

## 600V, 60A, 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;

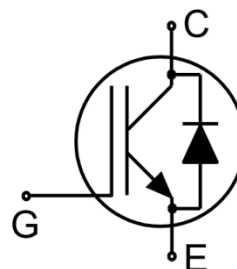
### Features

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

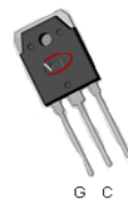
- Air Condition
- Inverters
- Motor drives



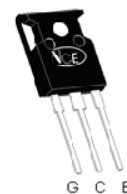
Schematic diagram

### Package Marking and Ordering Information

Device	Device Package	Device Marking
NCE60TD60BT	TO-247	NCE60TD60BT
NCE60TD60BP	TO-3P	NCE60TD60BP



TO-3P



TO-247

### 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	120	A
	Collector Current @ $T_C = 100^{\circ}\text{C}$	60	A
$I_{Cplus}$	Pulsed Collector Current, $t_p$ limited by $T_{jmax}$	180	A
-	turn off safe operating area, $V_{CE}=600\text{V}$ , $T_j=150^{\circ}\text{C}$	180	A
$I_F$	Diode Continuous Forward Current @ $T_C = 100^{\circ}\text{C}$	60	A
	Diode Maximum Forward Current	180	A
$P_D$	Power Dissipation @ $T_C = 25^{\circ}\text{C}$	316	W
	Power Dissipation @ $T_C = 100^{\circ}\text{C}$	126	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 $V_{GE}=15.0\text{V}$ , $V_{CC} \leq 400\text{V}$ , 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	Value	Units
R <sub>θJC</sub>	Thermal Resistance, Junction to case for IGBT	0.39	°C/W
R <sub>θJC</sub>	Thermal Resistance, Junction to case for Diode	1.72	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	40	°C/W

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

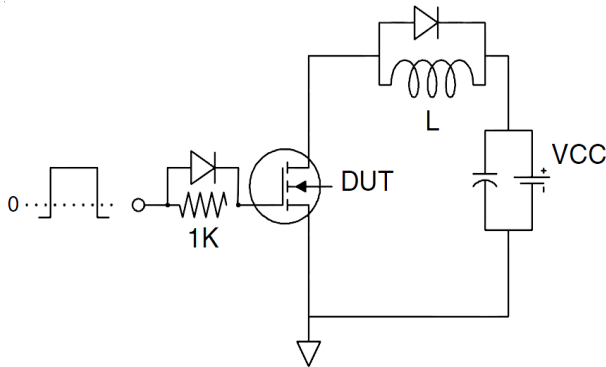
Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
<b>STATIC Characteristics</b>						
V <sub>(BR)CES</sub>	Collector-Emitter Breakdown Voltage	V <sub>GE</sub> =0V, I <sub>CE</sub> =1mA	600	--	--	V
I <sub>CES</sub>	Collector-Emitter Leakage Current	V <sub>GE</sub> =0V, V <sub>CE</sub> =600V	--	--	5	uA
I <sub>GES(F)</sub>	Gate to Emitter Forward Leakage	V <sub>GE</sub> =+30V, V <sub>CE</sub> =0V	--	--	200	nA
I <sub>GES(R)</sub>	Gate to Source Reverse Leakage	V <sub>GE</sub> =-30V, V <sub>CE</sub> =0V	--	--	200	nA
V <sub>CE(sat)</sub>	Collector-Emitter Saturation Voltage	I <sub>C</sub> =60A, T <sub>J</sub> =25°C	--	1.7	1.9	V
		V <sub>GE</sub> =15V, T <sub>J</sub> =150°C	--	1.9	--	V
V <sub>GE(th)</sub>	Gate Threshold Voltage	I <sub>C</sub> =1mA, V <sub>CE</sub> =V <sub>GE</sub>	4.0	5.0	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	--	7018	--	pF
C <sub>oes</sub>	Output Capacitance		--	199	--	
C <sub>res</sub>	Reverse Transfer Capacitance		--	138	--	
Q <sub>g</sub>	Total Gate Charge	V <sub>CC</sub> =480V, I <sub>C</sub> =60A V <sub>GE</sub> =15V	--	262	--	nC
Q <sub>ge</sub>	Gate to Emitter Charge		--	60	--	nC
Q <sub>gc</sub>	Gate to Collector Charge		--	113	--	nC
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	--	360	--	A
<b>Switching Characteristics</b>						
t <sub>d(ON)</sub>	Turn-on Delay Time	V <sub>CE</sub> =400V, I <sub>C</sub> =60A V <sub>GE</sub> =0/15V, R <sub>g</sub> =5Ω Inductive Load	--	19	--	ns
t <sub>r</sub>	Rise Time		--	17	--	
t <sub>d(OFF)</sub>	Turn-Off Delay Time		--	170	--	
t <sub>f</sub>	Fall Time		--	18	--	
E <sub>on</sub>	Turn-On Switching Loss		--	2.2	--	mJ
E <sub>off</sub>	Turn-Off Switching Loss		--	0.9	--	
E <sub>ts</sub>	Total Switching Loss		--	3.1	--	

