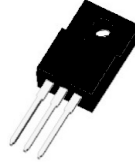


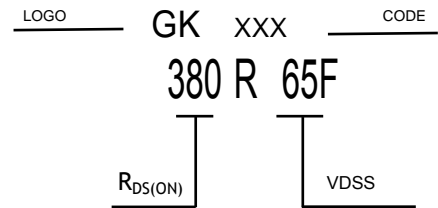
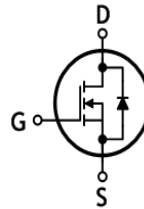
## FEATURES

- Drain-Source voltage:  $V_{DS}=650V$  (@ $T_J=150^\circ C$ )
- Low drain-source On resistance:  $R_{DS(on)}=0.38\Omega$  (Max.)
- Ultra low gate charge:  $Q_g=20nC$  (Typ.)
- RoHS compliant device
- 100% avalanche tested

$V_{DSS}$  650 V  
 $I_D$  11 A  
 $R_{DS(ON)}$  0.38  $\Omega$



TO-220F



## MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

**Absolute maximum ratings** ( $T_c=25^\circ C$  unless otherwise noted)

Characteristic	Symbol	Rating	Unit	
Drain-source voltage	$V_{DSS}$	650	V	
Gate-source voltage	$V_{GSS}$	$\pm 30$	V	
Drain current (DC) (Note 1)	$I_D$	$T_c=25^\circ C$	11	A
		$T_c=100^\circ C$	7	A
Drain current (Pulsed) (Note 1)	$I_{DM}$	44	A	
Single pulsed avalanche energy (Note 2)	$E_{AS}$	135	mJ	
Repetitive avalanche current (Note 1)	$I_{AR}$	5	A	
Repetitive avalanche energy (Note 1)	$E_{AR}$	63.2	mJ	
Power dissipation	$P_D$	32	W	
Diode dv/dt ruggedness (Note 3)	dv/dt	15	V/ns	
MOSFET dv/dt ruggedness (Note 4)	dv/dt	50	V/ns	
Junction temperature	$T_J$	150	$^\circ C$	
Storage temperature range	$T_{stg}$	-55~150	$^\circ C$	

### Thermal Characteristics

Characteristic	Symbol	Rating	Unit
Thermal resistance, junction to case	$R_{th(j-c)}$	Max. 3.9	$^\circ C/W$
Thermal resistance, junction to ambient	$R_{th(j-a)}$	Max. 62.5	

## Electrical Characteristics (T<sub>C</sub>=25°C unless otherwise specified)

Characteristic	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Drain-source breakdown voltage	BV <sub>DSS</sub>	I <sub>D</sub> =250uA, V <sub>GS</sub> =0	650	-	-	V
Gate threshold voltage	V <sub>GS(th)</sub>	I <sub>D</sub> =250uA, V <sub>DS</sub> =V <sub>GS</sub>	2	3	4	V
Drain-source cut-off current	I <sub>DSS</sub>	V <sub>DS</sub> =650V, V <sub>GS</sub> =0V	-	-	1	uA
		V <sub>DS</sub> =650V, T <sub>J</sub> =125°C	-	-	100	uA
Gate leakage current	I <sub>GSS</sub>	V <sub>DS</sub> =0V, V <sub>GS</sub> =±30V	-	-	±100	nA
Drain-source on-resistance	R <sub>DS(ON)</sub>	V <sub>GS</sub> =10V, I <sub>D</sub> =5.5A	-	0.31	0.38	Ω
Internal gate resistance	R <sub>g</sub>	f=1MHz, Open drain	-	21	28	Ω
Input capacitance	C <sub>iss</sub>	V <sub>DS</sub> =25V, V <sub>GS</sub> =0V, f=1MHz	629	787	945	pF
Output capacitance	C <sub>oss</sub>		344	431	518	
Reverse transfer capacitance	C <sub>rss</sub>		19	24	29	
Turn-on delay time (Note 3)	t <sub>d(on)</sub>	V <sub>DS</sub> =350V, I <sub>D</sub> =11A, R <sub>G</sub> =25Ω	-	17	25	ns
Rise time (Note 3)	t <sub>r</sub>		-	14	24	
Turn-off delay time (Note 3)	t <sub>d(off)</sub>		-	40	55	
Fall time (Note 3)	t <sub>f</sub>		-	5	8	
Total gate charge (Note 4)	Q <sub>g</sub>	V <sub>DS</sub> =400V, V <sub>GS</sub> =10V, I <sub>D</sub> =7A	-	20	25	nC
Gate-source charge (Note 4)	Q <sub>gs</sub>		-	6.5	10	
Gate-drain charge (Note 4)	Q <sub>gd</sub>		-	5	10	

