

## 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
NCE15TD60BD	TO-263	NCE15TD60BD
NCE15TD60B	TO-220	NCE15TD60B
NCE15TD60BF	TO-220F	NCE15TD60BF



TO-220F

TO-220

TO-263

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

Symbol	Parameter	TO-220/TO-263	TO-220F	Units
$V_{CES}$	Collector-Emitter Voltage	600		V
$V_{GES}$	Gate- Emitter Voltage	$\pm 30$		V
$I_C$	Collector Current	30	30*	A
	Collector Current @ $T_C = 100^\circ\text{C}$	15	15*	A
$I_{Cplus}$	Pulsed Collector Current, $t_p$ limited by $T_{jmax}$	45	45	A
-	turn off safe operating area, $V_{CE}=600\text{V}$ , $T_j=150^\circ\text{C}$	45	45	A
$I_F$	Diode Continuous Forward Current @ $T_C = 100^\circ\text{C}$	15	15*	A
$I_{FM}$	Diode Maximum Forward Current	45	45	A
$P_D$	Power Dissipation @ $T_C = 25^\circ\text{C}$	105	34	W
	Power Dissipation @ $T_C = 100^\circ\text{C}$	42	13.6	W
$T_J, T_{stg}$	Operating Junction and Storage Temperature Range	-55 to +150		$^\circ\text{C}$
$T_L$	Maximum Temperature for Soldering	260		$^\circ\text{C}$
$t_{sc}$	Short circuit withstand time $V_{GE}=15\text{V}$ , $V_{CC}\leq 400\text{V}$ , Allowed number of short circuits < 1000 Time between short circuits: $\geq 1.0\text{s}$ , $T_j \leq 150^\circ\text{C}$	3		us

**Thermal Characteristic**

Symbol	Parameter	TO-220/TO-263	TO-220F	Units
R <sub>θJC</sub>	Thermal Resistance, Junction to case for IGBT	1.19	3.67	°C/W
R <sub>θJC</sub>	Thermal Resistance, Junction to case for Diode	2.12	3.97	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	62	78	°C/W

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

Symbol	Parameter	Test Conditions	Rating			Units	
			Min.	Typ.	Max.		
<b>Static Characteristics</b>							
V <sub>(BR)CES</sub>	Collector-Emitter Breakdown Voltage	V <sub>GE</sub> =0V, I <sub>CE</sub> =1mA	600	--	--	V	
I <sub>CES</sub>	Collector-Emitter Leakage Current	V <sub>GE</sub> =0V, V <sub>CE</sub> =600V	--	--	4	uA	
I <sub>GES(F)</sub>	Gate to Emitter Forward Leakage	V <sub>GE</sub> =+30V, V <sub>CE</sub> =0V	--	--	100	nA	
I <sub>GES(R)</sub>	Gate to Source Reverse Leakage	V <sub>GE</sub> =-30V, V <sub>CE</sub> =0V	--	--	100	nA	
V <sub>CE(sat)</sub>	Collector-Emitter Saturation Voltage	I <sub>C</sub> =15A	T <sub>J</sub> =25°C	--	1.7	1.9	V
		V <sub>GE</sub> =15V		T <sub>J</sub> =100°C	--	1.9	--
V <sub>GE(th)</sub>	Gate Threshold Voltage	I <sub>C</sub> =1mA, V <sub>CE</sub> =V <sub>GE</sub>	4.0	--	6.0	V	
<b>Dynamic Characteristics</b>							
C <sub>ies</sub>	Input Capacitance	V <sub>CE</sub> =25V, V <sub>GE</sub> =0V, f=1MHz	--	1635	--	pF	
C <sub>oes</sub>	Output Capacitance		--	50	--		
C <sub>res</sub>	Reverse Transfer Capacitance		--	30	--		
Q <sub>g</sub>	Total Gate Charge	V <sub>CC</sub> =480V, I <sub>C</sub> =15A V <sub>GE</sub> =15V	--	63	--	nC	
Q <sub>ge</sub>	Gate to Emitter Charge		--	15	--		
Q <sub>gc</sub>	Gate to Collector Charge		--	26	--		
I <sub>C(SC)</sub>	Short circuit collector current Max.1000 short circuits Time between short circuits: ≥1.0s	V <sub>GE</sub> =15V, V <sub>CC</sub> ≤400V, t <sub>sc</sub> ≤3us, T <sub>J</sub> ≤150°C	--	82	--	A	
<b>Switching Characteristics</b>							
t <sub>d(ON)</sub>	Turn-on Delay Time	V <sub>CC</sub> =400V, I <sub>C</sub> =10A V <sub>GE</sub> =0/15V, R <sub>g</sub> =5Ω Inductive Load	--	16	--	ns	
t <sub>r</sub>	Rise Time		--	12	--		
t <sub>d(OFF)</sub>	Turn-Off Delay Time		--	124	--		
t <sub>f</sub>	Fall Time		--	12	--		
E <sub>on</sub>	Turn-On Switching Loss		--	0.25	--	mJ	
E <sub>off</sub>	Turn-Off Switching Loss		--	0.12	--		
E <sub>ts</sub>	Total Switching Loss		--	0.37	--		