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

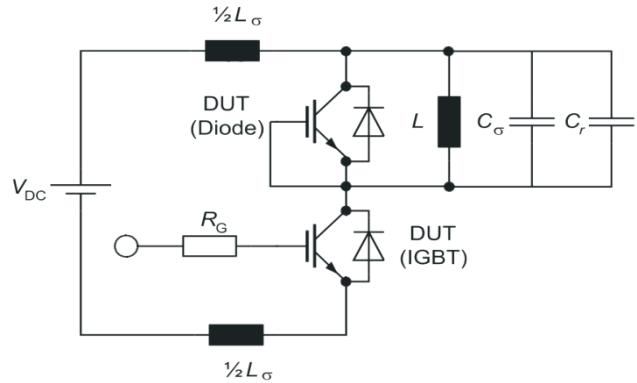
Symbol	Parameter	Test Conditions	Rating			Units
			Min.	Typ.	Max.	
V <sub>FM</sub>	Diode Forward Voltage	I <sub>F</sub> =60A	--	1.7	2.0	V
T <sub>rr</sub>	Reverse Recovery Time	V <sub>CC</sub> =400V, I <sub>F</sub> =60A, di/dt=200A/uS	--	186	--	ns
I <sub>RRM</sub>	Diode Peak Reverse Recovery Current		--	3.8	--	A
Q <sub>rr</sub>	Reverse Recovery Charge		--	0.3	--	uC
Pulse width t <sub>tp</sub> ≤380μs, δ≤2%						

