

## 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;

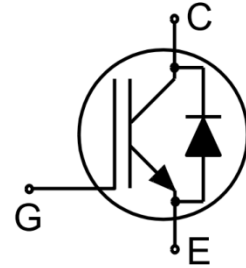
### Features

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

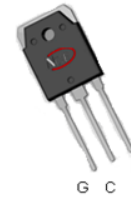
- Air Condition
- Inverters
- Motor drives



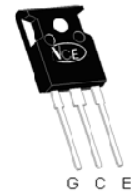
Schematic diagram

### 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 ( $T_C=25^{\circ}C$ 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 @ $T_C = 100^{\circ}C$	60	A
$I_{Cplus}$	Pulsed Collector Current, $t_p$ limited by $T_{jmax}$	180	A
-	turn off safe operating area, $V_{CE}=600V, T_j=150^{\circ}C$	180	A
$I_F$	Diode Continuous Forward Current @ $T_C = 100^{\circ}C$	60	A
$I_{FM}$	Diode Maximum Forward Current	180	A
$P_D$	Power Dissipation @ $T_C = 25^{\circ}C$	316	W
	Power Dissipation @ $T_C = 100^{\circ}C$	126	W
$T_J, T_{stg}$	Operating Junction and Storage Temperature Range	-55 to +150	$^{\circ}C$
$T_L$	Maximum Temperature for Soldering	260	$^{\circ}C$
$t_{sc}$	Short circuit withstand time $V_{GE}=15.0V, V_{CC} \leq 400V$ , Allowed number of short circuits < 1000 Time between short circuits: $\geq 1.0s, T_j \leq 150^{\circ}C$	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)**

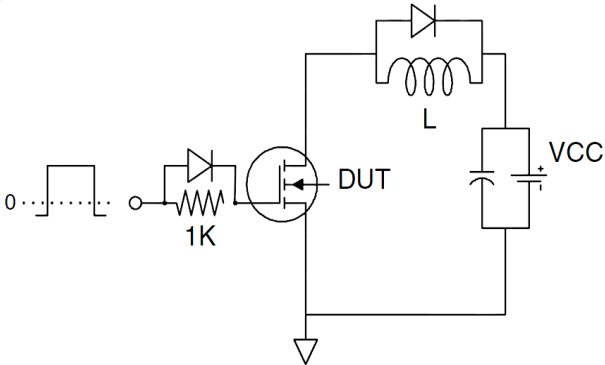
Symbol	Parameter	Test Conditions	Value			Units
			Min.	Typ.	Max.	
<b>STATIC Characteristics</b>						
V <sub>(BR)CES</sub>	Collector-Emitter Breakdown Voltage	V <sub>GE</sub> =0V, I <sub>CE</sub> =1mA	600	--	--	V
I <sub>CES</sub>	Collector-Emitter Leakage Current	V <sub>GE</sub> =0V, V <sub>CE</sub> =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) :**

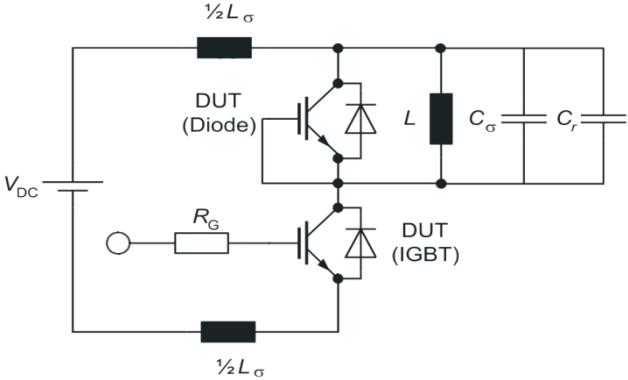
Symbol	Parameter	Test Conditions	Rating			Units
			Min.	Typ.	Max.	
V <sub>FM</sub>	Diode Forward Voltage	I <sub>F</sub> =60A	--	1.7	2.0	V
T <sub>rr</sub>	Reverse Recovery Time	V <sub>CC</sub> =400V, I <sub>F</sub> =60A, di/dt=200A/uS	--	186	--	ns
I <sub>RRM</sub>	Diode Peak Reverse Recovery Current		--	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

