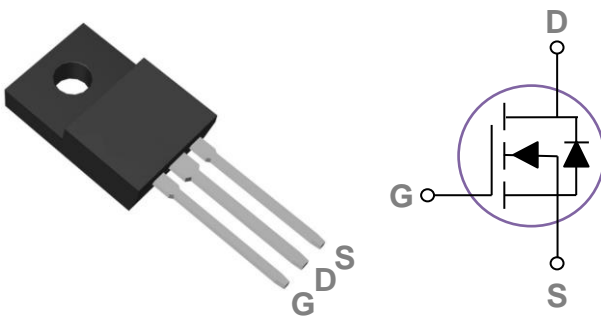


**General Description**

These N-Channel enhancement mode power field effect transistors are using super junction MOS 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 fast switching applications.

**TO220F Pin Configuration**



|       |       |     |
|-------|-------|-----|
| BVDSS | RDSON | ID  |
| 650V  | 320mΩ | 14A |

**Features**

- 650V, 14A,  $R_{DS(ON)} = 320m\Omega @ V_{GS} = 10V$
- Improved dv/dt capability
- Fast switching
- 100% EAS Guaranteed
- Green Device Available

**Applications**

- PFC Power Supply Stages
- Motor Control
- DC-DC Converters
- Adapter

**Absolute Maximum Ratings**  $T_c=25^\circ C$  unless otherwise noted

| Symbol    | Parameter  | Rating     | Units |
|-----------|--|------------|-------|
| $V_{DS}$  | Drain-Source Voltage                             | 650        | V     |
| $V_{GS}$  | Gate-Source Voltage                              | $\pm 30$   | V     |
| $I_D$     | Drain Current – Continuous ( $T_c=25^\circ C$ )  | 14         | A     |
|           | Drain Current – Continuous ( $T_c=100^\circ C$ ) | 8.8        | A     |
| $I_{DM}$  | Drain Current – Pulsed <sup>1</sup>              | 56         | A     |
| EAS       | Single Pulse Avalanche Energy                    | 290        | mJ    |
| $P_D$     | Power Dissipation ( $T_c=25^\circ C$ )           | 38         | W     |
|           | Power Dissipation – Derate above 25°C            | 0.304      | W/°C  |
| $T_{STG}$ | Storage Temperature Range                        | -55 to 150 | °C    |
| $T_J$     | Operating Junction Temperature Range             | -55 to 150 | °C    |

**Thermal Characteristics**

| Symbol          | Parameter                              | Typ. | Max. | Unit |
|-----------------|--|------|------|------|
| $R_{\theta JA}$ | Thermal Resistance Junction to ambient | ---  | 62   | °C/W |
| $R_{\theta JC}$ | Thermal Resistance Junction to Case    | ---  | 3.25 | °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> =1mA                          | 650  | ---  | ---  | V    |
| I <sub>DSS</sub>  | Drain-Source Leakage Current   | V <sub>DS</sub> =650V, V <sub>GS</sub> =0V, T <sub>J</sub> =25°C  | ---  | ---  | 1    | μA   |
|                   |                                | V <sub>DS</sub> =520V, V <sub>GS</sub> =0V, T <sub>J</sub> =125°C | ---  | ---  | 10   | μA   |
| 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                 | --- | 270 | 320 | mΩ |
| V <sub>GS(th)</sub> | Gate Threshold Voltage            | V <sub>GS</sub> =V <sub>DS</sub> , I <sub>D</sub> =250μA | 2   | 3   | 4   | V  |