## Source-Drain Diode Ratings and Characteristics (T<sub>C</sub>=25°C unless otherwise noted)

Characteristic	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Source current (DC)	I <sub>S</sub>	Integral reverse diode in the MOSFET	-	-	11	A
Source current (Pulsed)	I <sub>SM</sub>		-	-	44	A
Forward voltage	V <sub>SD</sub>	V <sub>GS</sub> =0V, I <sub>S</sub> =11A	-	-	1.2	V
Reverse recovery time (Note 3,4)	t <sub>rr</sub>	I <sub>S</sub> =11A, V <sub>GS</sub> =0V, dI <sub>S</sub> /dt=100A/us	-	326	450	ns
Reverse recovery charge (Note 3,4)	Q <sub>rr</sub>		-	2.8	4.5	uC

Note:

1. Calculated continuous current based on maximum allowable junction temperature
2. L=10mH, I<sub>AS</sub>=5A, V<sub>DD</sub>=50V, Starting T<sub>J</sub>=25°C
3. Guaranteed by design, not subject to production testing
4. Pulse test: Pulse width≤300us, Duty cycle≤2%

RATING AND CHARACTERISTIC CURVES

Fig. 1 Typical Output Characteristics

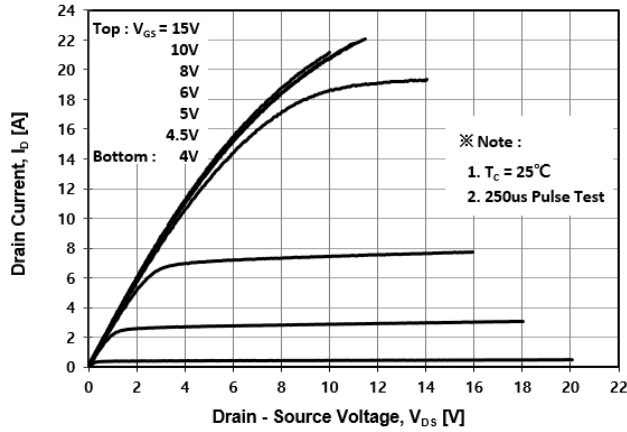


Fig. 2 Typical Transfer Characteristics

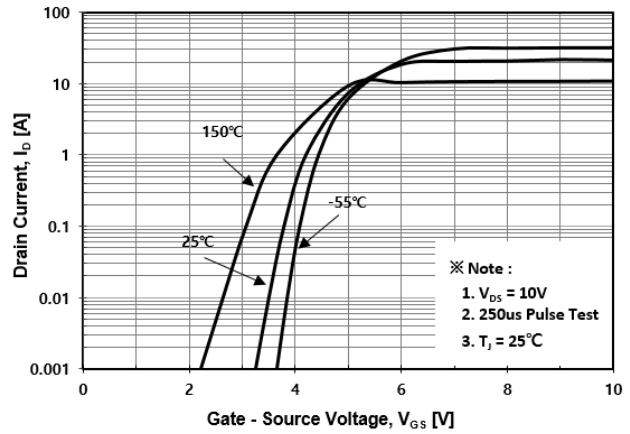


Fig.3 On-Resistance Variation with Drain Current and Gate Voltage

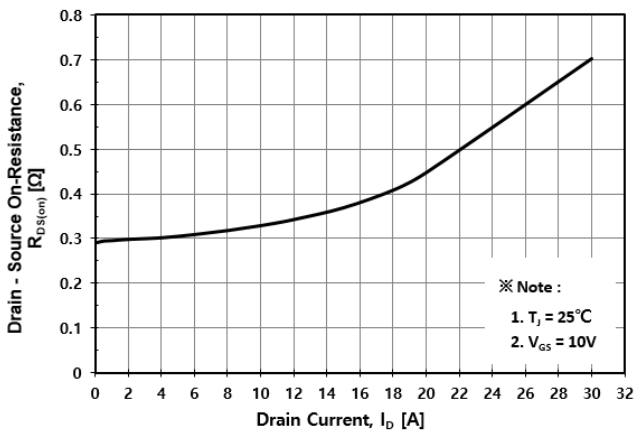


Fig. 4 Body Diode Forward Voltage Variation with Source Current

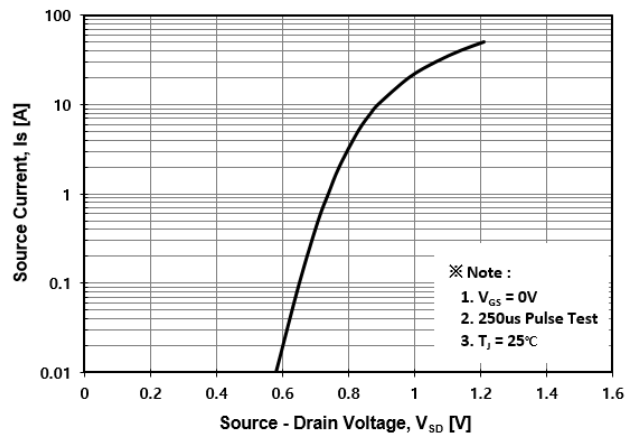


Fig. 5 Typical Capacitance Characteristics

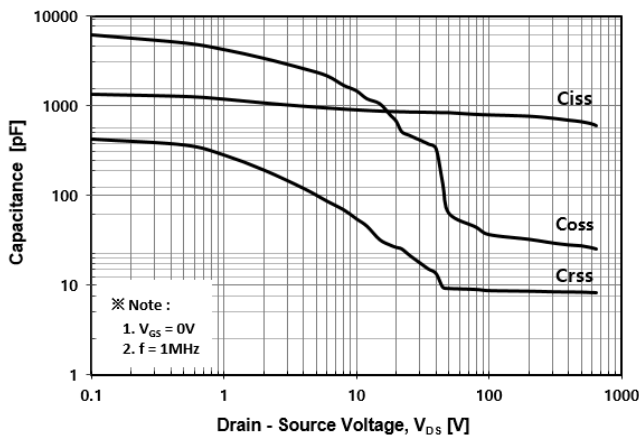
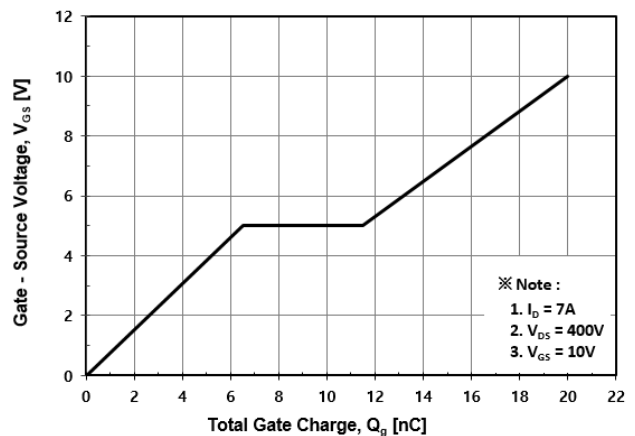
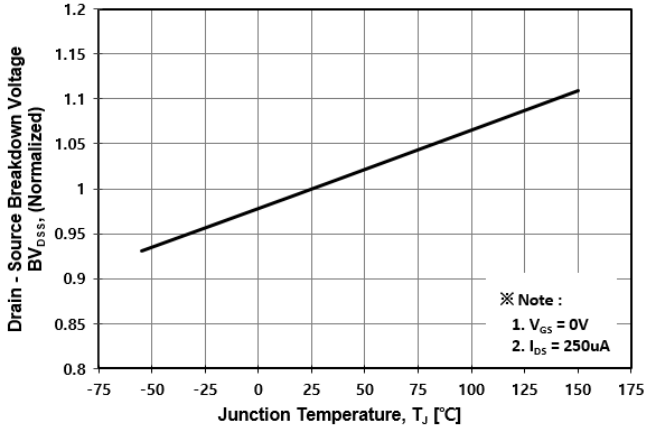