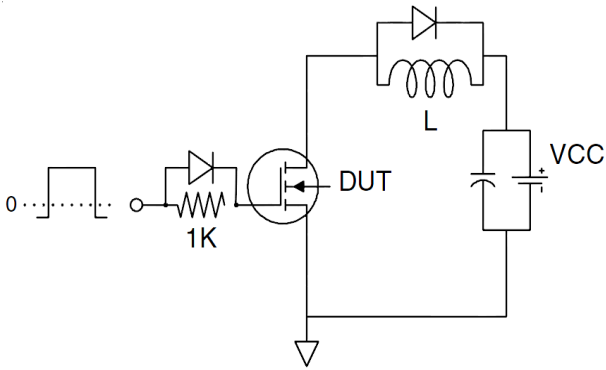
**Electrical Characteristics of the Diode(T<sub>c</sub>= 25°C unless otherwise specified):**

Symbol	Parameter	Test Conditions	Rating			Units
			Min.	Typ.	Max.	
V <sub>FM</sub>	Diode Forward Voltage	I <sub>F</sub> =15A	--	1.5	1.7	V
T <sub>rr</sub>	Reverse Recovery Time	I <sub>F</sub> =15A, di/dt=200A/us	--	170	--	ns
I <sub>RRM</sub>	Diode Peak Reverse Recovery Current		--	6.5	--	A
Q <sub>rr</sub>	Reverse Recovery Charge		--	0.7	--	uC
Pulse width t <sub>tp</sub> ≤380μs, δ≤2%						

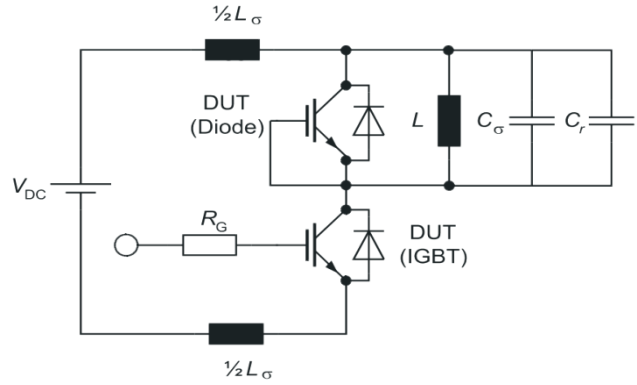
\* TO-220F Ic Follow TO-220/TO-263.