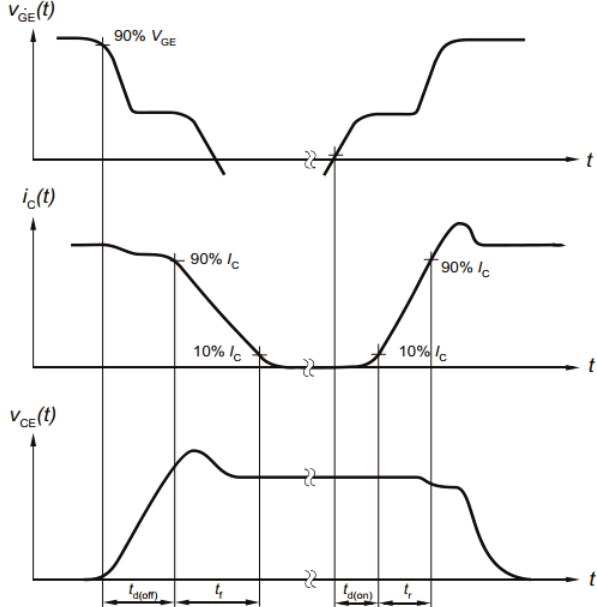


2) Switch Time Test Circuit

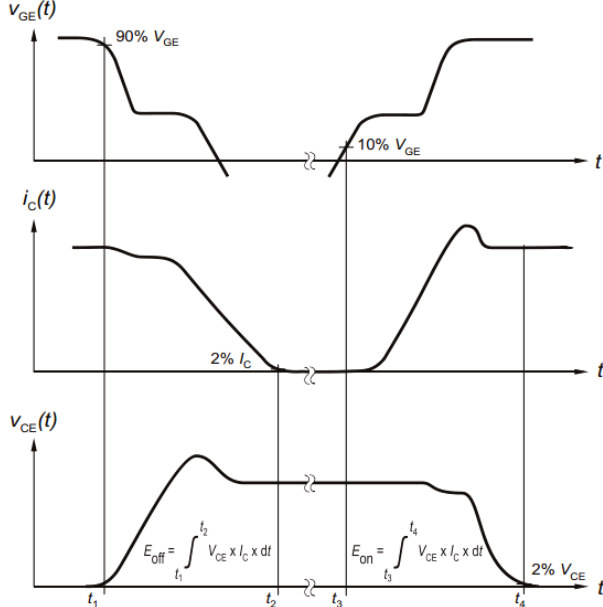


Switching characteristics

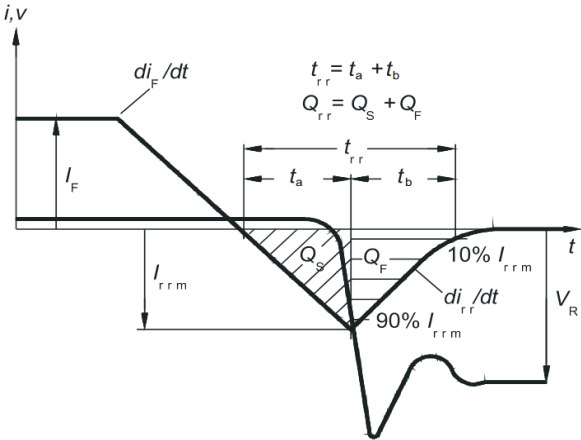
1) definition of switching times



2) definition of switching losses



3) Definition of diode switching characteristics



Typical Electrical and Thermal Characteristics

Figure 1 Output Characteristics

