Drain–Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 3.2 A (Note 2) |  | 0.7 | 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)  $R_{\theta JA} = 40^\circ\text{C/W}$  when mounted on a  
1in<sup>2</sup> pad of 2 oz copper



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

Scale 1 : 1 on letter size paper

2. Pulse Test: Pulse Width < 300 $\mu\text{s}$ , 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  $T_C = 25^\circ\text{C}$  and  $R_{DS(on)}$  is at  $T_{J(max)}$  and  $V_{GS} = 10\text{V}$ . Package current limitation is 21A

## Typical Characteristics

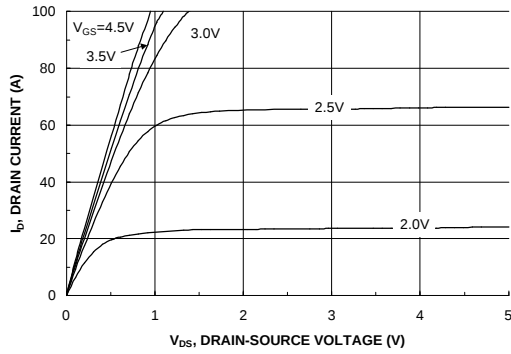


Figure 1. On-Region Characteristics

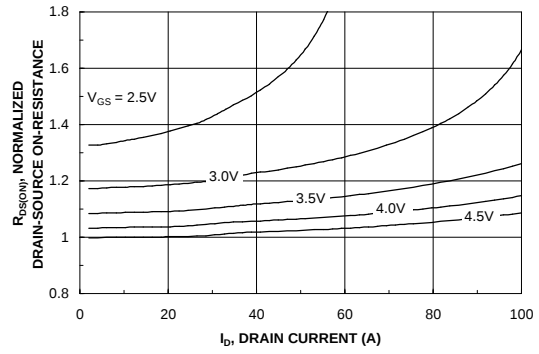


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage

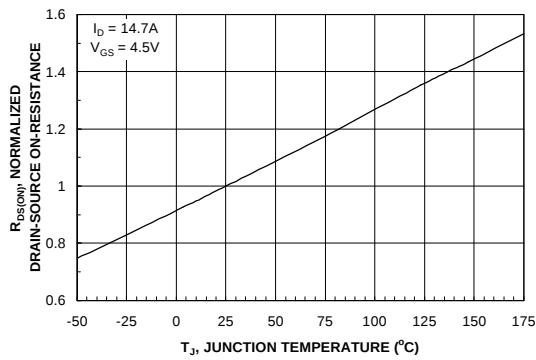


Figure 3. On-Resistance Variation with Temperature