## Test Circuit

### 1) Gate Charge Test Circuit

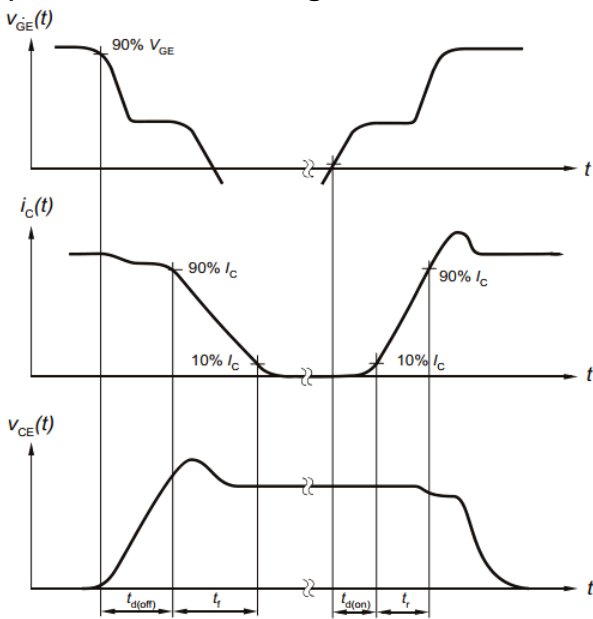


### 2) Switch Time Test Circuit

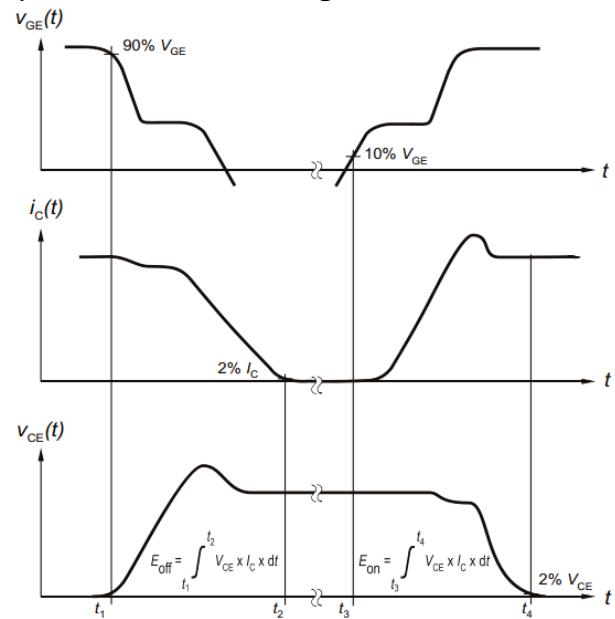


## Switching characteristics

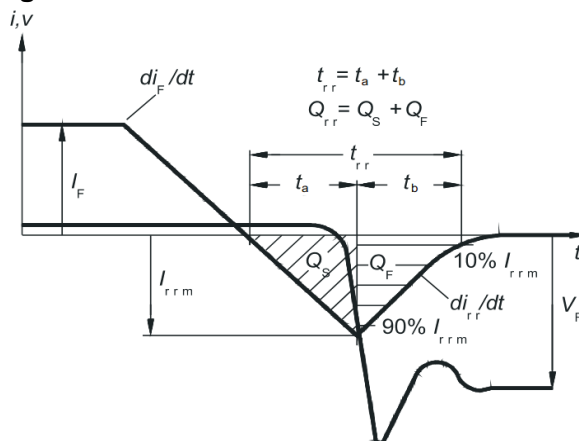
### 1) definition of switching times



### 2) definition of switching losses



### 3) Definition of diode switching characteristics



## Typical Electrical and Thermal Characteristics

Figure 1 Output Characteristics