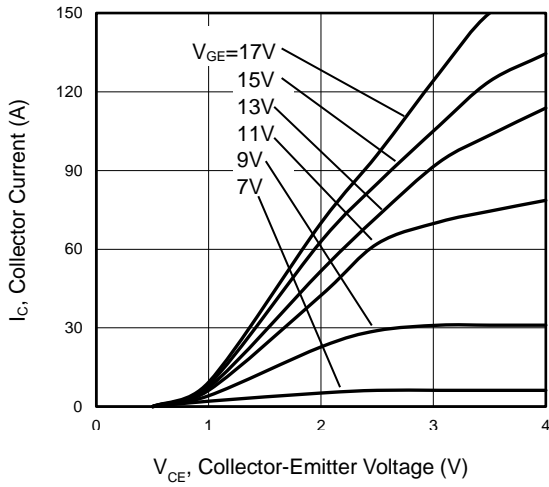


Figure 2 Transfer Characteristics

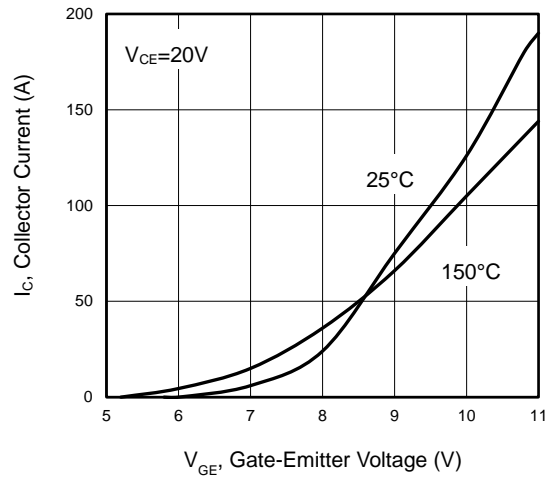


Figure 3  $V_{CEsat}$  vs. Case Temperature

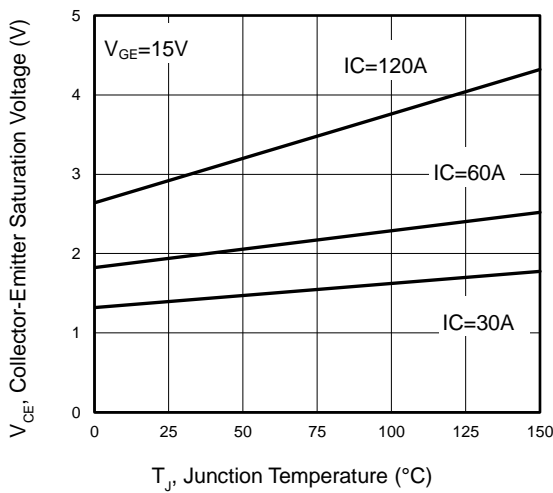


Figure 4 Saturation Voltage vs.  $V_{GE}$

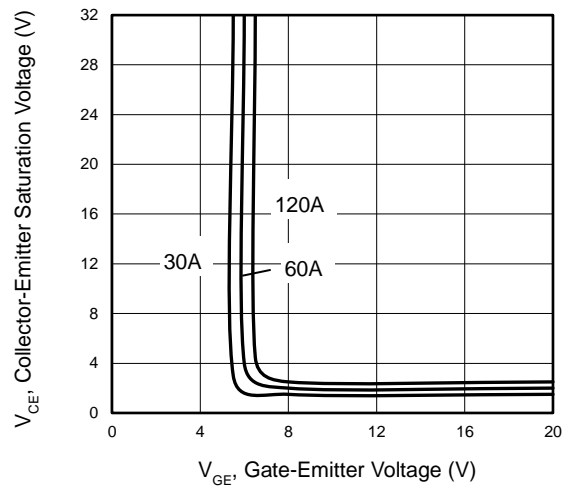


Figure 5 Capacitance Characteristics

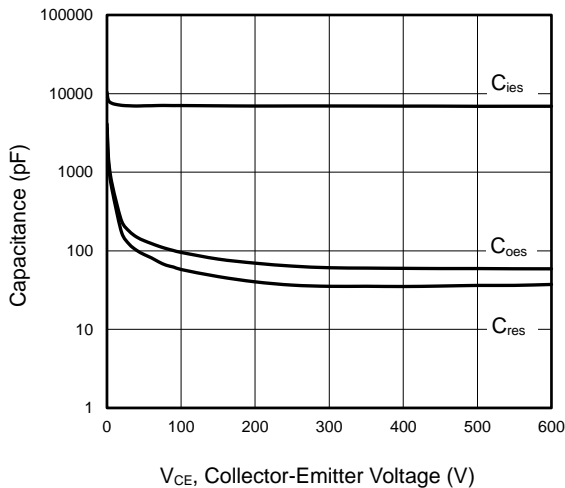
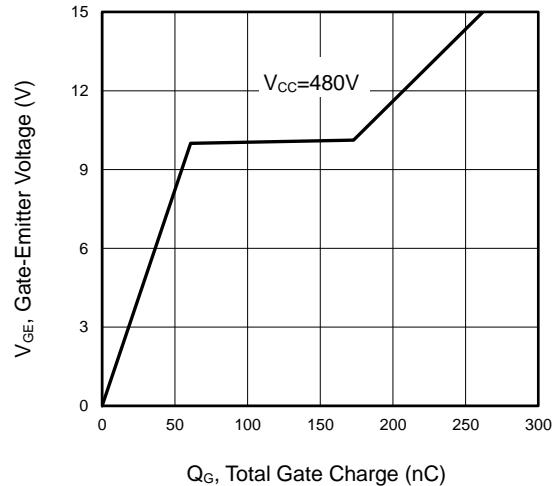


