

## 600V, 15A, Trench FS II Fast IGBT

### General Description

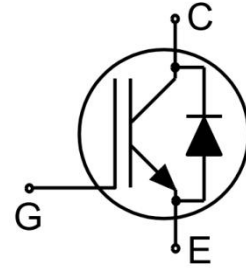
Using NCE's proprietary trench design and advanced FS (Field Stop) second generation technology, the 600V Trench FSII IGBT offers superior conduction and switching performances, and easy parallel operation;

### Features

- Trench FSII Technology offering
- Very low  $V_{CE(sat)}$
- High speed switching
- Positive temperature coefficient in  $V_{CE(sat)}$
- Very tight parameter distribution
- High ruggedness, temperature stable behavior

### Application

- Air Condition
- Inverters
- Motor drives



Schematic diagram

### Package Marking and Ordering Information

Device	Device Package	Device Marking
NCE15TD60BF	TO-220F	NCE15TD60BF



TO-220F

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

Symbol	Parameter	Value	Units
$V_{CES}$	Collector-Emitter Voltage	600	V
$V_{GES}$	Gate- Emitter Voltage	$\pm 30$	V
$I_C$	Collector Current	30	A
	Collector Current @ $T_C = 100^\circ\text{C}$	15	A
$I_{Cpuls}$	Pulsed Collector Current, $t_p$ limited by $T_{jmax}$	45	A
-	turn off safe operating area, $V_{CE}=600\text{V}$ , $T_J=175^\circ\text{C}$	45	A
$I_F$	Diode Continuous Forward Current @ $T_C = 100^\circ\text{C}$	15	A
$I_{FM}$	Diode Maximum Forward Current	45	A
$P_D$	Power Dissipation @ $T_C = 25^\circ\text{C}$	40	W
	Power Dissipation @ $T_C = 100^\circ\text{C}$	20	W
$T_J, T_{stg}$	Operating Junction and Storage Temperature Range	-55 to +175	$^\circ\text{C}$
$T_L$	Maximum Temperature for Soldering	260	$^\circ\text{C}$
$t_{sc}$	Short circuit withstand time $V_{GE}=15.0\text{V}$ , $V_{CC}\leq 400\text{V}$ , Allowed number of short circuits<1000Time between short circuits: $\geq 1.0\text{s}$ , $T_J\leq 150^\circ\text{C}$	5	us

**Thermal Characteristic**

Symbol	Parameter	Value	Units
$R_{\theta JC}$	Thermal Resistance, Junction to case for IGBT	3.75	$^{\circ}\text{C/W}$
$R_{\theta JC}$	Thermal Resistance, Junction to case for Diode	3.37	$^{\circ}\text{C/W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	78	$^{\circ}\text{C/W}$