**Dynamic and switching Characteristics**

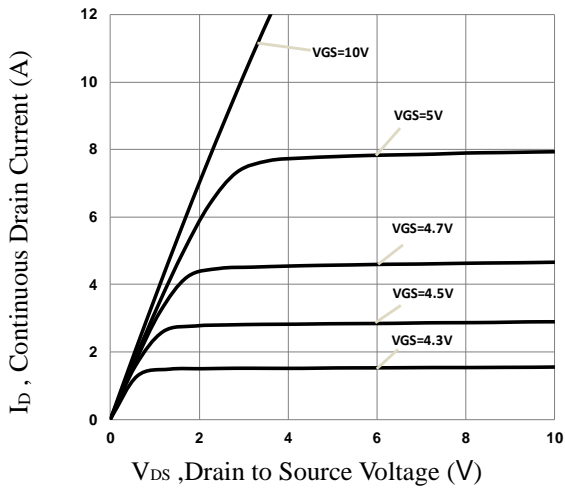
|                     |                                    |  |     |     |      |    |
|---------------------|------------------------------------|--|-----|-----|------|----|
| Q <sub>g</sub>      | Total Gate Charge <sup>2,3</sup>   | V <sub>DS</sub> =480V, V <sub>GS</sub> =10V, I <sub>D</sub> =7A                        | --- | 27  | 40   | nC |
| Q <sub>gs</sub>     | Gate-Source Charge <sup>2,3</sup>  |  | --- | 5.5 | 10   |    |
| Q <sub>gd</sub>     | Gate-Drain Charge <sup>2,3</sup>   |  | --- | 8   | 15   |    |
| T <sub>d(on)</sub>  | Turn-On Delay Time <sup>2,3</sup>  | V <sub>DS</sub> =480V, V <sub>GS</sub> =10V, R <sub>G</sub> =25Ω<br>I <sub>D</sub> =7A | --- | 20  | 30   | ns |
| T <sub>r</sub>      | Rise Time <sup>2,3</sup>           |  | --- | 43  | 65   |    |
| T <sub>d(off)</sub> | Turn-Off Delay Time <sup>2,3</sup> |  | --- | 91  | 140  |    |
| T <sub>f</sub>      | Fall Time <sup>2,3</sup>           |  | --- | 42  | 63   |    |
| C <sub>iss</sub>    | Input Capacitance                  | V <sub>DS</sub> =100V, V <sub>GS</sub> =0V, F=1MHz                                     | --- | 910 | 1360 | pF |
| C <sub>oss</sub>    | Output Capacitance                 |  | --- | 28  | 42   |    |
| C <sub>rss</sub>    | Reverse Transfer Capacitance       |  | --- | 1.1 | 3.9  |    |
| R <sub>g</sub>      | Total Gate Charge <sup>2,3</sup>   | V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, F=1MHz                                       | --- | 7   | ---  | Ω  |

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

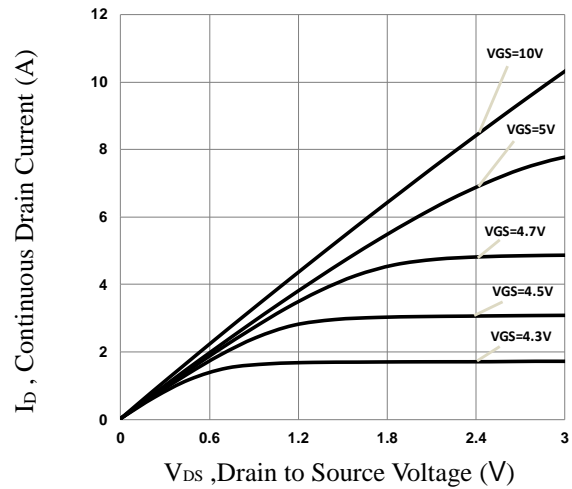
| Symbol          | Parameter                 | Conditions  | Min. | Typ. | Max. | Unit |
|-----------------|---------------------------|---|------|------|------|------|
| I <sub>S</sub>  | Continuous Source Current | V <sub>G</sub> =V <sub>D</sub> =0V, Force Current             | ---  | ---  | 14   | A    |
| I <sub>SM</sub> | Pulsed Source Current     |   | ---  | ---  | 28   | A    |
| V <sub>SD</sub> | Diode Forward Voltage     | V <sub>GS</sub> =0V, I <sub>S</sub> =7A, T <sub>J</sub> =25°C | ---  | ---  | 1.4  | V    |
| t <sub>rr</sub> | Reverse Recovery Time     | V <sub>R</sub> =400V, I <sub>S</sub> =10A                     | ---  | 330  | ---  | ns   |
| Q <sub>rr</sub> | Reverse Recovery Charge   | di/dt=100A/μs, T <sub>J</sub> =25°C                           | ---  | 4.1  | ---  | μC   |

Note :