Figure 6 Gate charge waveform



Typical Electrical and Thermal Characteristics

Figure 7 Forward Characteristics

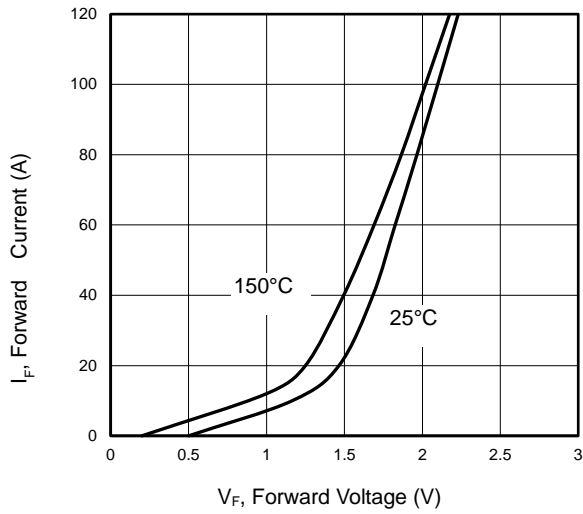


Figure 8  $V_F$  vs. temperature

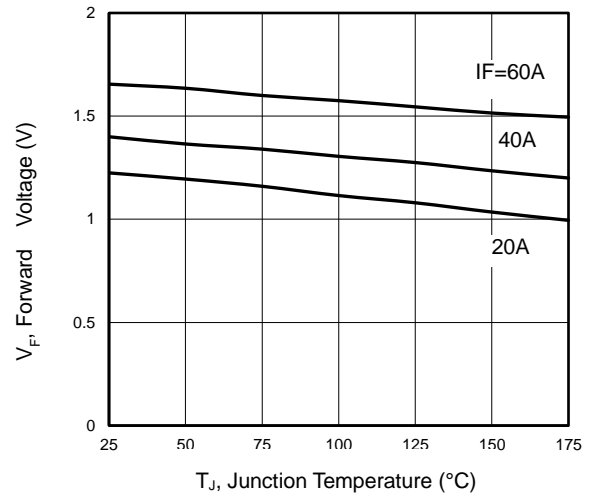


Figure 9 Typical Switching Times as a Function of Gate Resistor

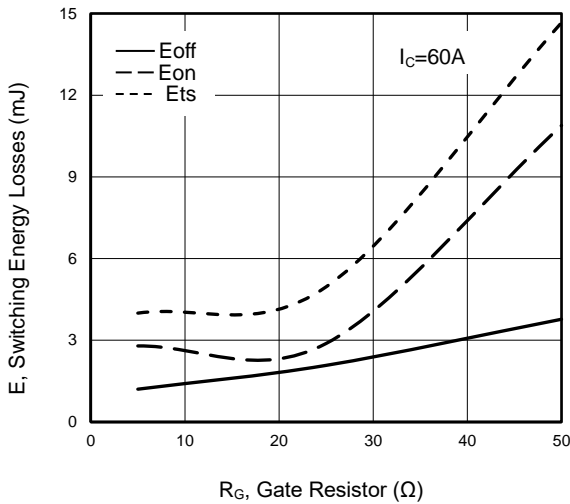