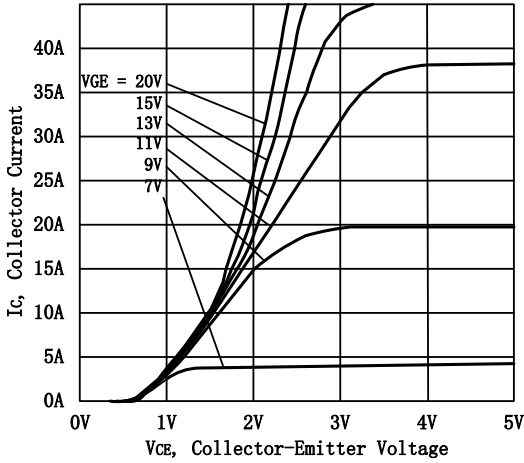


Figure 2 Transfer Characteristics

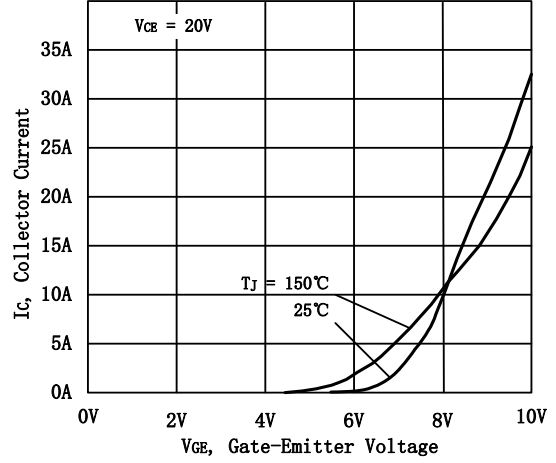


Figure 3 VCEsat vs. Case Temperature

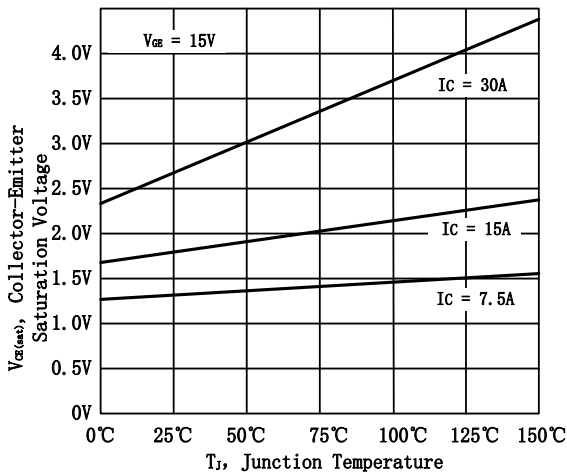


Figure 4 Saturation Voltage vs. VGE

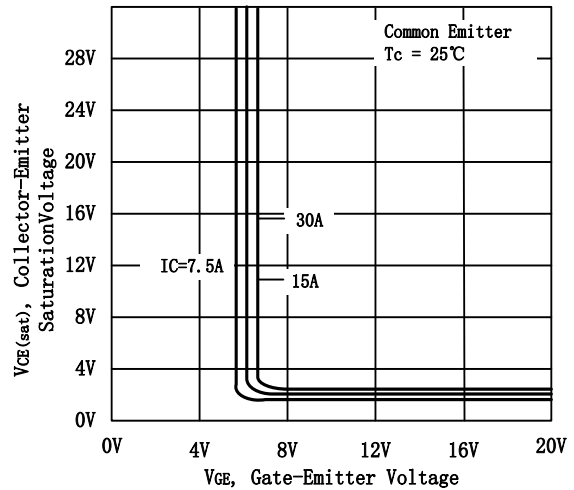


Figure 5 Capacitance Characteristics

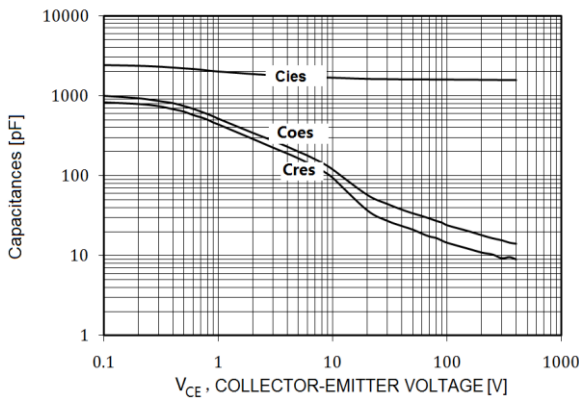
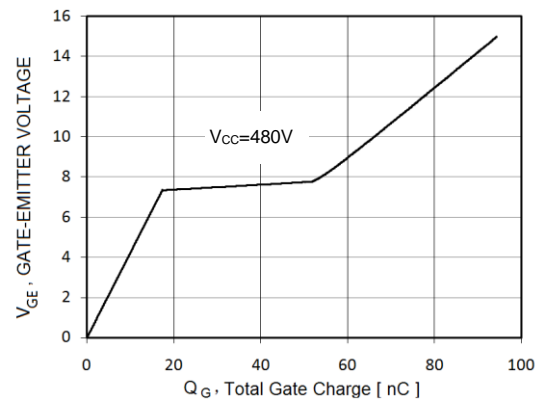
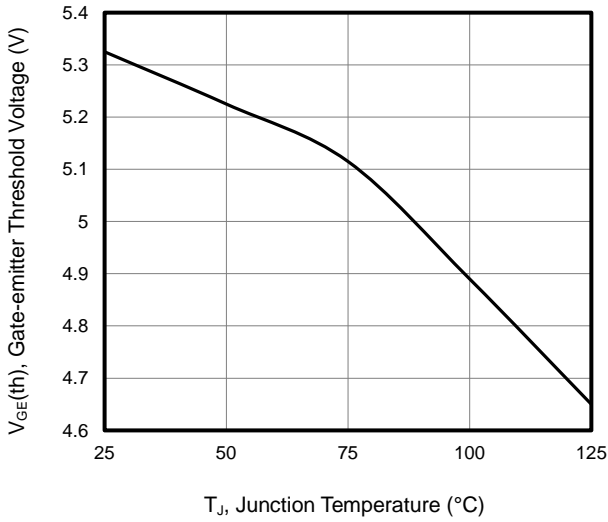