Test Circuit

1) Gate Charge Test Circuit

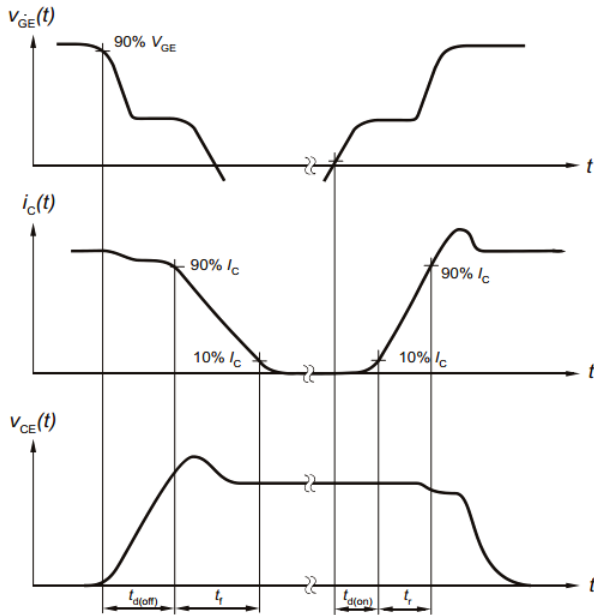


2) Switch Time Test Circuit

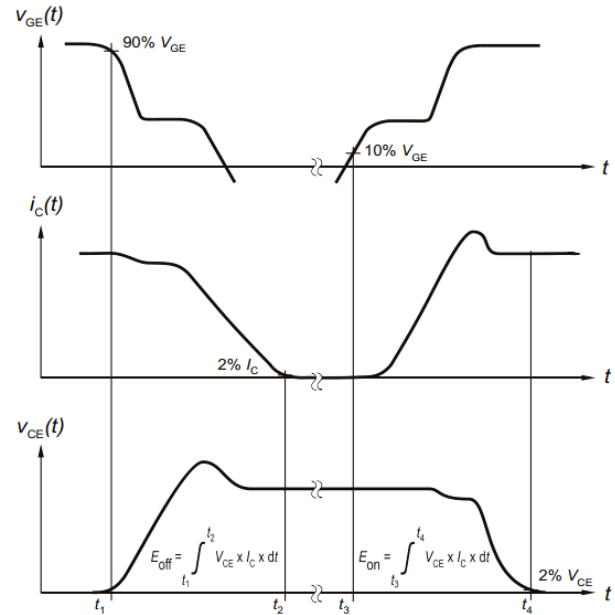


Switching characteristics

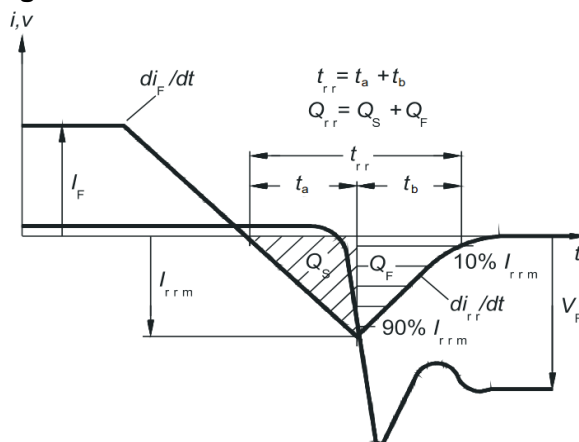
1) definition of switching times



2) definition of switching losses

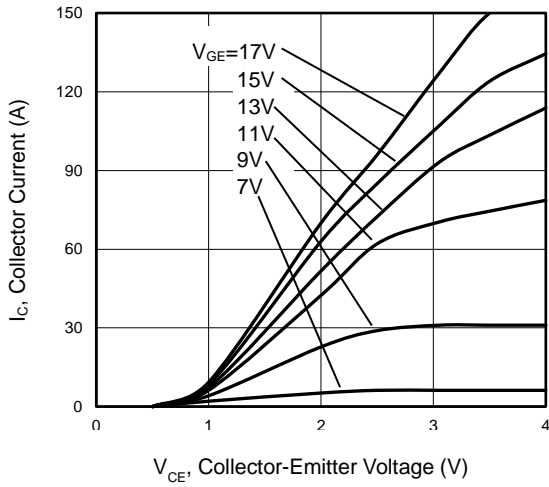


3) Definition of diode switching characteristics

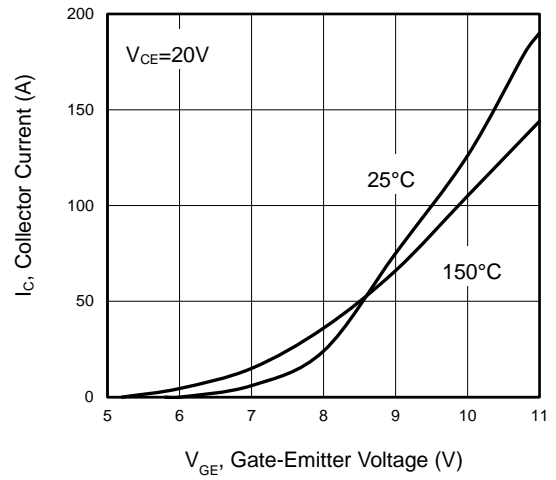