Figure 10 Typical Switching Times as a Function of Junction Temperature

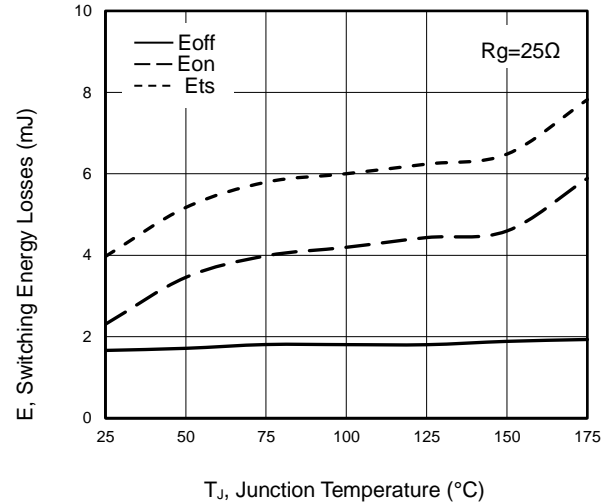


Figure 11 Gate-emitter Threshold Voltage as a Function of Junction Temperature

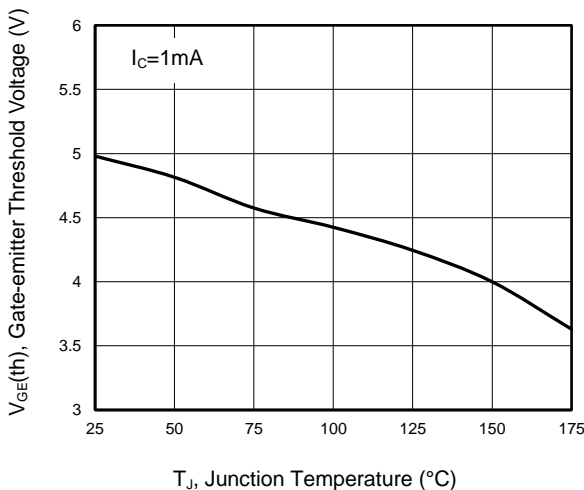
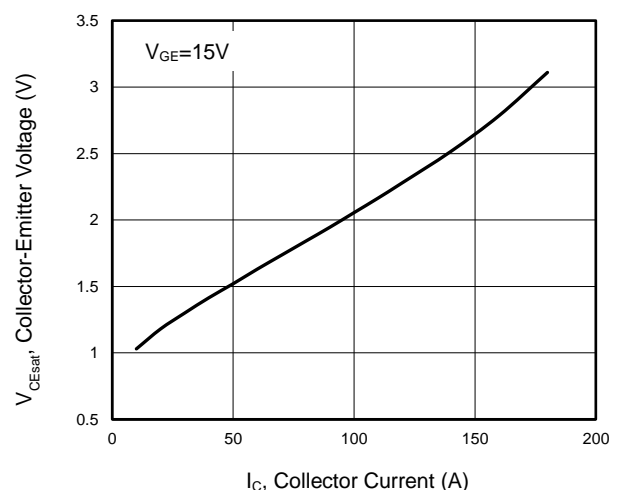
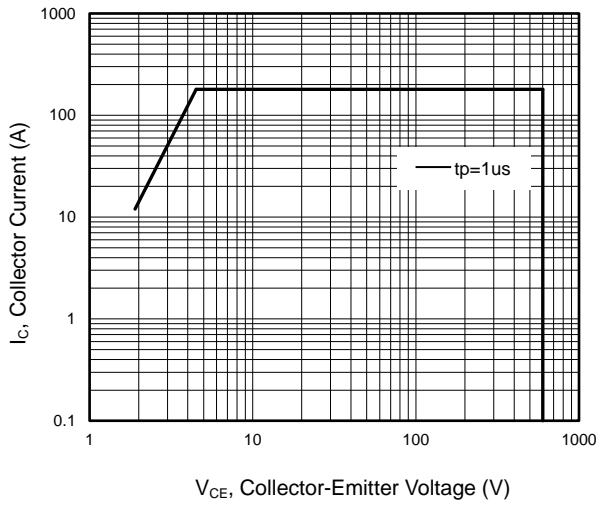


