

## General Description

These N-Channel enhancement mode power field effect transistors are using advanced super junction technology. This advanced technology has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode. These devices are well suited for high efficiency switch mode power supply

| BVDSS | RDSON | ID  |
|-------|-------|-----|
| 500V  | 0.5Ω  | 13A |

## Features

- Improved dv/dt capability
- Fast switching
- 100% EAS Guaranteed
- Green Device Available

## TO220F Pin Configuration



## Applications

- High efficient switched mode power supplies
- TV Power
- Adapter/charger
- Server Power
- PV Inverter / UPS

## Absolute Maximum Ratings $T_c=25^{\circ}\text{C}$ unless otherwise noted

| Symbol    | Parameter                                                | Rating     | Units                 |
|-----------|----------------------------------------------------------|------------|-----------------------|
| $V_{DS}$  | Drain-Source Voltage                                     | 500        | V                     |
| $V_{GS}$  | Gate-Source Voltage                                      | $\pm 30$   | V                     |
| $I_D$     | Drain Current – Continuous ( $T_c=25^{\circ}\text{C}$ )  | 13         | A                     |
|           | Drain Current – Continuous ( $T_c=100^{\circ}\text{C}$ ) | 8.2        | A                     |
| $I_{DM}$  | Drain Current – Pulsed <sup>1</sup>                      | 52         | A                     |
| EAS       | Single Pulse Avalanche Energy <sup>2</sup>               | 720        | mJ                    |
| IAS       | Single Pulse Avalanche Current <sup>2</sup>              | 12         | A                     |
| $P_D$     | Power Dissipation ( $T_c=25^{\circ}\text{C}$ )           | 48         | W                     |
|           | Power Dissipation – Derate above $25^{\circ}\text{C}$    | 0.38       | W/ $^{\circ}\text{C}$ |
| $T_{STG}$ | Storage Temperature Range                                | -55 to 150 | $^{\circ}\text{C}$    |
| $T_J$     | Operating Junction Temperature Range                     | -55 to 150 | $^{\circ}\text{C}$    |

## Thermal Characteristics

| Symbol          | Parameter                              | Typ. | Max. | Unit                 |
|-----------------|----------------------------------------|------|------|----------------------|
| $R_{\theta JA}$ | Thermal Resistance Junction to ambient | ---  | 62   | $^{\circ}\text{C/W}$ |
| $R_{\theta JC}$ | Thermal Resistance Junction to Case    | ---  | 2.6  | $^{\circ}\text{C/W}$ |

**Electrical Characteristics (T<sub>J</sub>=25 °C, unless otherwise noted)**
**Off Characteristics**

| Symbol            | Parameter                      | Conditions                                                        | Min. | Typ. | Max. | Unit |
|-------------------|--------------------------------|-------------------------------------------------------------------|------|------|------|------|
| BV <sub>DSS</sub> | Drain-Source Breakdown Voltage | V <sub>GS</sub> =0V, I <sub>D</sub> =250uA                        | 500  | ---  | ---  | V    |
| I <sub>DSS</sub>  | Drain-Source Leakage Current   | V <sub>DS</sub> =500V, V <sub>GS</sub> =0V, T <sub>J</sub> =25°C  | ---  | ---  | 1    | uA   |
|                   |                                | V <sub>DS</sub> =400V, V <sub>GS</sub> =0V, T <sub>J</sub> =100°C | ---  | ---  | 10   | uA   |
| I <sub>GSS</sub>  | Gate-Source Leakage Current    | V <sub>GS</sub> =±30V, V <sub>DS</sub> =0V                        | ---  | ---  | ±100 | nA   |

**On Characteristics**

|                     |                                   |                                                          |     |      |     |   |
|---------------------|-----------------------------------|----------------------------------------------------------|-----|------|-----|---|
| R <sub>DS(ON)</sub> | Static Drain-Source On-Resistance | V <sub>GS</sub> =10V, I <sub>D</sub> =6A                 | --- | 0.37 | 0.5 | Ω |
| V <sub>GS(th)</sub> | Gate Threshold Voltage            | V <sub>GS</sub> =V <sub>DS</sub> , I <sub>D</sub> =250uA | 2   | 3    | 4   | V |
| g <sub>fs</sub>     | Forward Transconductance          | V <sub>DS</sub> =30V, I <sub>D</sub> =4A                 | --- | 10   | --- | S |