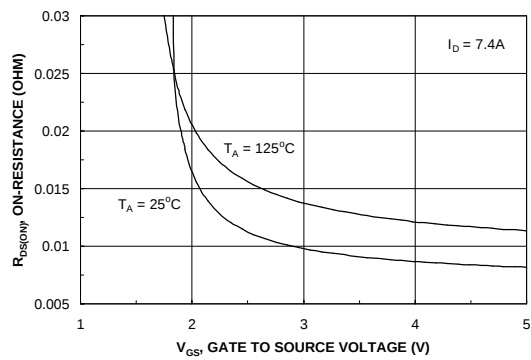


Figure 4. On-Resistance Variation with Gate-to-Source Voltage

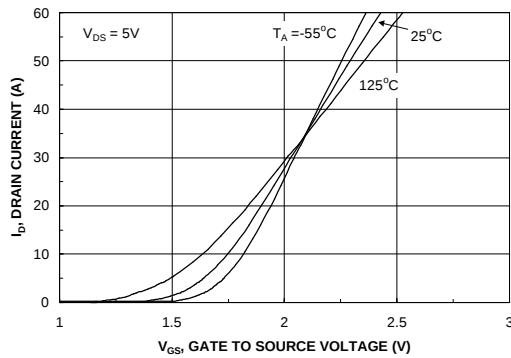


Figure 5. Transfer Characteristics

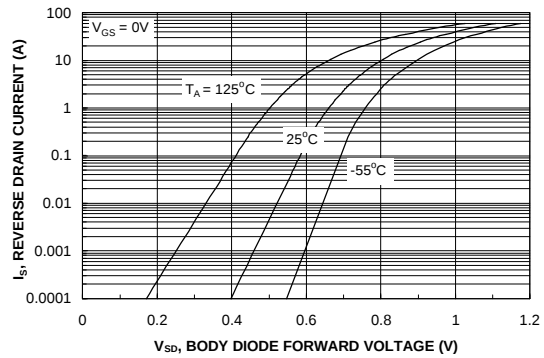


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature

## Typical Characteristics

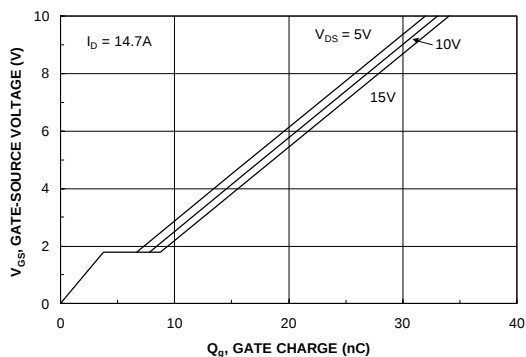


Figure 7. Gate Charge Characteristics

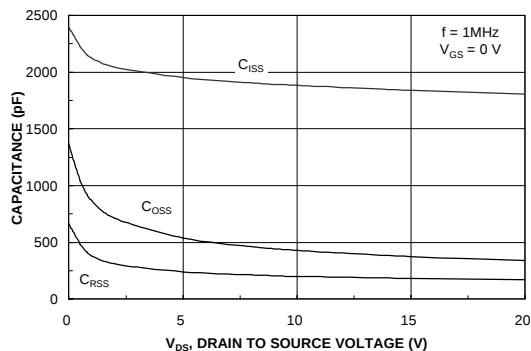


Figure 8. Capacitance Characteristics

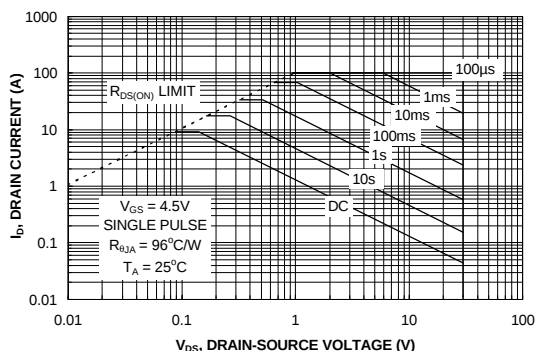


Figure 9. Maximum Safe Operating Area

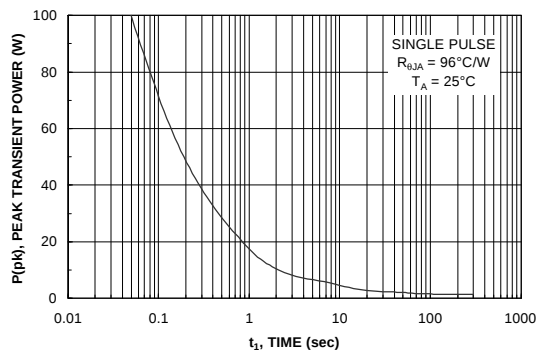


Figure 10. Single Pulse Maximum Power Dissipation

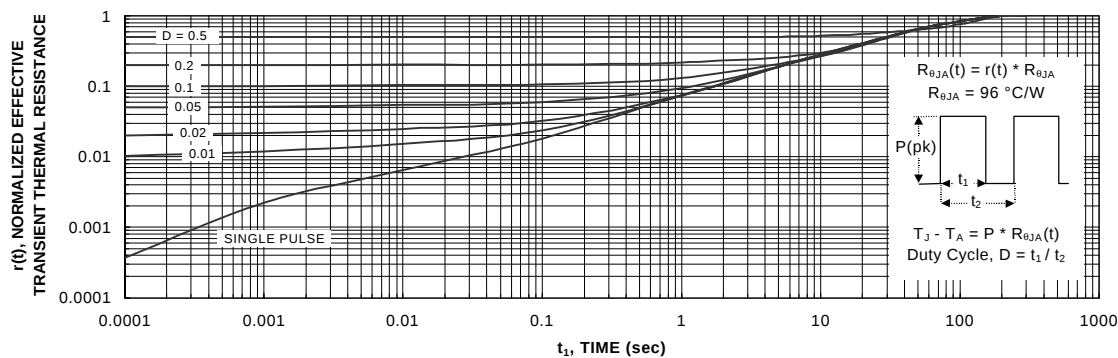


Figure 11. Transient Thermal Response Curve

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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