Figure 12 Typical Collector-emitter Saturation Voltage as a function of Collector Current

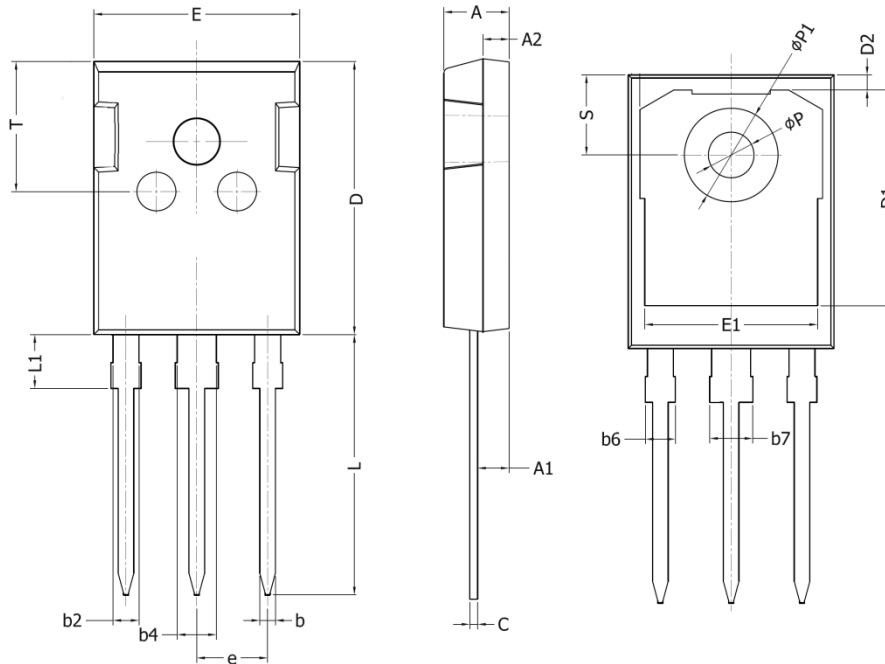


## Typical Electrical and Thermal Characteristics

Figure 13 Forward Bias Safe Operating Area

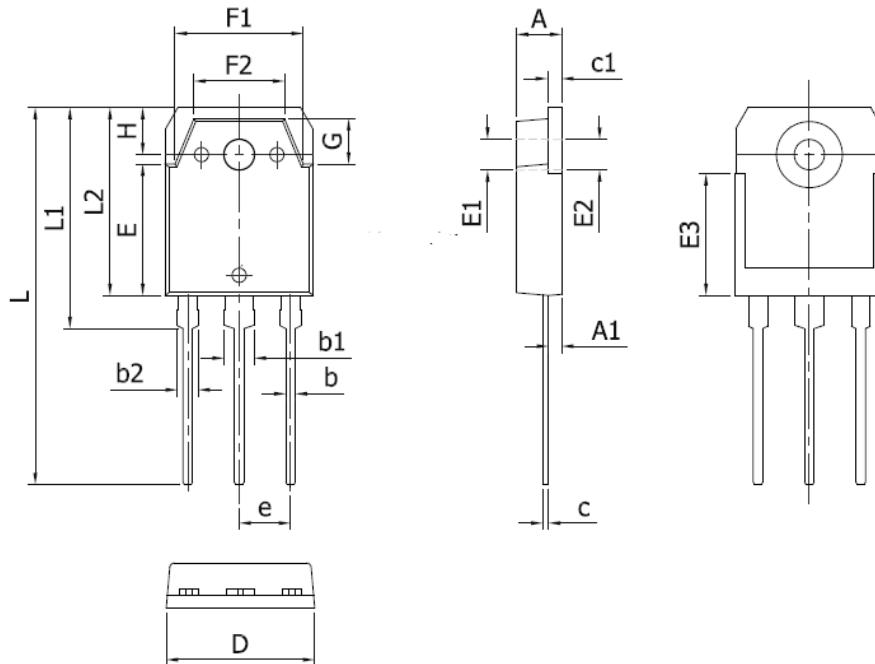


## TO-247-3L Package Information



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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