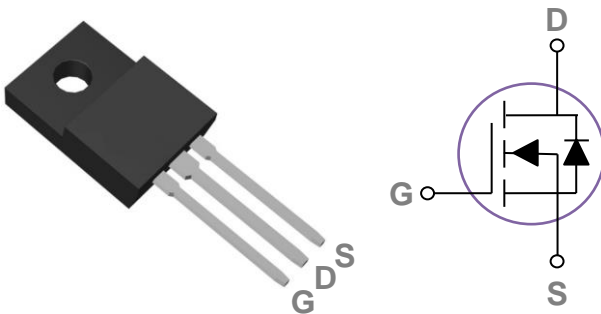


### General Description

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	900mΩ	5A

### Features

- 650V,5A,  $R_{DS(ON)} = 900m\Omega @ V_{GS} = 10V$
- 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 ( $T_c=25^\circ C$ )	5	A
	Drain Current – Continuous ( $T_c=100^\circ C$ )	3.2	A
$I_{DM}$	Drain Current – Pulsed <sup>1</sup>	20	A
EAS	Single Pulse Avalanche Energy	46	mJ
$P_D$	Power Dissipation ( $T_c=25^\circ C$ )	22	W
	Power Dissipation – Derate above $25^\circ C$	0.176	W/ $^\circ C$
$T_{STG}$	Storage Temperature Range	-55 to 150	$^\circ C$
$T_J$	Operating Junction Temperature Range	-55 to 150	$^\circ C$

### Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Unit
$R_{\theta JA}$	Thermal Resistance Junction to ambient	---	62	$^\circ C/W$
$R_{\theta JC}$	Thermal Resistance Junction to Case	---	5.7	$^\circ C/W$

**Electrical Characteristics ( $T_J=25\text{ }^\circ\text{C}$ , unless otherwise noted)**
**Off Characteristics**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$BV_{DSS}$	Drain-Source Breakdown Voltage	$V_{GS}=0V, I_D=1mA$	650	---	---	V
$I_{DSS}$	Drain-Source Leakage Current	$V_{DS}=650V, V_{GS}=0V, T_J=25^\circ\text{C}$	---	---	1	$\mu\text{A}$
		$V_{DS}=520V, V_{GS}=0V, T_J=125^\circ\text{C}$	---	---	10	$\mu\text{A}$
$I_{GSS}$	Gate-Source Leakage Current	$V_{GS}=\pm 30V, V_{DS}=0V$	---	---	$\pm 100$	nA

**On Characteristics**

$R_{DS(ON)}$	Static Drain-Source On-Resistance	$V_{GS}=10V, I_D=1.5A$	---	760	900	$\text{m}\Omega$
$V_{GS(th)}$	Gate Threshold Voltage	$V_{GS}=V_{DS}, I_D=250\mu\text{A}$	2	3	4	V

**Dynamic and switching Characteristics**

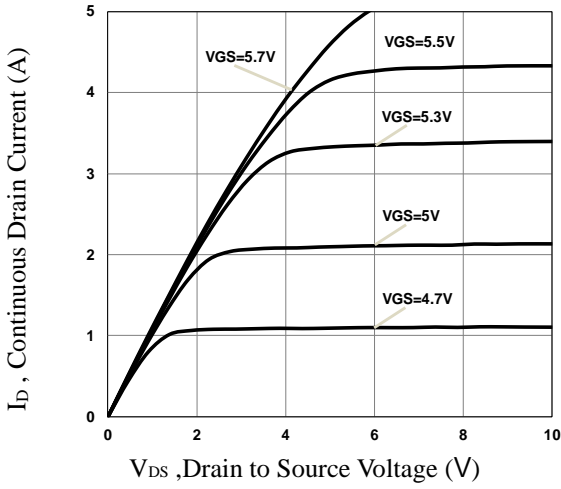
$Q_g$	Total Gate Charge <sup>2,3</sup>	$V_{DS}=480V, V_{GS}=10V, I_D=3A$	---	11	17	nC
$Q_{gs}$	Gate-Source Charge <sup>2,3</sup>		---	1.4	5	
$Q_{gd}$	Gate-Drain Charge <sup>2,3</sup>		---	4.8	8	
$T_{d(on)}$	Turn-On Delay Time <sup>2,3</sup>	$V_{DS}=480V, V_{GS}=10V, R_G=25\Omega$ $I_D=3A$	---	14	21	ns
$T_r$	Rise Time <sup>2,3</sup>		---	25	40	
$T_{d(off)}$	Turn-Off Delay Time <sup>2,3</sup>		---	45	70	
$T_f$	Fall Time <sup>2,3</sup>		---	20	30	
$C_{iss}$	Input Capacitance	$V_{DS}=100V, V_{GS}=0V, F=1\text{MHz}$	---	335	505	pF
$C_{oss}$	Output Capacitance		---	17	26	
$C_{rss}$	Reverse Transfer Capacitance		---	1	4	