## Typical Electrical and Thermal Characteristics

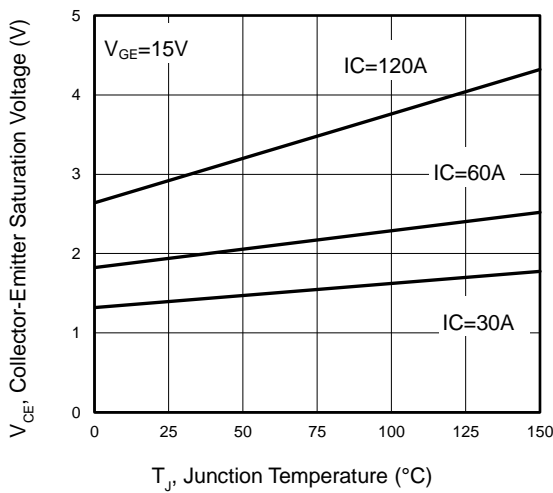
**Figure 1 Output Characteristics**



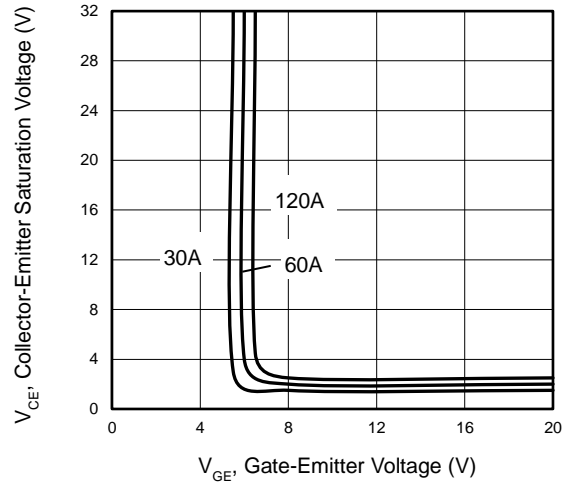
**Figure 2 Transfer Characteristics**



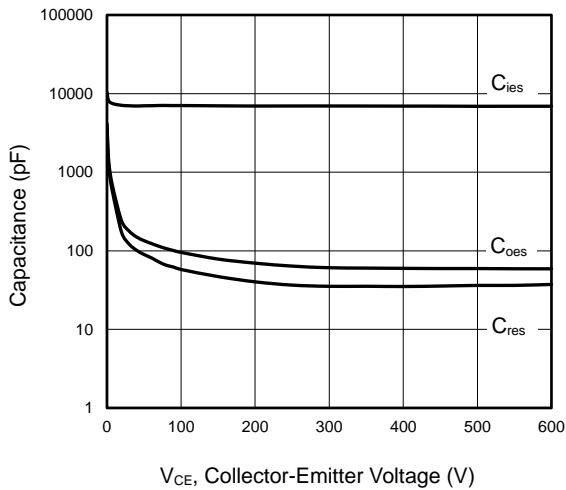
**Figure 3  $V_{CEsat}$  vs. Case Temperature**



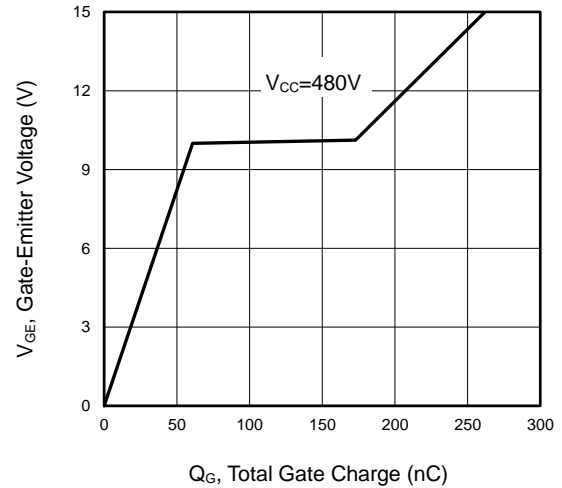
**Figure 4 Saturation Voltage vs.  $V_{GE}$**