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

Symbol	Parameter	Conditions	Rating			Units
			Min.	Typ.	Max.	
<b>Static Characteristics</b>						
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	$V_{GE}=0V, I_{CE}=1mA$	600	--	--	V
$I_{CES}$	Collector-Emitter Leakage Current	$V_{GE}=0V, V_{CE}=600V$	--	--	5	$\mu\text{A}$
$I_{GES(F)}$	Gate to Emitter Forward Leakage	$V_{GE}=+30V, V_{CE}=0V$	--	--	200	nA
$I_{GES(R)}$	Gate to Emitter Reverse Leakage	$V_{GE}=-30V, V_{CE}=0V$	--	--	200	nA
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C=15A, T_J=25^{\circ}\text{C}$	--	1.7	1.9	V
		$V_{GE}=15V, T_J=175^{\circ}\text{C}$	--	1.9	--	V
$V_{GE(th)}$	Gate Threshold Voltage	$I_C=1mA, V_{CE}=V_{GE}$	4.0	--	6.0	V
<b>Dynamic Characteristics</b>						
$C_{ies}$	Input Capacitance	$V_{CE}=25V, V_{GE}=0V, f=1\text{MHz}$	--	1635	--	pF
$C_{oes}$	Output Capacitance		--	50	--	
$C_{res}$	Reverse Transfer Capacitance		--	30	--	
$Q_g$	Total Gate Charge	$V_{CC}=480V, I_C=15A, V_{GE}=15V$	--	63	--	nC
$Q_{ge}$	Gate to Emitter Charge		--	15	--	
$Q_{gc}$	Gate to Collector Charge		--	26	--	
$I_{C(SC)}$	Short circuit collector current Max.1000 short circuits Time between short circuits: $\geq 1.0s$	$V_{GE}=15V, V_{CC}\leq 400V, t_{sc}\leq 5\mu s, T_J\leq 150^{\circ}\text{C}$	--	82	--	A
<b>Switching Characteristics</b>						
$t_{d(ON)}$	Turn-on Delay Time	$V_{CC}=400V, I_C=15A, V_{GE}=0/15V, R_g=5\Omega$ Inductive Load	--	16	--	ns
$t_r$	Rise Time		--	12	--	
$t_{d(OFF)}$	Turn-Off Delay Time		--	124	--	
$t_f$	Fall Time		--	12	--	
$E_{on}$	Turn-On Switching Loss		--	0.25	--	mJ
$E_{off}$	Turn-Off Switching Loss		--	0.12	--	
$E_{ts}$	Total Switching Loss		--	0.37	--	

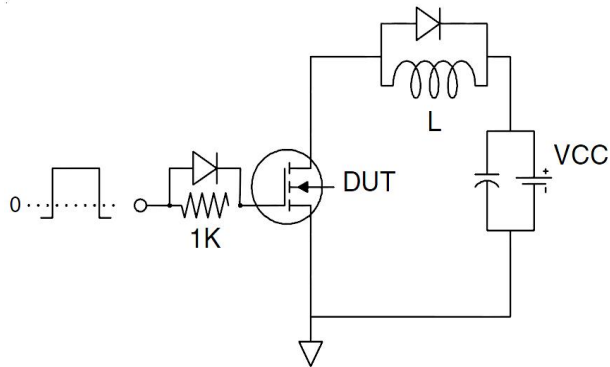
**Electrical Characteristics of the Diode ( $T_c=25^{\circ}\text{C}$  unless otherwise specified)**

Symbol	Parameter	Conditions	Rating			Units
			Min.	Typ.	Max.	
$V_{FM}$	Diode Forward Voltage	$I_F=15A$	--	1.75	2.40	V
$T_{rr}$	Reverse Recovery Time	$I_F=15A, di/dt=200A/\mu s$	--	170	--	ns
$I_{RRM}$	Diode Peak Reverse Recovery Current		--	6.5	--	A
$Q_{rr}$	Reverse Recovery Charge		--	0.6	--	$\mu\text{C}$

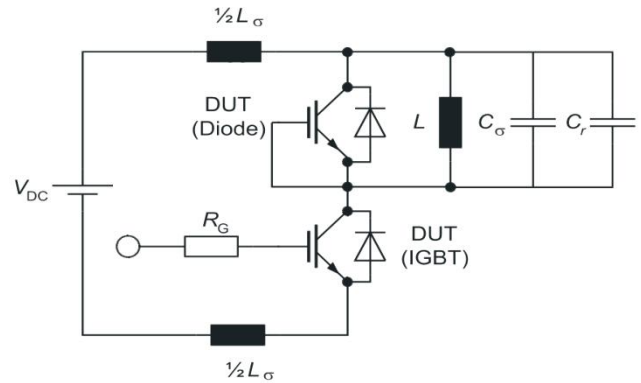
Pulse width  $t_p\leq 380\mu s, \delta\leq 2\%$