Fig. 6 Typical Total Gate Charge Characteristics

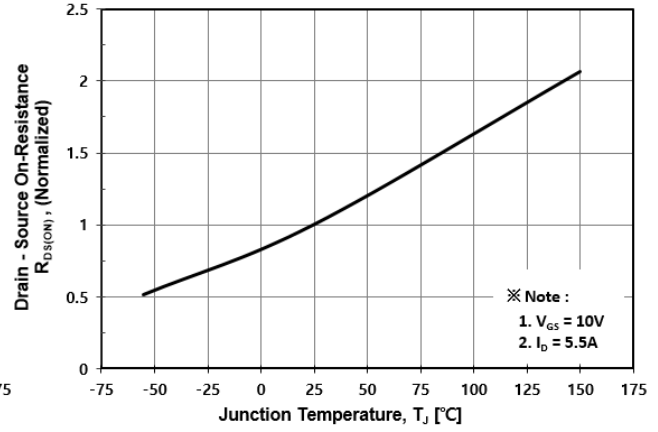


**RATING AND CHARACTERISTIC CURVES**

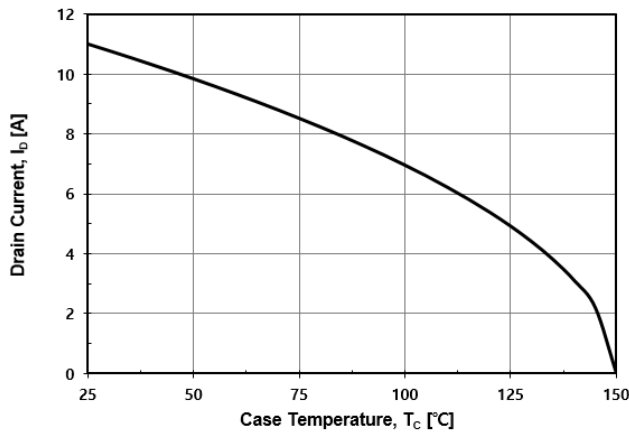
**Fig. 7 Breakdown Voltage Variation vs. Temperature**



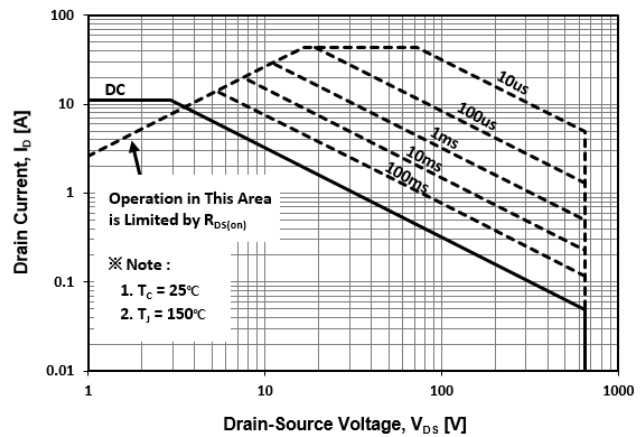
**Fig. 8 On-Resistance Variation vs. Temperature**