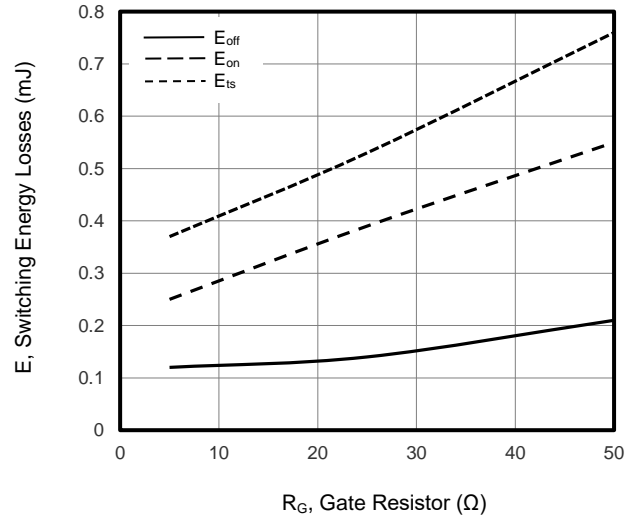
Figure 6 Gate charge waveform



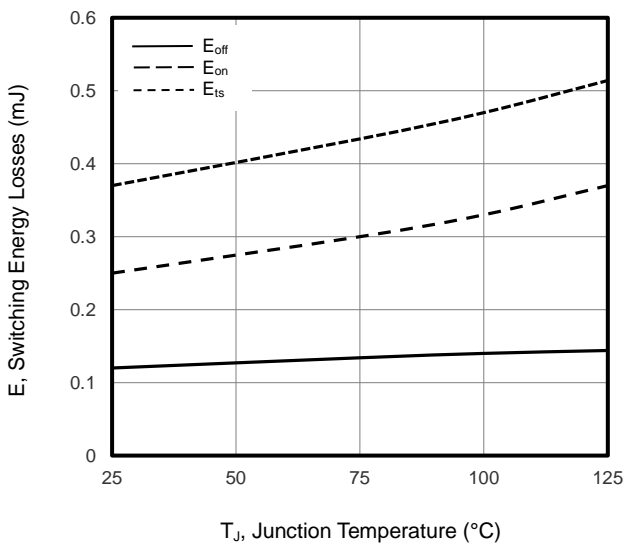
**Figure 7 Gate-emitter Threshold Voltage as a Function of Junction Temperature**



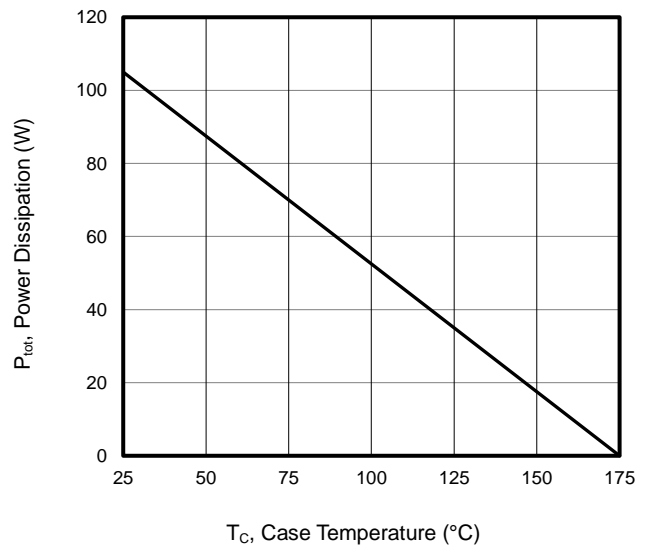
**Figure 8 Typical Switching Times as a Function of Gate Resistor**



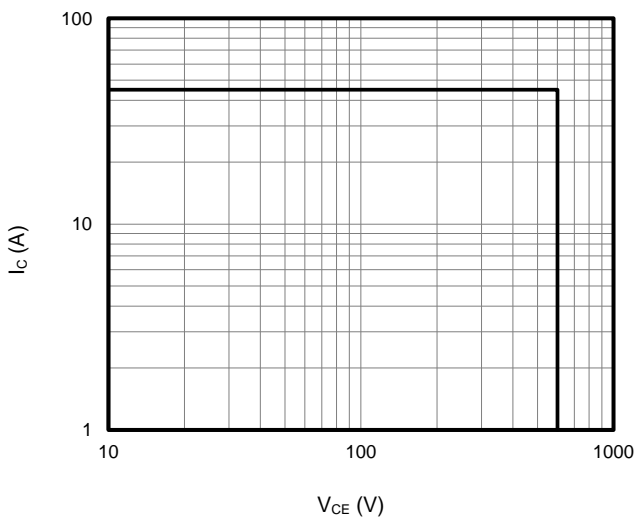
**Figure 9 Typical Switching Times as a Function of Junction Temperature**