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

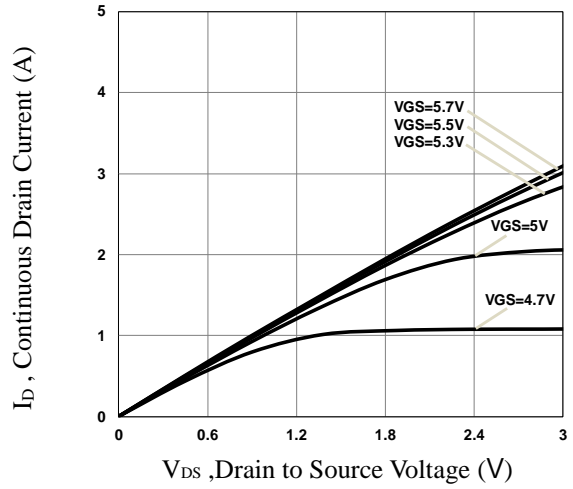
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$I_S$	Continuous Source Current	$V_G=V_D=0V, \text{Force Current}$	---	---	5	A
$I_{SM}$	Pulsed Source Current		---	---	10	A
$V_{SD}$	Diode Forward Voltage	$V_{GS}=0V, I_S=3A, T_J=25^\circ\text{C}$	---	---	1.4	V
$t_{rr}$	Reverse Recovery Time	$V_R=400V, I_S=3A$	---	240	---	ns
$Q_{rr}$	Reverse Recovery Charge	$di/dt=100A/\mu\text{s}, T_J=25^\circ\text{C}$	---	1.9	---	$\mu\text{C}$

Note :

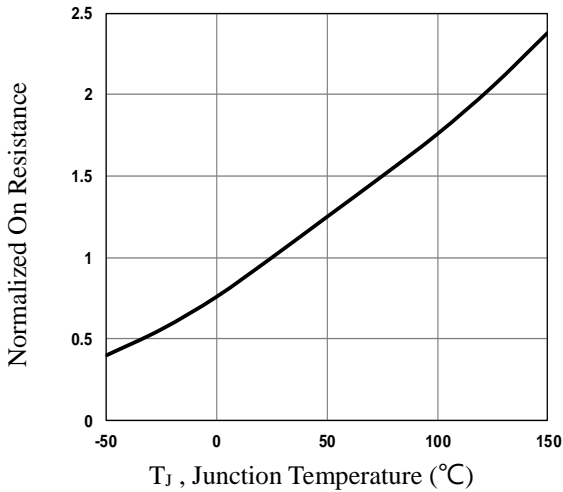
1. Repetitive Rating : Pulsed width limited by maximum junction temperature.
2. The data tested by pulsed , pulse width  $\leq 300\mu\text{s}$  , duty cycle  $\leq 2\%$ .
3. Essentially independent of operating temperature.



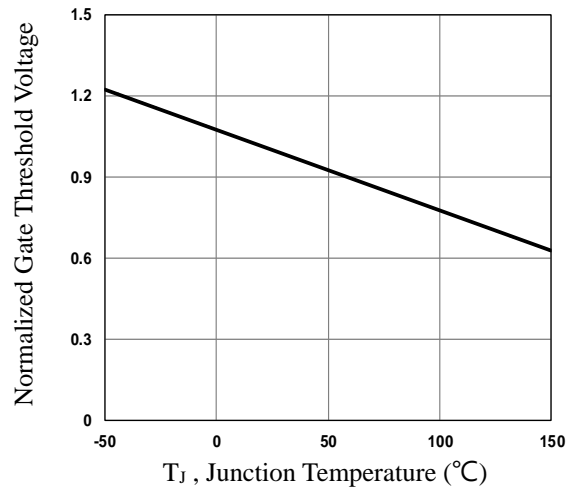
**Fig.1 Typical Output Characteristics**



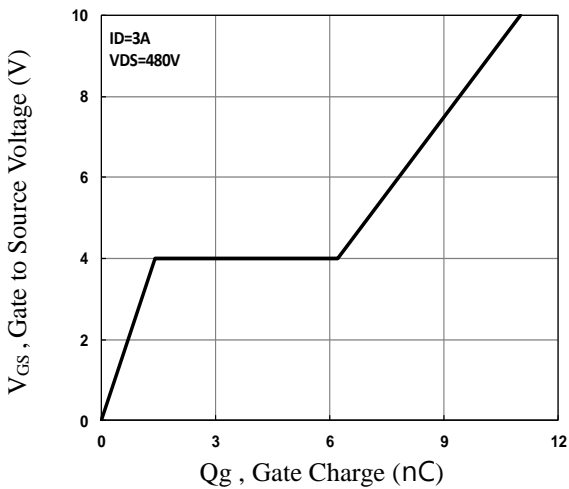
**Fig.2 Typical Output Characteristics**