**Figure 5 Capacitance Characteristics**



**Figure 6 Gate charge waveform**



Typical Electrical and Thermal Characteristics

Figure 7 Forward Characteristics

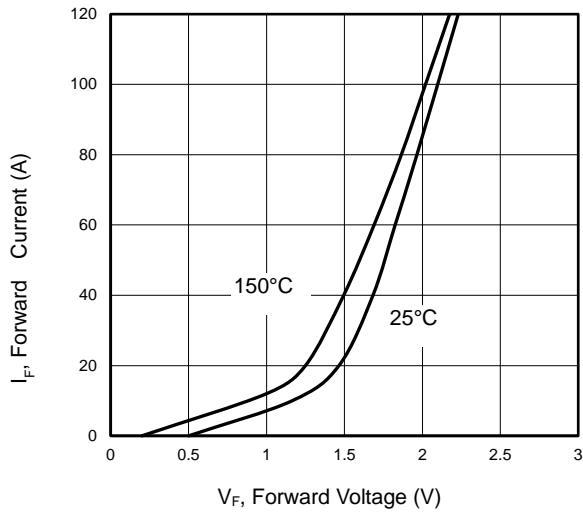


Figure 8  $V_F$  vs. temperature

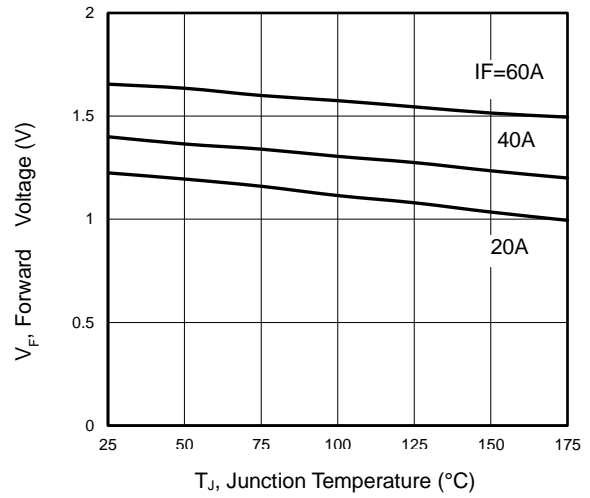


Figure 9 Typical Switching Times as a Function of Gate Resistor

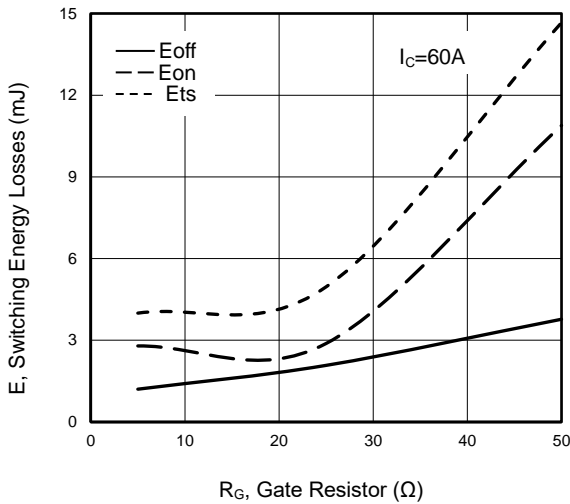