### Test Circuit

#### 1) Gate Charge Test Circuit

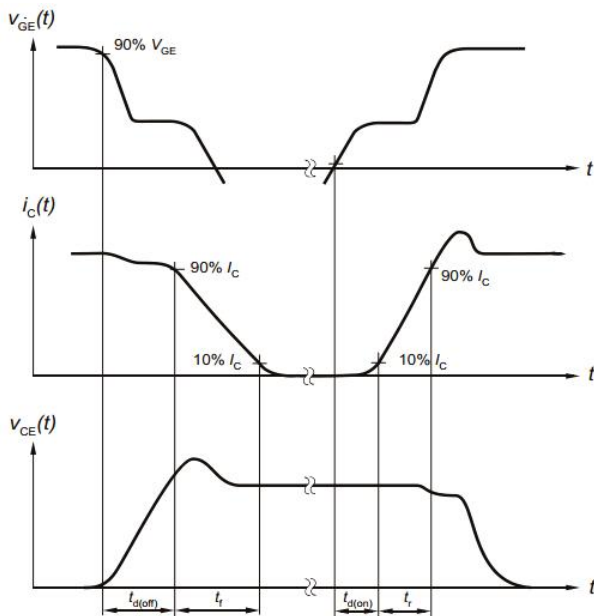


#### 2) Switch Time Test Circuit

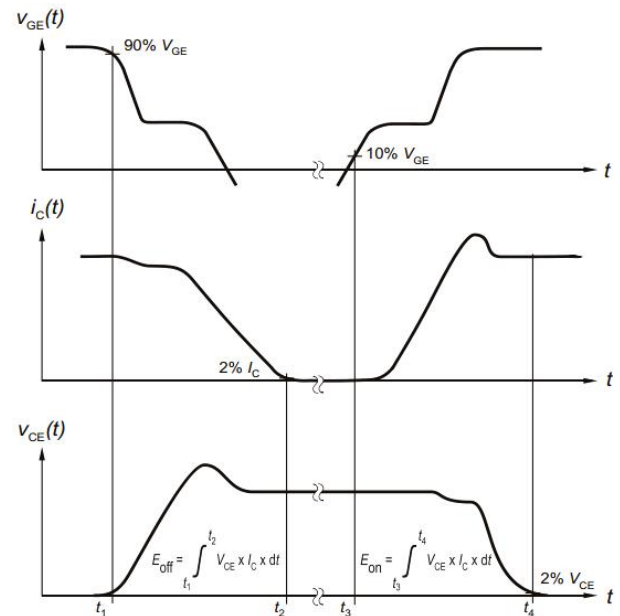


### Switching characteristics

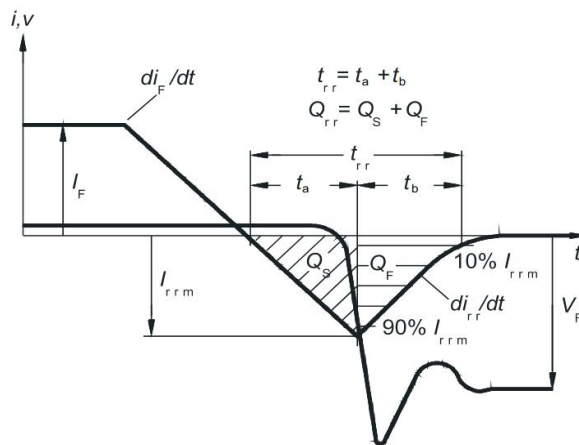
#### 1) Definition of switching times



#### 2) Definition of switching losses

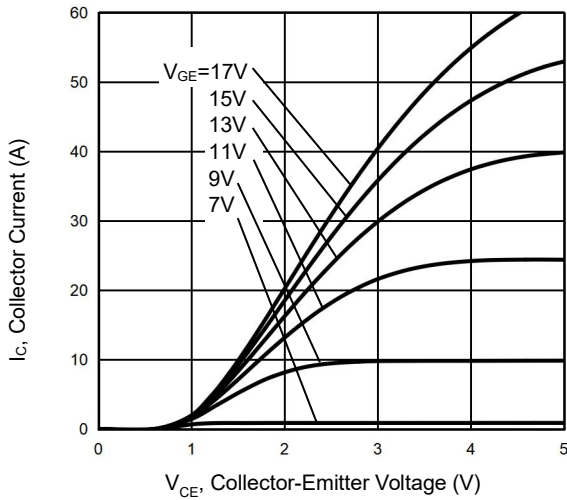