**Dynamic and switching Characteristics**

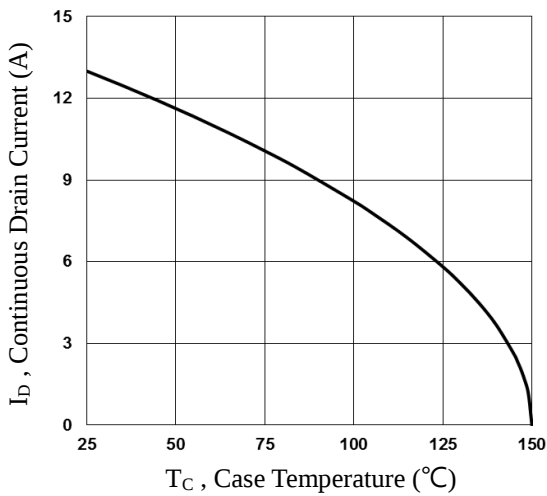
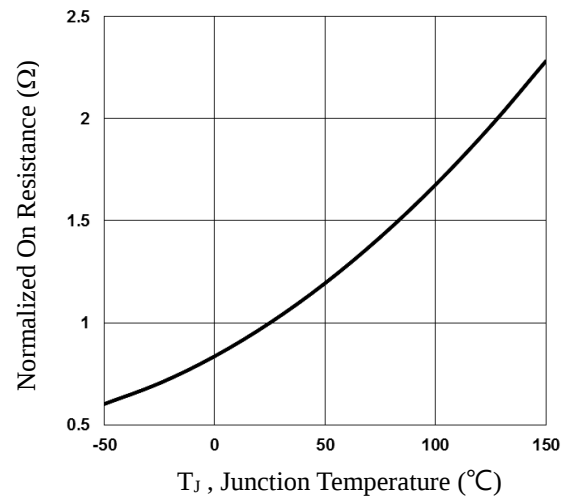
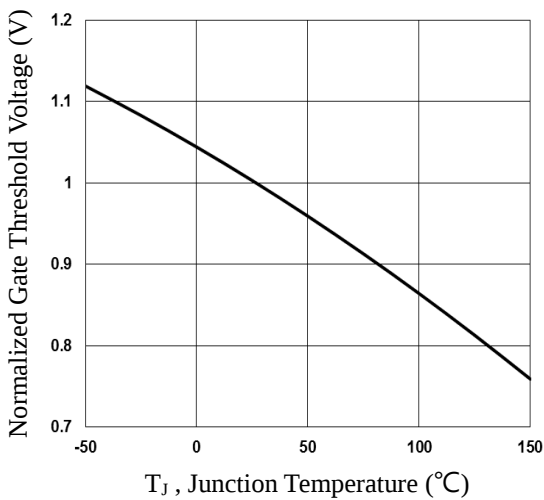
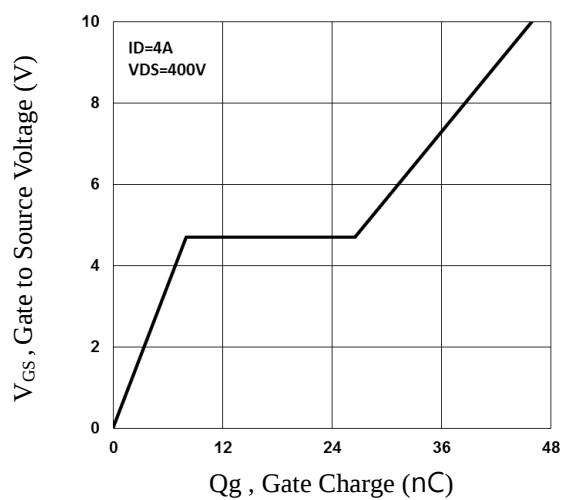
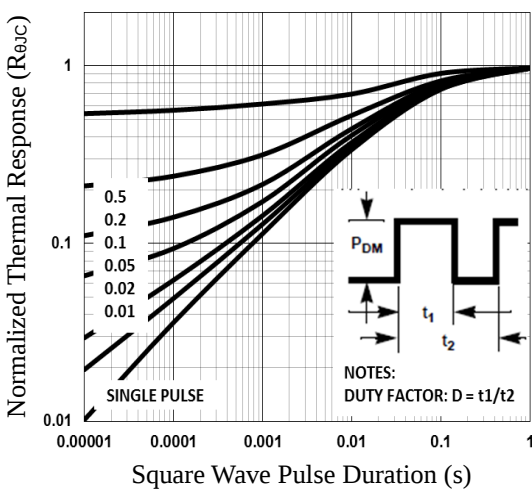
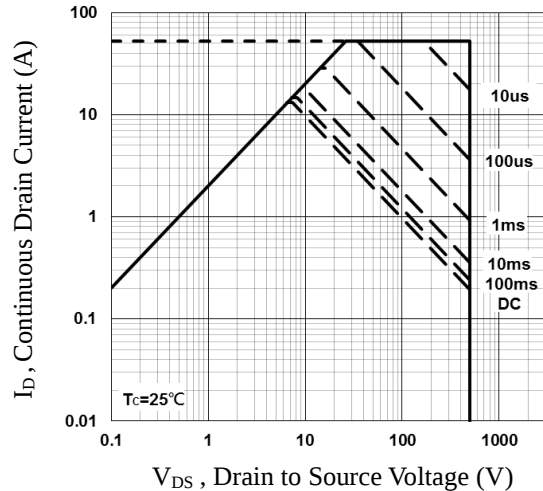
|                     |                                    |                                                                                        |     |      |      |    |
|---------------------|------------------------------------|----------------------------------------------------------------------------------------|-----|------|------|----|
| Q <sub>g</sub>      | Total Gate Charge <sup>3,4</sup>   | V <sub>DS</sub> =400V, V <sub>GS</sub> =10V, I <sub>D</sub> =4A                        | --- | 46   | 92   | nC |
| Q <sub>gs</sub>     | Gate-Source Charge <sup>3,4</sup>  |                                                                                        | --- | 8    | 16   |    |
| Q <sub>gd</sub>     | Gate-Drain Charge <sup>3,4</sup>   |                                                                                        | --- | 18.5 | 36   |    |
| T <sub>d(on)</sub>  | Turn-On Delay Time <sup>3,4</sup>  | V <sub>DD</sub> =250V, V <sub>GS</sub> =10V, R <sub>G</sub> =25Ω<br>I <sub>D</sub> =4A | --- | 42   | 84   | ns |
| T <sub>r</sub>      | Rise Time <sup>3,4</sup>           |                                                                                        | --- | 47   | 94   |    |
| T <sub>d(off)</sub> | Turn-Off Delay Time <sup>3,4</sup> |                                                                                        | --- | 95   | 190  |    |
| T <sub>f</sub>      | Fall Time <sup>3,4</sup>           |                                                                                        | --- | 38   | 76   |    |
| C <sub>iss</sub>    | Input Capacitance                  | V <sub>DS</sub> =25V, V <sub>GS</sub> =0V, F=1MHz                                      | --- | 1590 | 3000 | pF |
| C <sub>oss</sub>    | Output Capacitance                 |                                                                                        | --- | 176  | 350  |    |
| C <sub>rss</sub>    | Reverse Transfer Capacitance       |                                                                                        | --- | 24   | 48   |    |
| R <sub>g</sub>      | Gate resistance                    | V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, F=1MHz                                       | --- | 2.2  | 4.4  | Ω  |