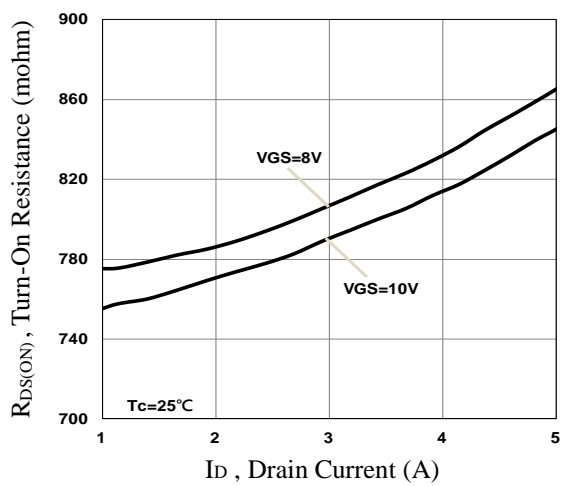
**Fig.3 Normalized  $R_{DS(on)}$  vs.  $T_J$**



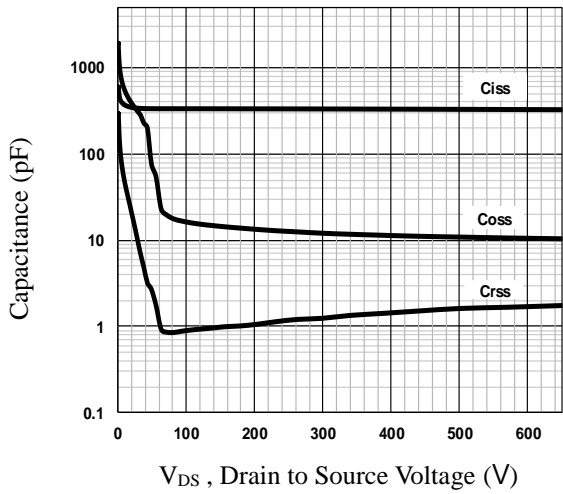
**Fig.4 Normalized  $V_{th}$  vs.  $T_J$**