#### 3) Definition of diode switching characteristics

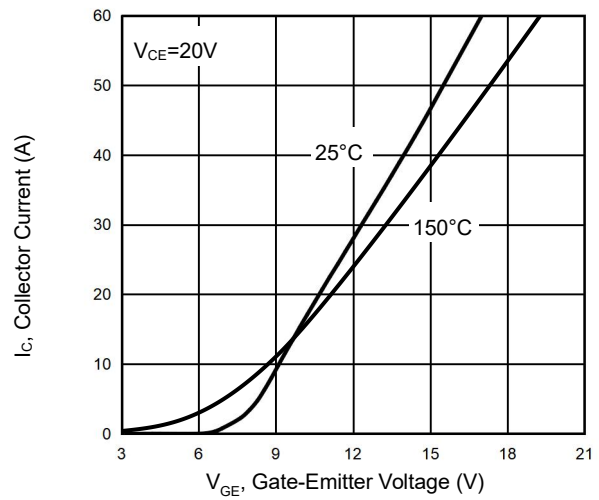


## Typical Electrical and Thermal Characteristics

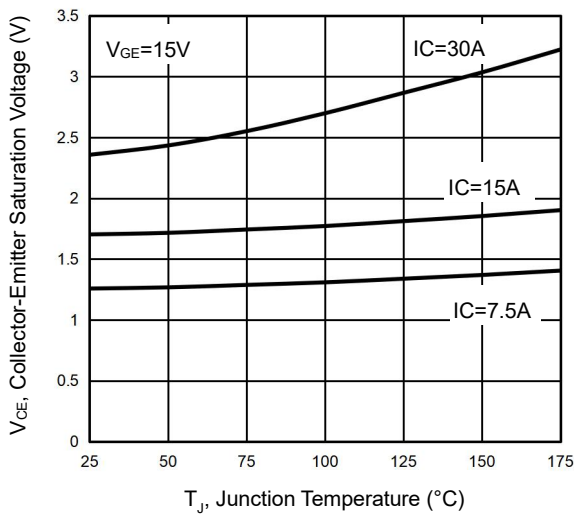
**Figure 1 Output Characteristics**



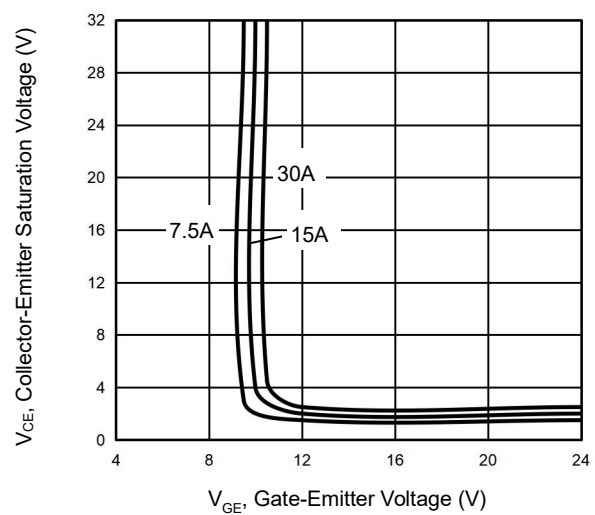
**Figure 2 Transfer Characteristics**



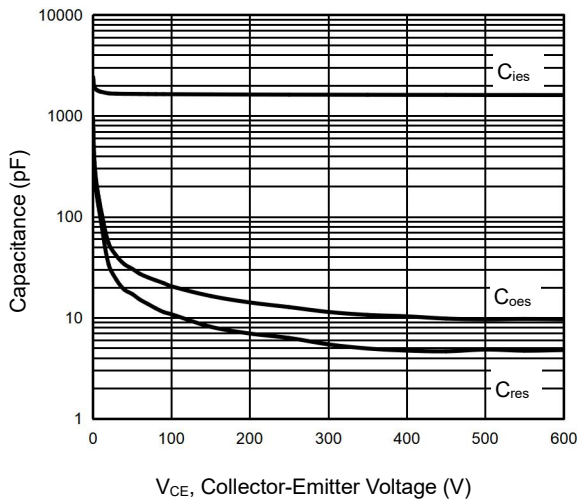
**Figure 3  $V_{CEsat}$  vs. Case Temperature**