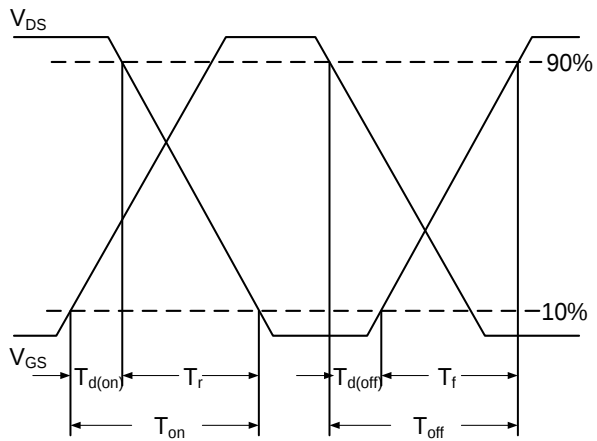
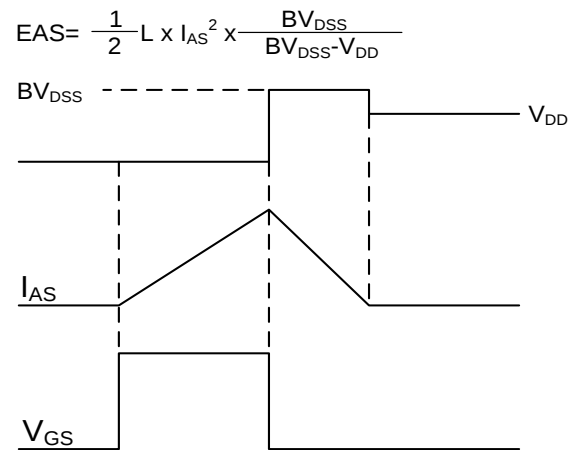
**Drain-Source Diode Characteristics and Maximum Ratings**