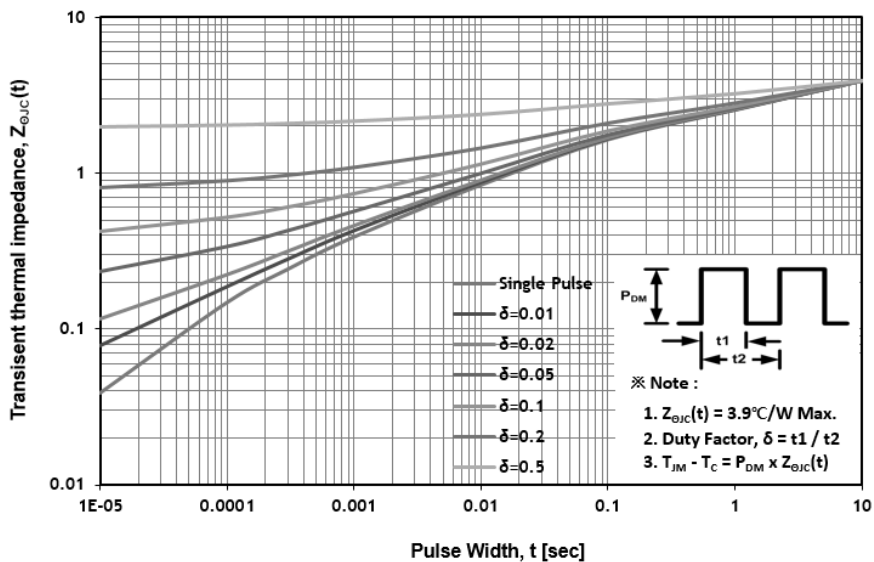
**Fig. 9 Maximum Drain Current vs. Case Temperature**



**Fig. 10 Maximum Safe Operating Area**



**Fig. 11 Transient Thermal Impedance**



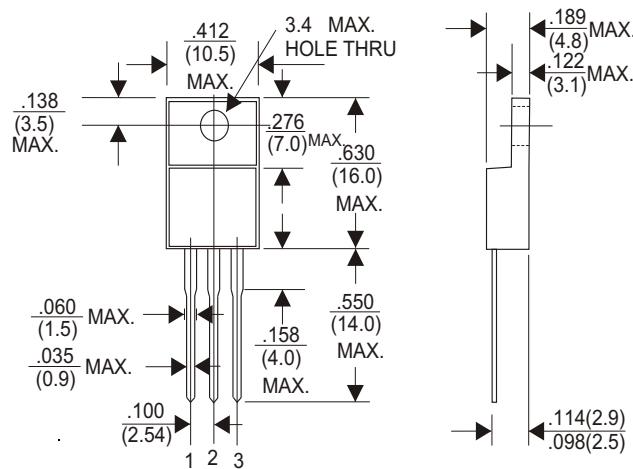
Soldering parameters

Reflow Condition		Pb-Free assembly (see as below)
Pre Heat	-Temperature Min ( $T_{s(min)}$ )	+150 °C
	-Temperature Max( $T_{s(max)}$ )	+200 °C
	-Time (Min to Max) (ts)	60-180 secs.
Average ramp up rate (Liquid us Temp ( $T_L$ ) to peak)		3 °C/sec. Max
$T_{s(max)}$ to $T_L$ - Ramp-up Rate		3 °C/sec. Max
Reflow	-Temperature( $T_L$ )(Liquid us)	+217 °C
	-Temperature( $t_L$ )	60-150 secs.
Peak Temp ( $T_P$ )		+260(+0/-5) °C
Time within 5 °C of actual Peak Temp ( $t_p$ )		30 secs. Max
Ramp-down Rate		6 °C/sec. Max
Time 25 °C to Peak Temp ( $T_P$ )		8 min. Max
Do not exceed		+260 °C



Package Dimensions & Suggested Pad Layout

TO-220F (FULLY INSULATED)



Dimensions in inches and (millimeters)