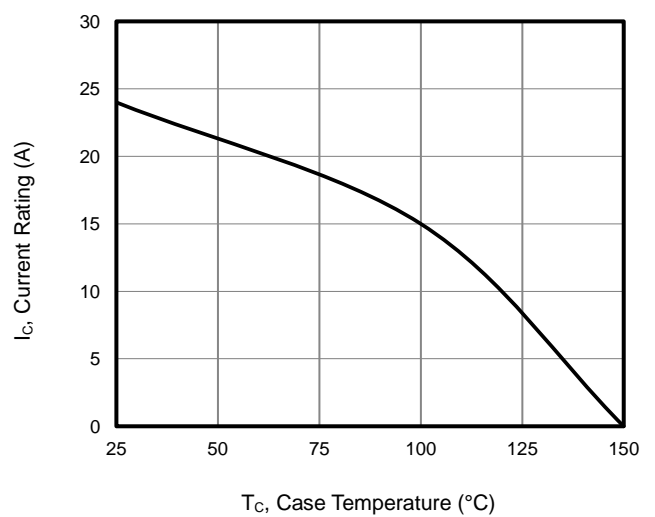
**Figure 10 Power Dissipation as a Function of Case Temperature**



**Figure 11 Reverse Bias SOA**

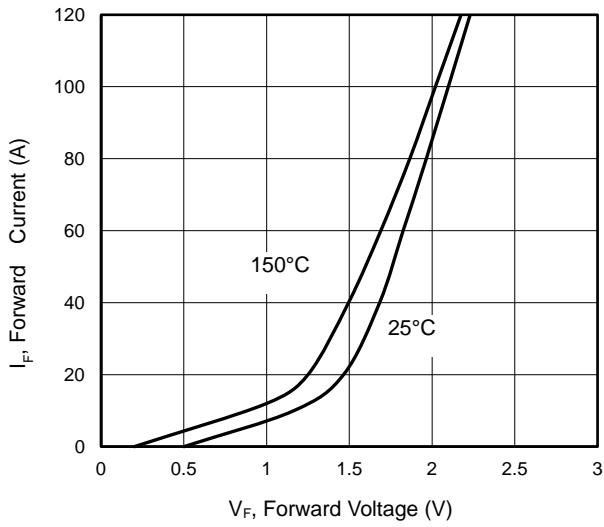


**Figure 12 Current De-rating**

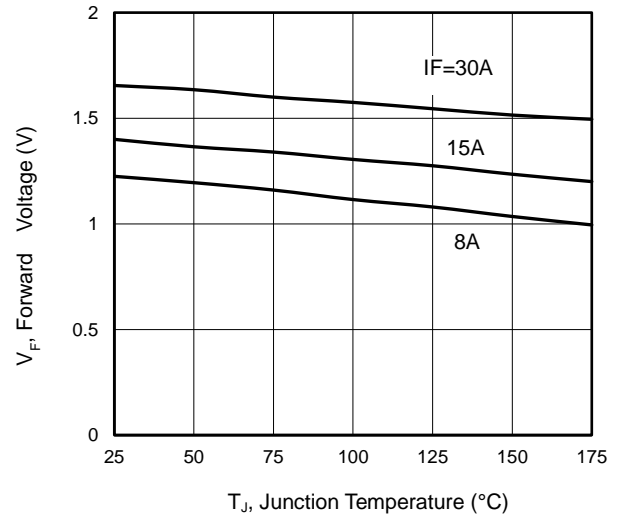


## Typical Electrical and Thermal Characteristics (continued)

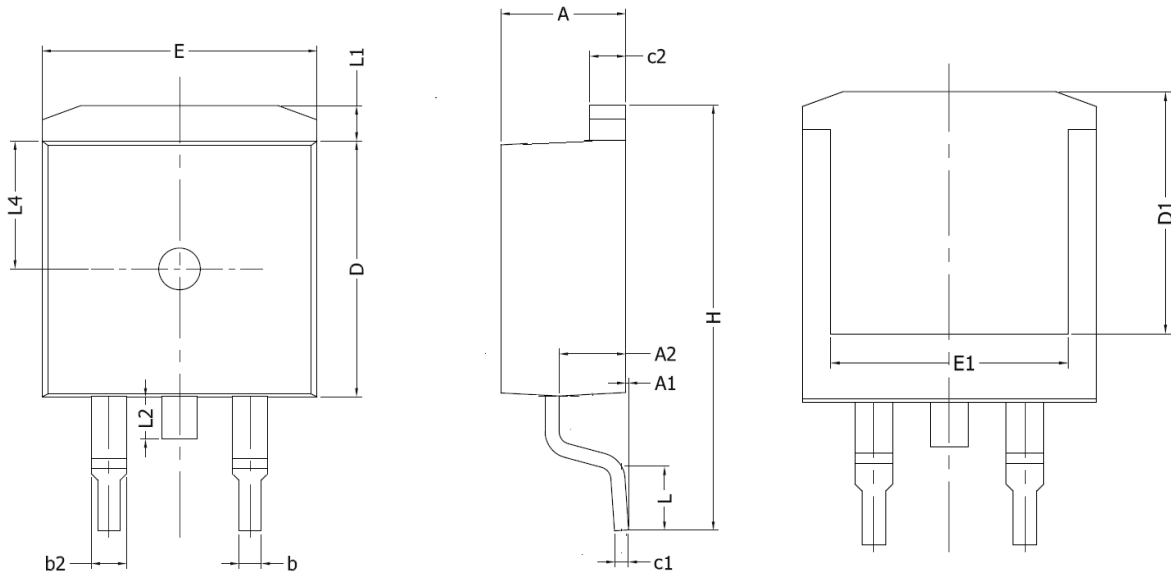
**Figure 13 Forward Characteristics**



**Figure 14  $V_F$  vs. temperature**

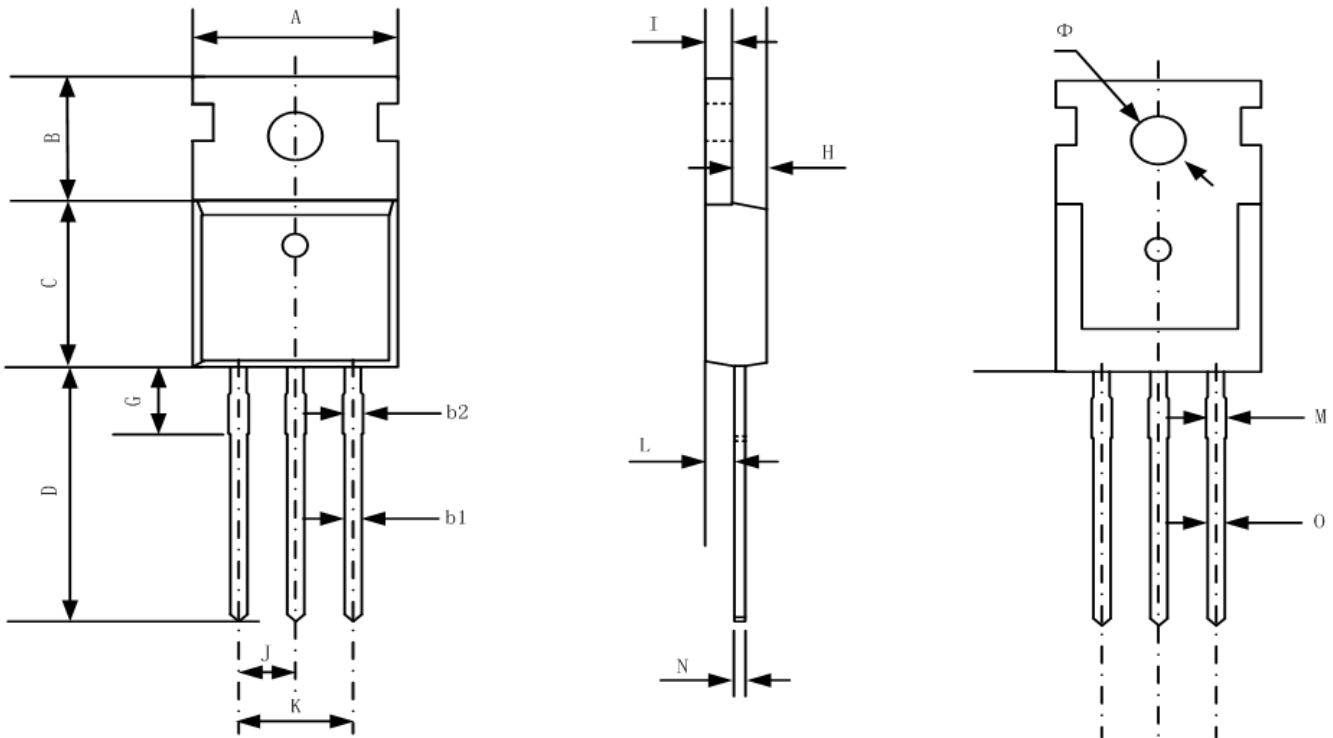


## TO-263-3L Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.40	4.60	0.17	0.18
A1	0.00	0.25	0.00	0.01
A2	2.20	2.60	0.09	0.10
b	0.76	0.89	0.03	0.04
b2	1.23	1.37	0.05	0.05
C	0.47	0.60	0.02	0.02
c1	0.46	0.56	0.02	0.02
c2	1.25	1.35	0.05	0.05
D	0.91	0.93	0.04	0.04
D1	8.00	-	0.31	-
E	9.80	10.00	0.39	0.39
E1	7.80	-	0.31	-
e	2.54BSC		0.10BSC	
H	14.90	15.70	0.59	0.62
L	2.00	2.60	0.08	0.10
L1	1.17	1.40	0.05	0.06
L2	-	1.75	-	0.07
L4	4.60REF		0.18REF	