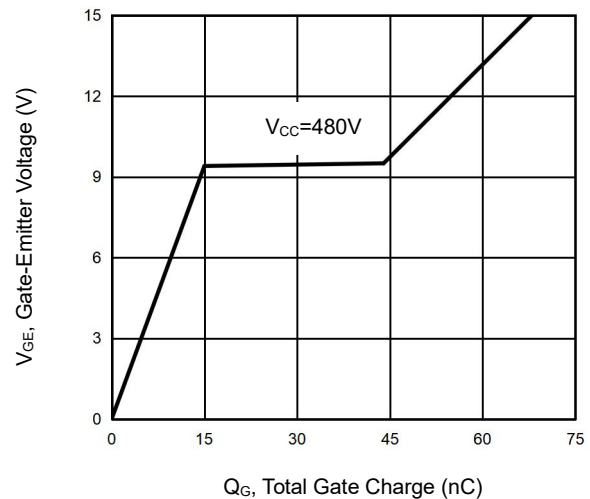
**Figure 4 Saturation Voltage vs.  $V_{GE}$**



**Figure 5 Capacitance Characteristics**

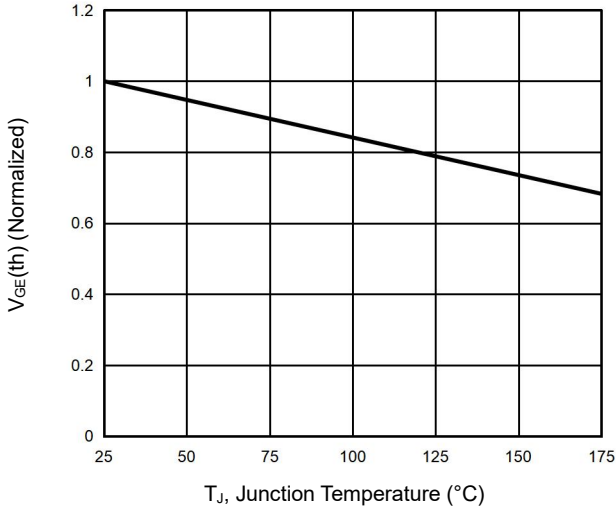


**Figure 6 Gate charge waveform**

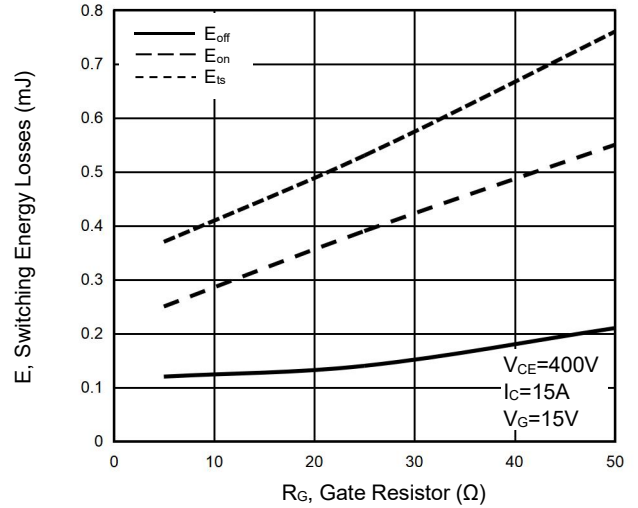


## Typical Electrical and Thermal Characteristics

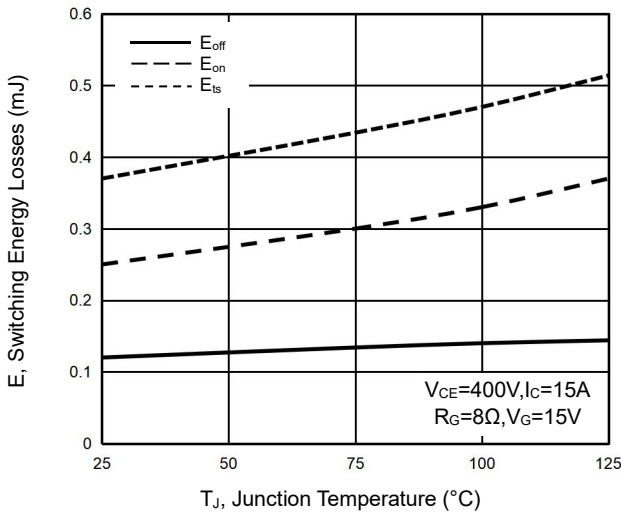