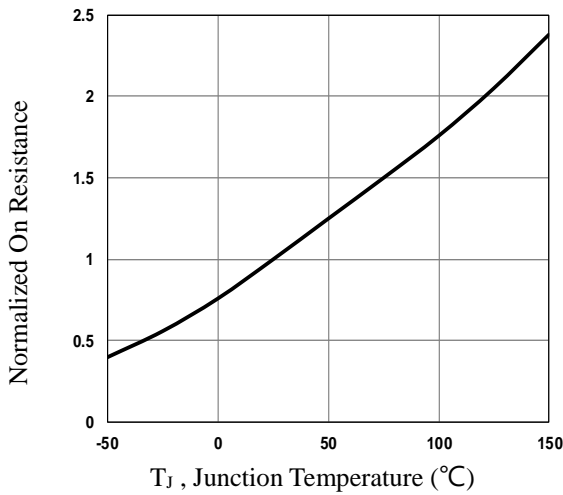
1. Repetitive Rating : Pulsed width limited by maximum junction temperature.
2. The data tested by pulsed , pulse width ≤ 300us , duty cycle ≤ 2%.
3. Essentially independent of operating temperature.



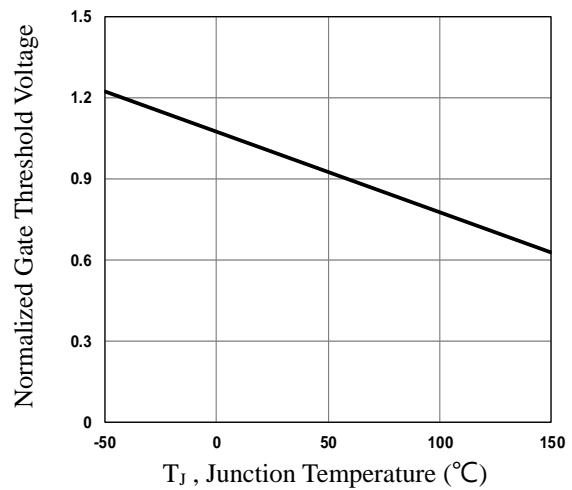
**Fig.1 Typical Output Characteristics**



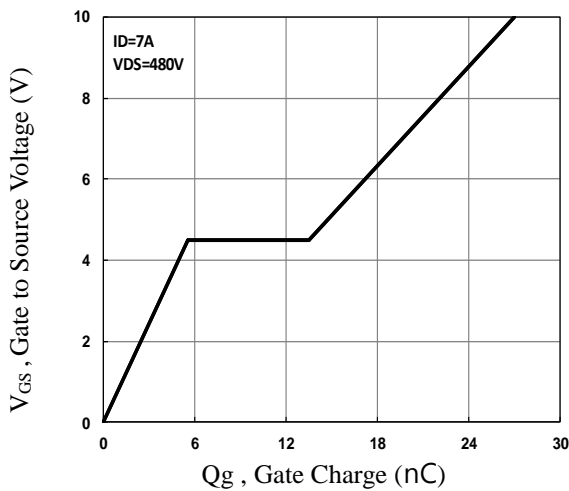
**Fig.2 Typical Output Characteristics**



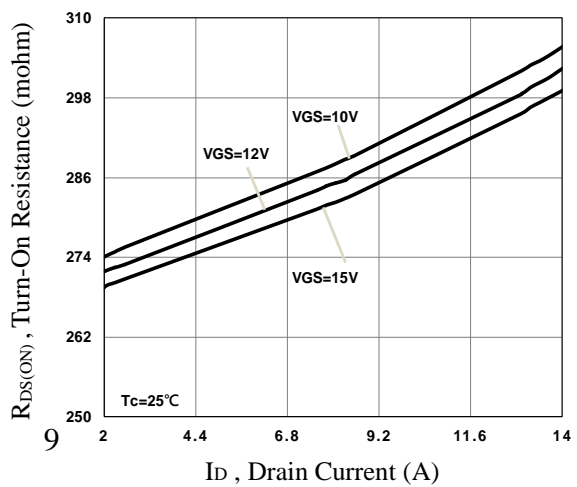
**Fig.3 Normalized  $R_{DS(on)}$  vs.  $T_J$**



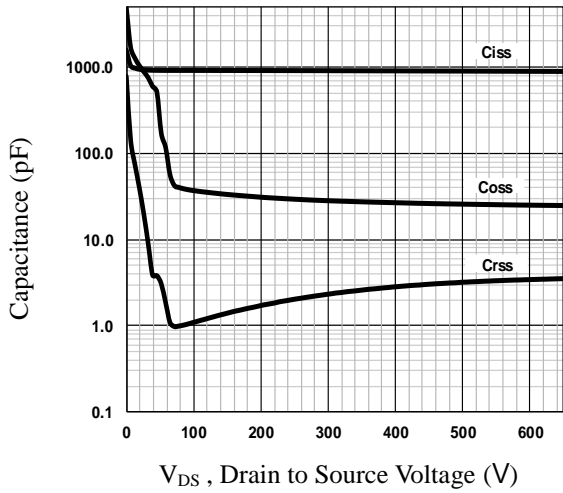
**Fig.4 Normalized  $V_{th}$  vs.  $T_J$**