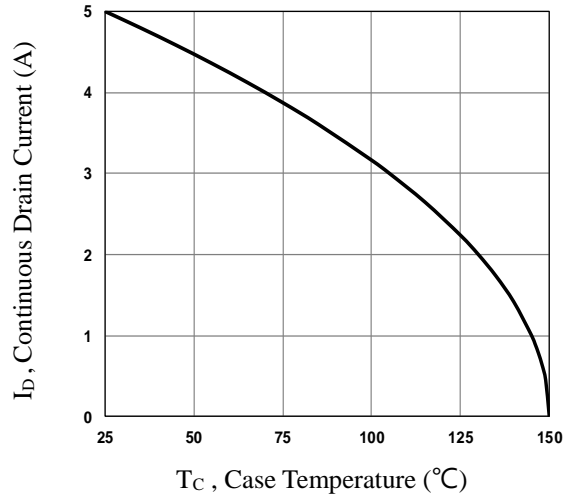
**Fig.5 Gate Charge Characteristics**



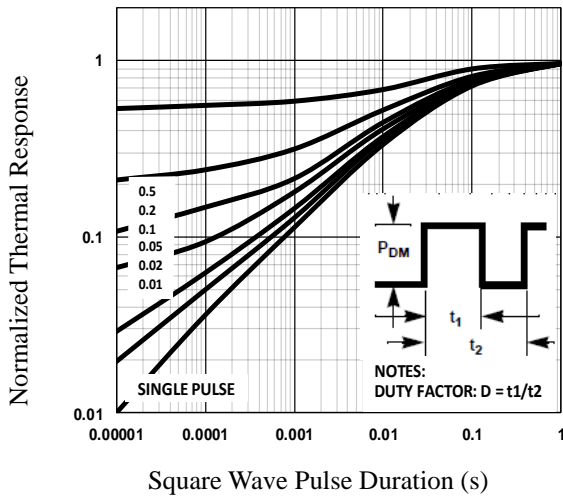
**Fig.6 Turn-On Resistance vs.  $I_D$**



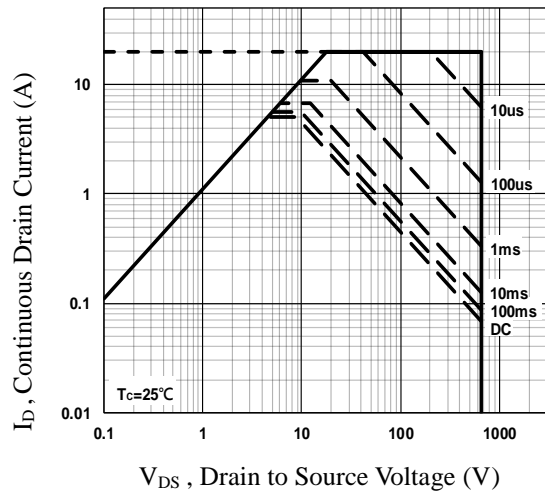
**Fig.7 Capacitance Characteristics**



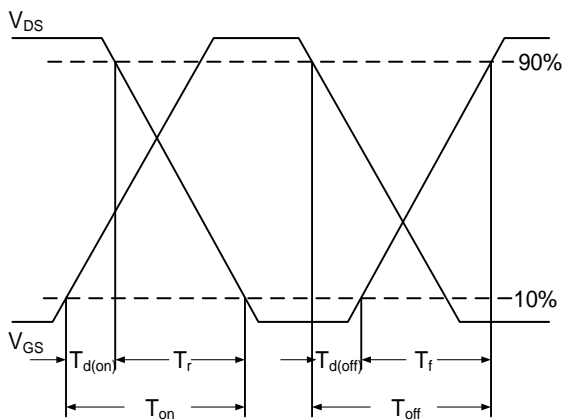
**Fig.8 Continuous Drain Current vs. T<sub>c</sub>**



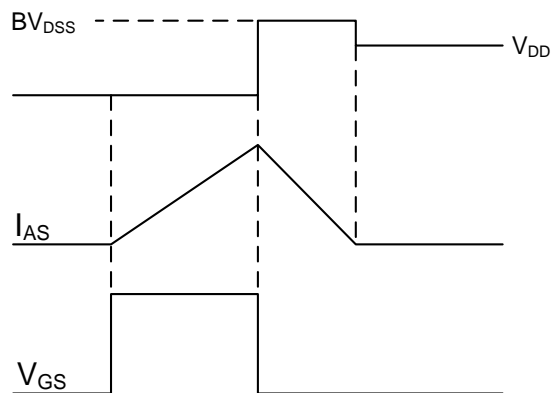
**Fig.9 Normalized Transient Impedance**



**Fig.10 Maximum Safe Operation Area**

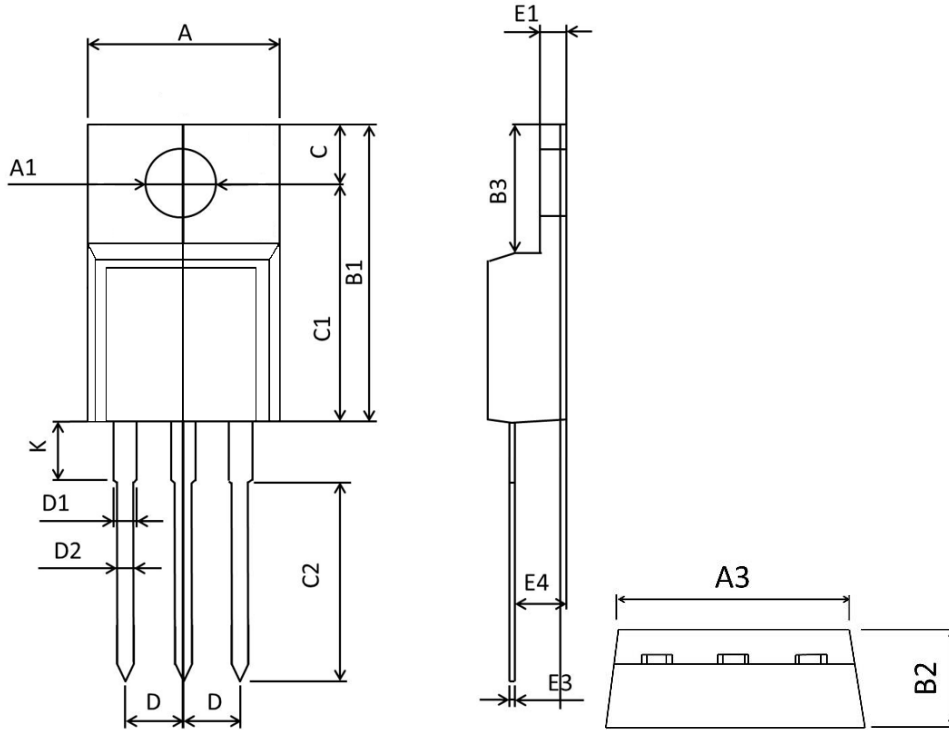


**Fig.11 Switching Time Waveform**



**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