**Figure 7 Gate-emitter Threshold Voltage as a Function of Junction Temperature**



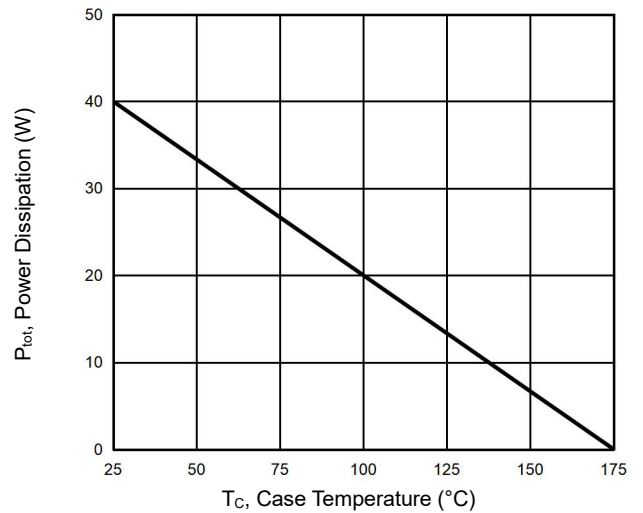
**Figure 8 Typical Switching Times as a Function of Gate Resistor**



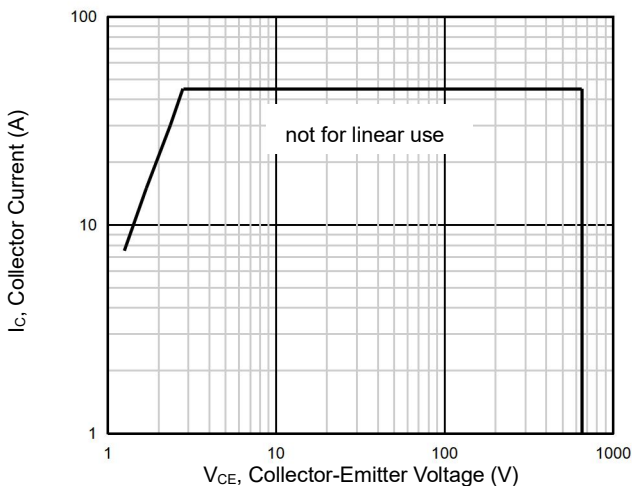
**Figure 9 Typical Switching Times as a Function of Junction Temperature**



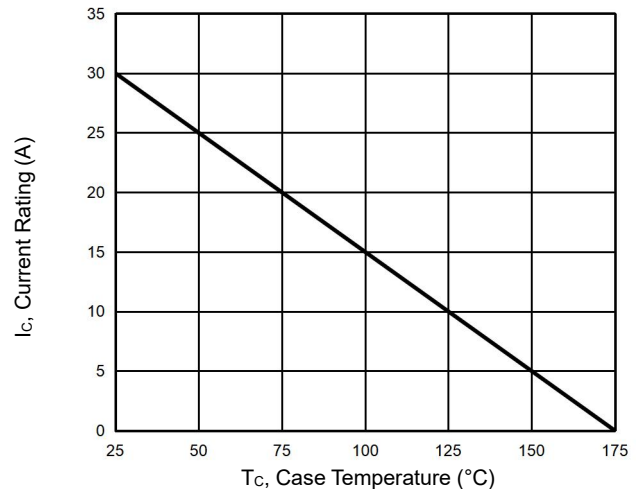
**Figure 10 Power Dissipation as a Function of Case Temperature**