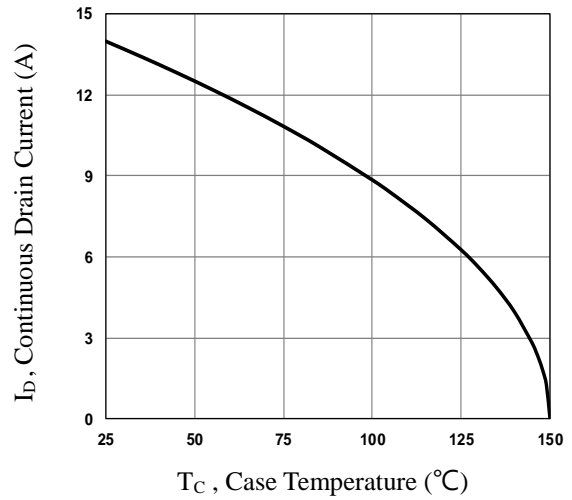
**Fig.5 Gate Charge Characteristics**



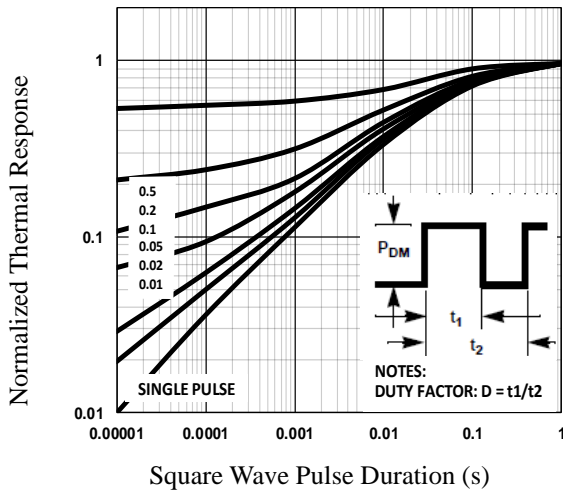
**Fig.6 Turn-On Resistance vs.  $I_D$**



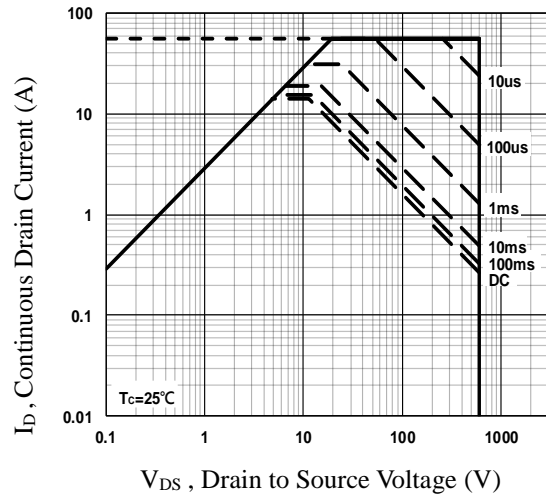
**Fig.7 Capacitance Characteristics**



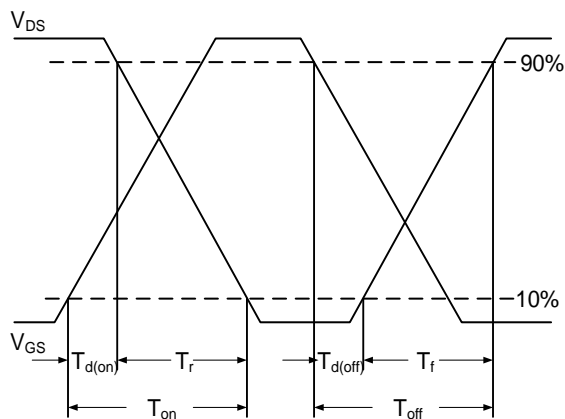
**Fig.8 Continuous Drain Current vs.  $T_c$**