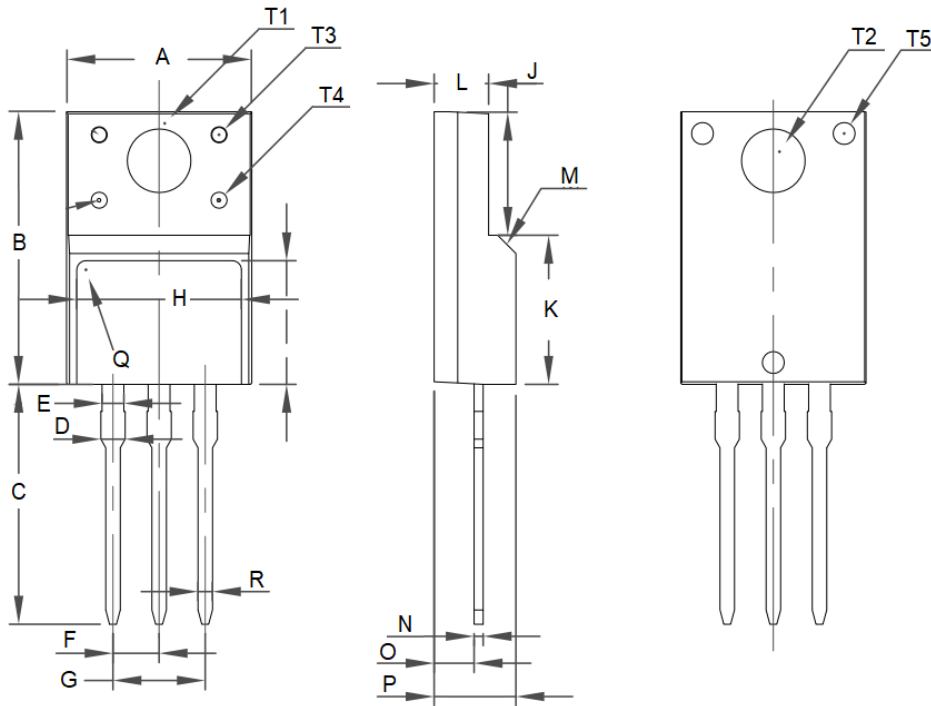
## TO-220-3L-C Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	9.70	10.20	0.38	0.40
B	6.30	6.70	0.25	0.26
C	9.00	9.47	0.35	0.37
D	12.78	13.38	0.50	0.53
G	2.65 REF		0.104 REF	
H	3.00	3.40	0.12	0.13
I	1.25	1.40	0.05	0.06
J	2.40	2.70	0.09	0.11
K	5.00	5.15	0.20	0.20
L	2.20	2.60	0.09	0.10
M	1.25	1.45	0.05	0.06
N	0.45	0.60	0.02	0.02
O	0.70	0.90	0.03	0.04
Φ	3.6 REF		0.142 REF	



## TO-220F Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	9.96	10.36	0.39	0.41
B	15.67	16.07	0.62	0.63
C	13.14	13.54	0.52	0.53
D	1.20	1.40	0.05	0.06
E	1.20 BSC		0.05 BSC	
F	2.54 BSC		0.10 BSC	
G	5.08 BSC		0.20 BSC	
H	7.60	8.00	0.30	0.31
I	7.10	7.50	0.28	0.30
J	6.48	6.88	0.26	0.27
K	8.99	9.39	0.35	0.37
L	2.34	2.74	0.09	0.11
M	45°		1.77 BSC	
N	0.49	0.52	0.02	0.02
O	2.15	2.55	0.08	0.10
P	4.50	4.90	0.18	0.19
Q	0.50		0.02 BSC	
R	0.77	0.83	0.03	0.03
S	4°	5°	0.16	0.20
T1	3.45 BSC		0.14 BSC	
T2	3.18 BSC		0.13 BSC	
T3	1.50 BSC		0.06 BSC	
T4	1.20 BSC		0.05 BSC	
T5	1.50 BSC		0.06 BSC	

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