**Figure 11 Forward Bias Safe Operating**



**Figure 12  $I_C$  vs. Temperature**



Typical Electrical and Thermal Characteristics

Figure 13 Forward Characteristics

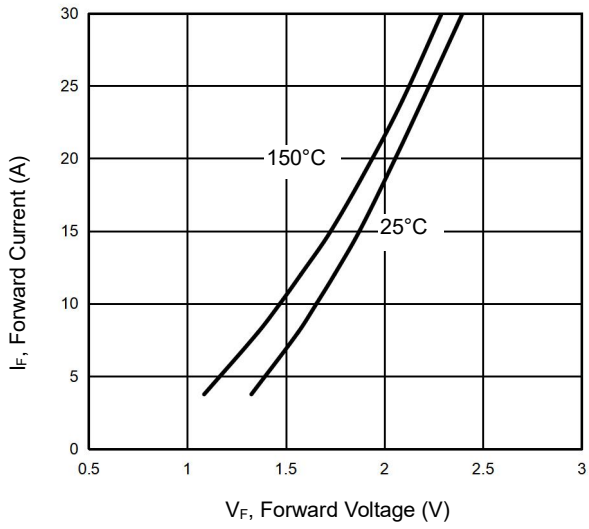
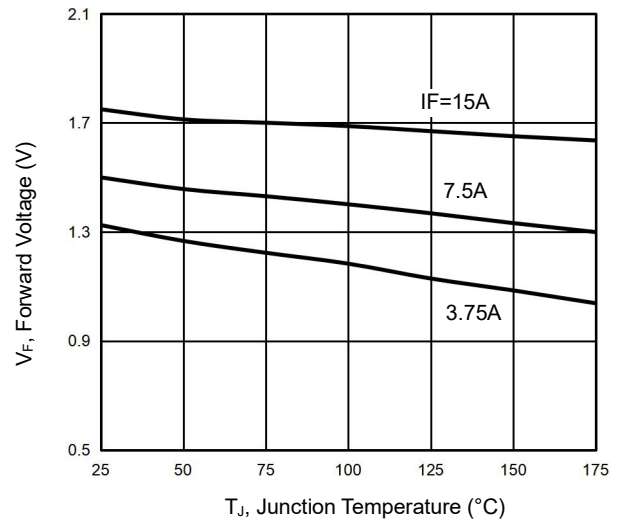
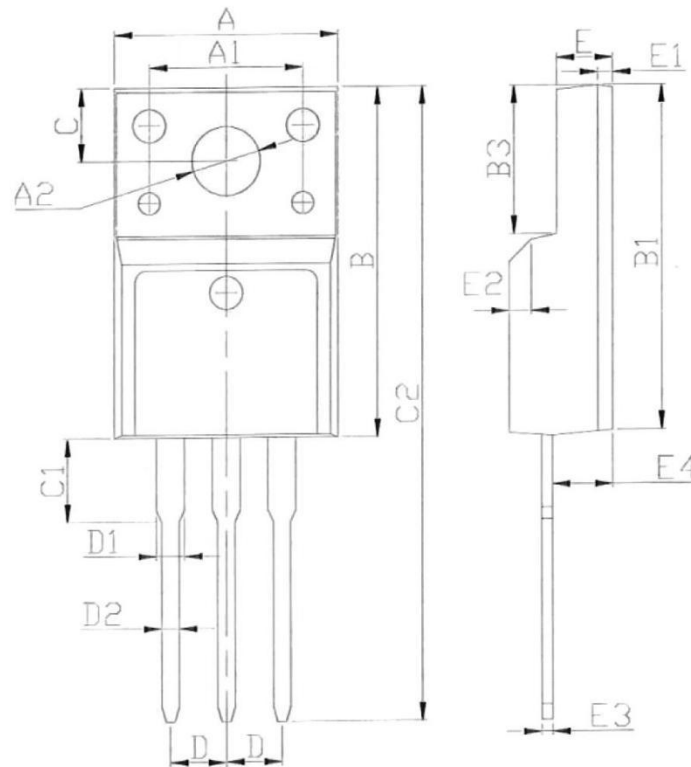