Figure 10 Typical Switching Times as a Function of Junction Temperature

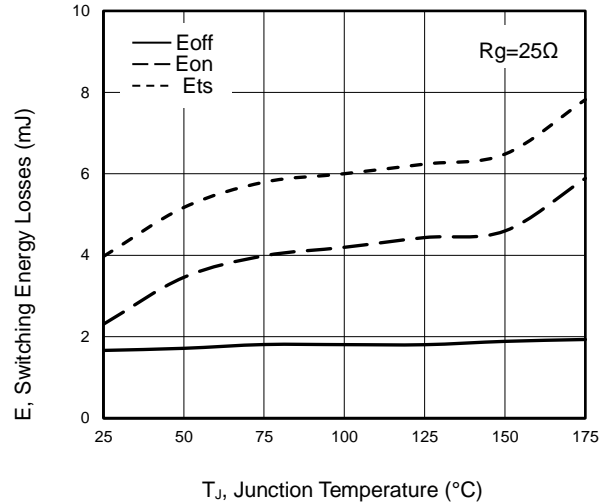


Figure 11 Gate-emitter Threshold Voltage as a Function of Junction Temperature

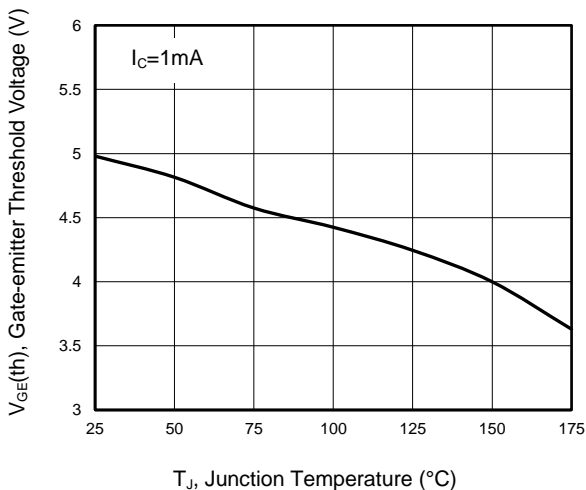
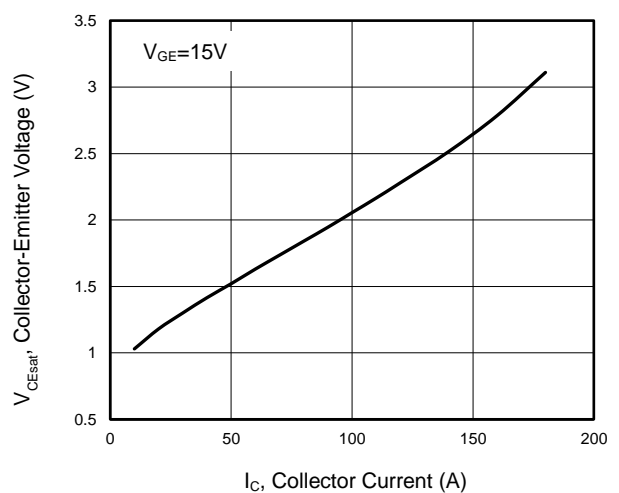
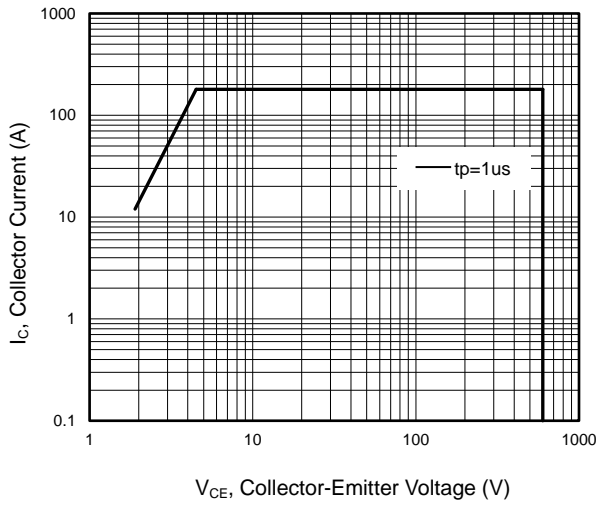


Figure 12 Typical Collector-emitter Saturation Voltage as a function of Collector Current