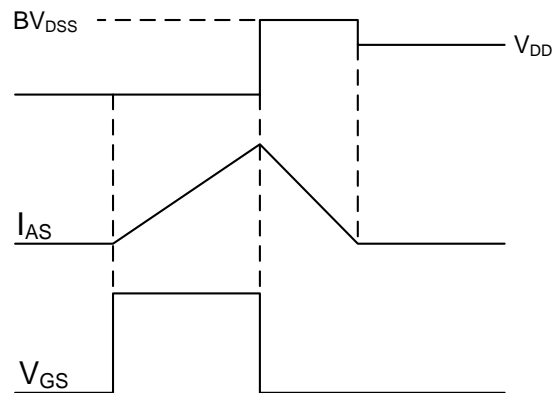
**Fig.9 Normalized Transient Impedance**



**Fig.10 Maximum Safe Operation Area**

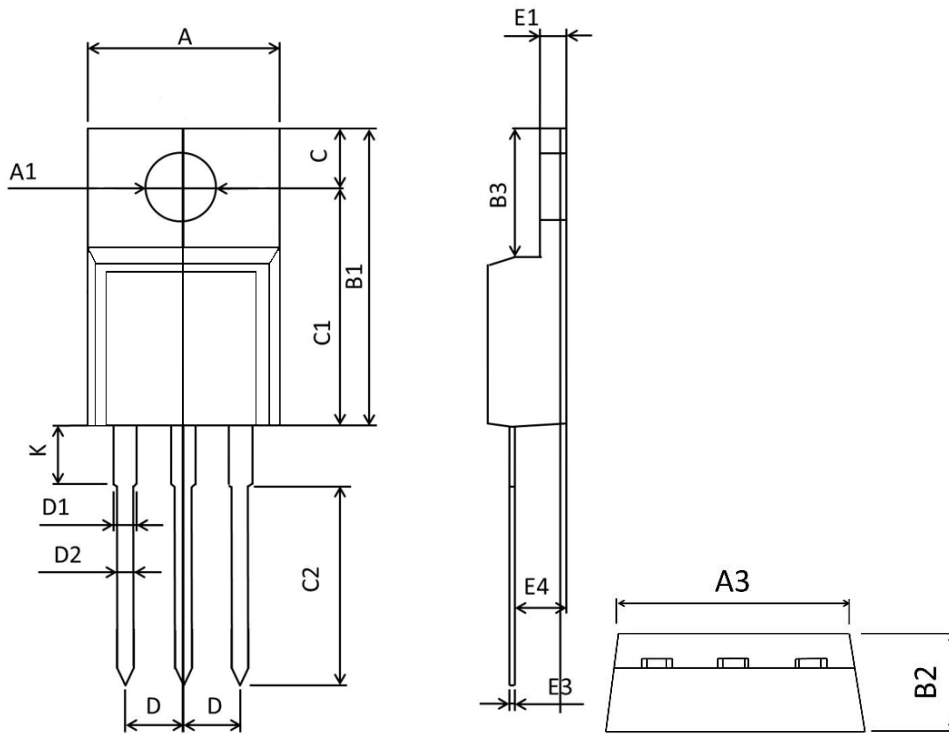


**Fig.11 Switching Time Waveform**



**Fig.12 EAS Waveform**

## TO220F PACKAGE INFORMATION



| Symbol | Dimensions In Millimeters |        | Dimensions In Inches |       |
|--------|---------------------------|--------|----------------------|-------|
|        | Min                       | Max    | Min                  | Max   |
| A      | 9.860                     | 10.460 | 0.389                | 0.411 |
| A1     | 3.100                     | 3.500  | 0.122                | 0.138 |
| B1     | 15.450                    | 16.300 | 0.608                | 0.642 |
| B2     | 4.400                     | 5.000  | 0.173                | 0.197 |
| B3     | 6.280                     | 7.100  | 0.247                | 0.280 |
| C      | 3.100                     | 3.500  | 0.122                | 0.138 |
| C1     | 12.270                    | 12.870 | 0.483                | 0.507 |
| C2     | 9.600                     | 10.520 | 0.378                | 0.414 |
| D      | 2.540BSC                  |        | 0.1BSC               |       |
| D1     | 1.070                     | 1.470  | 0.042                | 0.058 |
| D2     | 0.600                     | 1.000  | 0.024                | 0.039 |
| K      | 2.800                     | 3.500  | 0.110                | 0.138 |
| E1     | 2.340                     | 2.740  | 0.092                | 0.108 |
| E3     | 0.350                     | 0.650  | 0.014                | 0.026 |
| E4     | 2.460                     | 2.960  | 0.097                | 0.117 |