Figure 14  $V_F$  vs. temperature

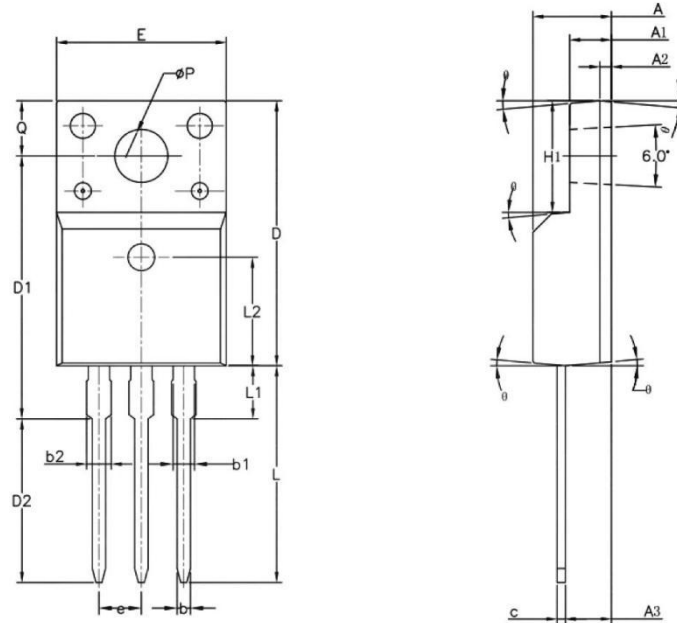


## TO-220F-L Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	9.86	10.46	0.38	0.41
A1	6.80	7.20	0.26	0.28
A2	2.92	3.32	0.11	0.13
A3	9.40	10.00	0.37	0.39
B	15.40	16.40	0.60	0.64
B1	15.10	16.10	0.59	0.63
B2	4.40	5.00	0.17	0.19
B3	6.40	7.00	0.25	0.27
C	3.05	3.55	0.12	0.13
C1	2.95	3.55	0.11	0.13
C2	28.20	29.20	1.11	1.14
D	2.54	--	0.10	--
D1	--	1.47	--	0.05
D2	0.60	1.00	0.02	0.03
E	2.30	2.80	0.09	0.11
E1	0.45	0.95	0.01	0.03
E2	1.0×45°			
E3	0.30	0.70	0.01	0.02
E4	2.45	3.05	0.09	0.12

## TO-220F-P Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.50	4.83	0.17	0.19
A1	2.34	2.74	0.09	0.10
A2	0.70REF		0.02REF	
A3	2.56	2.93	0.10	0.11
b	0.70	0.9	0.02	0.03
b1	1.18	1.38	0.04	0.05
b2	--	1.47	--	0.05
c	0.45	0.60	0.01	0.02
D	15.67	16.07	0.61	0.63
D1	15.55	15.95	0.61	0.62
D2	9.60	10.00	0.37	0.39
E	9.96	10.36	0.39	0.40
e	2.54BSC		0.10BSC	
H1	6.48	6.88	0.25	0.27
L	12.68	13.28	0.49	0.52
L1	--	3.50	--	0.13
L2	6.50REF		0.25REF	
ØP	3.08	3.28	0.12	0.13
Q	3.20	3.40	0.12	0.13
θ1	1°	5°	1°	5°



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