| Symbol          | Parameter                 | Conditions                                                    | Min. | Typ. | Max. | Unit |
|-----------------|---------------------------|---------------------------------------------------------------|------|------|------|------|
| I <sub>S</sub>  | Continuous Source Current | V <sub>G</sub> =V <sub>D</sub> =0V, Force Current             | ---  | ---  | 13   | A    |
| I <sub>SM</sub> | Pulsed Source Current     |                                                               | ---  | ---  | 26   | A    |
| V <sub>SD</sub> | Diode Forward Voltage     | V <sub>GS</sub> =0V, I <sub>S</sub> =1A, T <sub>J</sub> =25°C | ---  | ---  | 1    | V    |
| t <sub>rr</sub> | Reverse Recovery Time     | V <sub>GS</sub> =0V, I <sub>S</sub> =13A, di/dt=100A/μs       | ---  | 297  | ---  | ns   |
| Q <sub>rr</sub> | Reverse Recovery Charge   | T <sub>J</sub> =25°C                                          | ---  | 3667 | ---  | nC   |

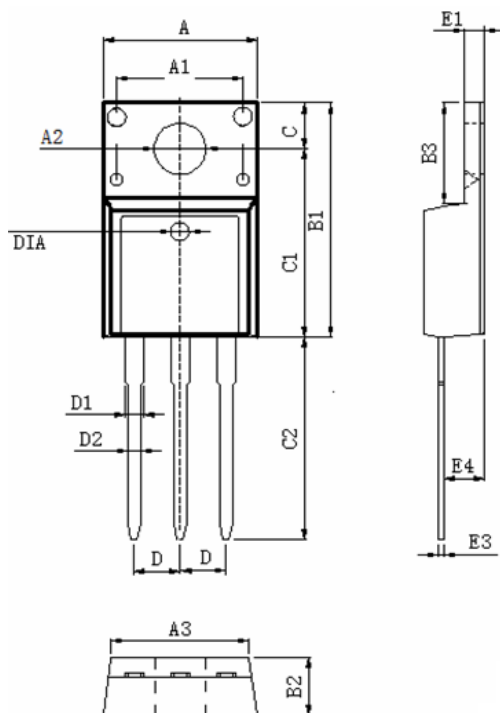
Note :

1. Repetitive Rating : Pulsed width limited by maximum junction temperature.
2. V<sub>DD</sub>=50V, V<sub>GS</sub>=10V, L=10mH, I<sub>AS</sub>=12A, R<sub>G</sub>=25Ω, Starting T<sub>J</sub>=25°C.
3. The data tested by pulsed, pulse width ≤ 300us, duty cycle ≤ 2%.
4. Essentially independent of operating temperature.


**Fig.1 Continuous Drain Current vs.  $T_C$** 

**Fig.2 Normalized  $R_{DS(on)}$  vs.  $T_J$** 

**Fig.3 Normalized  $V_{th}$  vs.  $T_J$** 

**Fig.4 Gate Charge Waveform**

**Fig.5 Normalized Transient Impedance**

**Fig.6 Maximum Safe Operation Area**


**Fig.7 Switching Time Waveform**

**Fig.8 EAS Waveform**

## TO220F PACKAGE INFORMATION



| Symbol | Dimensions In Millimeters |              | Dimensions In Inches |                |
|--------|---------------------------|--------------|----------------------|----------------|
|        | MAX                       | MIN          | MAX                  | MIN            |
| A      | 10.460                    | 9.860        | 0.412                | 0.388          |
| A1     | 7.100                     | 6.900        | 0.280                | 0.272          |
| A2     | 3.500                     | 3.100        | 0.138                | 0.122          |
| A3     | 9.900                     | 9.500        | 0.390                | 0.374          |
| B1     | 16.170                    | 15.570       | 0.637                | 0.613          |
| B2     | 4.900                     | 4.500        | 0.193                | 0.177          |
| B3     | 6.880                     | 6.480        | 0.271                | 0.255          |
| C      | 3.500                     | 3.100        | 0.138                | 0.122          |
| C1     | 12.870                    | 12.270       | 0.507                | 0.483          |
| C2     | 13.380                    | 12.580       | 0.527                | 0.495          |
| D      | 2.590                     | 2.490        | 0.102                | 0.098          |
| D1     | 1.470                     | 1.070        | 0.058                | 0.042          |
| D2     | 0.900                     | 0.700        | 0.035                | 0.028          |
| E1     | 2.740                     | 2.340        | 0.108                | 0.092          |
| E3     | 0.600                     | 0.400        | 0.024                | 0.016          |
| E4     | 2.960                     | 2.560        | 0.117                | 0.101          |
| DIA    | Φ1.5 TYP.                 | deep0.1 TYP. | Φ0.059 TYP.          | deep0.004 TYP. |



500V N-Channel MOSFETs

**PMF13N50M**

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