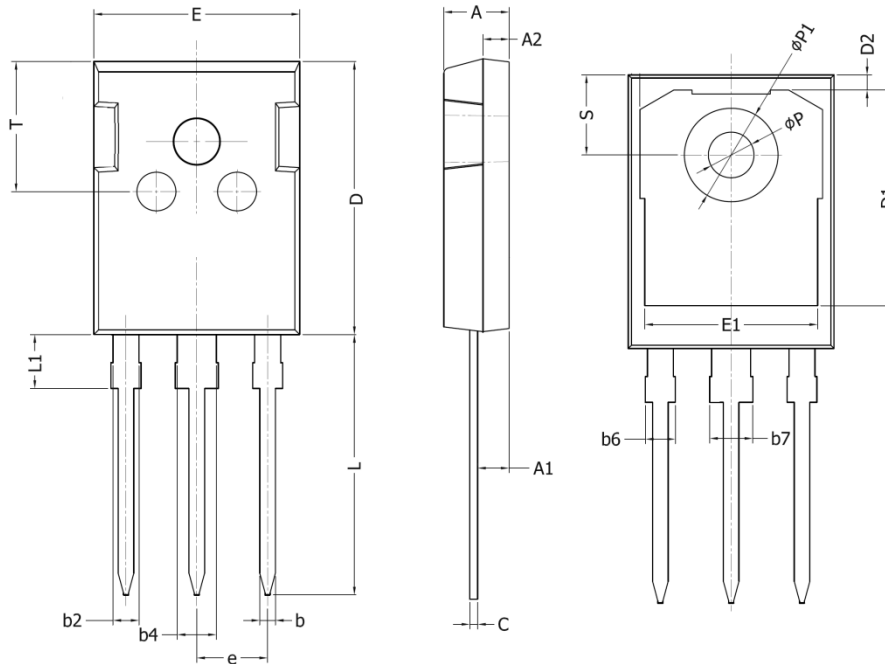


### Typical Electrical and Thermal Characteristics

Figure 13 Forward Bias Safe Operating Area

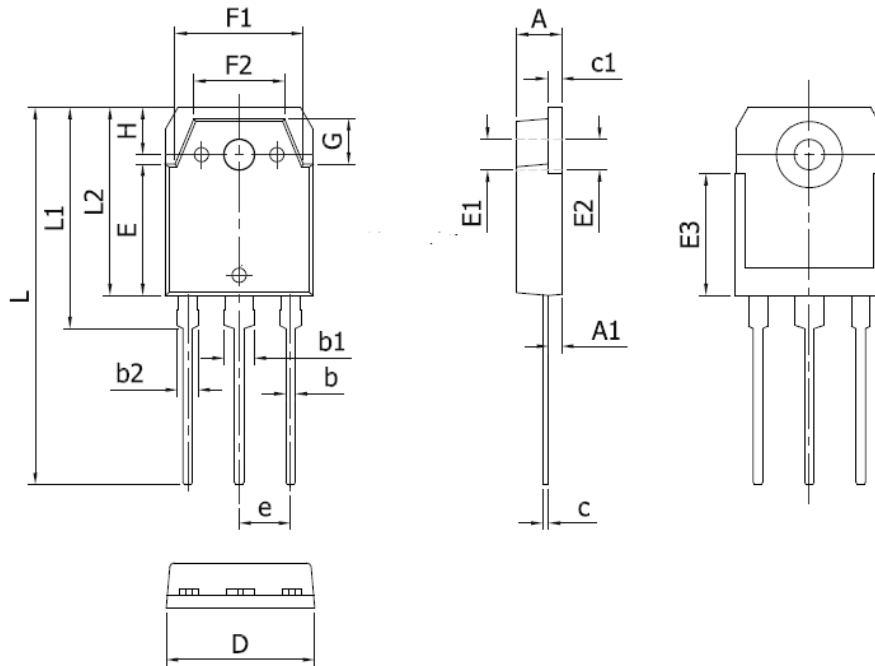


## TO-247-3L Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.90	5.10	0.193	0.201
A1	2.31	2.51	0.091	0.099
A2	1.9	2.1	0.075	0.083
b	1.16	1.26	0.046	0.050
b1	1.15	1.22	0.045	0.048
b2	1.96	2.06	0.077	0.081
b4	2.96	3.06	0.117	0.120
b6	-	2.25	-	0.089
b7	-	3.25	-	0.128
C	0.59	0.66	0.023	0.026
D	20.90	21.10	0.823	0.831
D1	16.25	16.85	0.640	0.663
D2	1.05	1.35	0.041	0.053
E	15.70	15.90	0.618	0.626
E1	13.10	13.50	0.516	0.531
e	5.436 BSC		0.214 BSC	
L	19.80	20.10	0.780	0.791
P	3.40	3.60	0.134	0.142
P1	7.00	7.40	0.276	0.291
S	6.05	6.25	0.238	0.246
T	9.80	10.20	0.386	0.402

## TO-3P-3L Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.60	5.00	0.18	0.20
A1	1.20	1.60	0.05	0.06
b	0.80	1.20	0.03	0.05
b1	2.80	3.20	0.11	0.13
b2	1.80	2.20	0.07	0.09
c	0.50	0.70	0.02	0.03
c1	1.45	1.65	0.06	0.06
D	15.45	15.85	0.61	0.62
E	13.70	14.10	0.54	0.56
E1	3.30 REF		0.13 REF	
E2	3.20 REF		0.13 REF	
F1	13.40	13.80	0.53	0.54
F2	9.40	9.80	0.37	0.39
L	39.70	40.10	1.56	1.58
L1	23.20	23.60	0.91	0.93
L2	19.70	20.10	0.78	0.79
G	4.60	5.00	0.18	0.20
e	5.45 TYP.		0.21 TYP.	
H	5.00 REF		0.20 REF	



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