

## 1200V, 40A, Trench FS II Fast IGBT

### General Description:

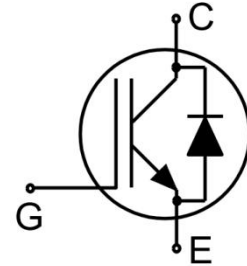
Using NCE's proprietary trench design and advanced FS (Field Stop) second generation technology, the 1200V Trench FSII IGBT offers superior conduction and switching performances, and easy parallel operation;

### 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

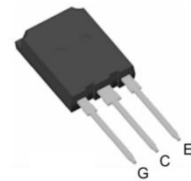
- PV power
- Three-level Solar String Inverter
- UPS



Schematic diagram

### Package Marking and Ordering Information

Device	Device Package	Device Marking
NCE40TS120VTP	TO-247P	NCE40TS120VTP



TO-247P

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

Symbol	Parameter	Value	Units
$V_{CES}$	Collector-Emitter Voltage	1200	V
$V_{GES}$	Gate- Emitter Voltage	$\pm 30$	V
$I_C$	Collector Current	80	A
	Collector Current @ $T_C = 100^\circ\text{C}$	40	A
$I_{Cpuls}$	Pulsed Collector Current, $t_p$ limited by $T_{jmax}$	160	A
-	turn off safe operating area, $V_{CE}=1200\text{V}$ , $T_j=175^\circ\text{C}$	160	A
$I_F$	Diode Continuous Forward Current @ $T_C = 100^\circ\text{C}$	40	A
$I_{FM}$	Diode Maximum Forward Current	160	A
$P_D$	Power Dissipation @ $T_C = 25^\circ\text{C}$	468	W
	Power Dissipation @ $T_C = 100^\circ\text{C}$	234	W
$T_J, T_{stg}$	Operating Junction and Storage Temperature Range	-55 to +175	$^\circ\text{C}$
$T_L$	Maximum Temperature for Soldering	260	$^\circ\text{C}$

**Thermal Characteristic**

Symbol	Parameter	Value	Units
$R_{\theta JC}$	Thermal Resistance, Junction to case for IGBT	0.32	$^{\circ}\text{C}/\text{W}$
$R_{\theta JC}$	Thermal Resistance, Junction to case for Diode	0.61	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	40	$^{\circ}\text{C}/\text{W}$

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

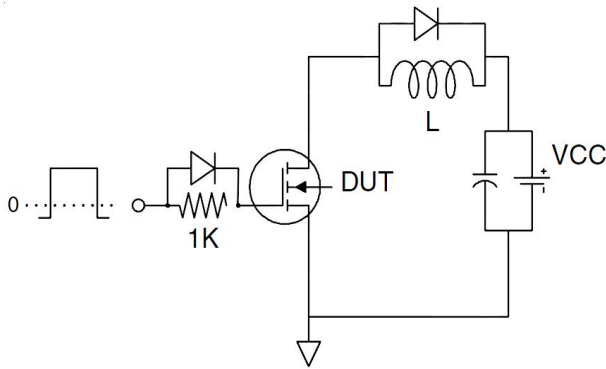
Symbol	Parameter	Conditions	Value			Units	
			Min.	Typ.	Max.		
<b>Static Characteristics</b>							
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	$V_{GE}=0\text{V}, I_{CE}=1\text{mA}$	1200	--	--	V	
$I_{CES}$	Collector-Emitter Leakage Current	$V_{GE}=0\text{V}, V_{CE}=1200\text{V}$	--	--	200	$\mu\text{A}$	
$I_{GES(F)}$	Gate to Emitter Forward Leakage	$V_{GE}=+30\text{V}, V_{CE}=0\text{V}$	--	--	200	nA	
$I_{GES(R)}$	Gate to Emitter Reverse Leakage	$V_{GE}=-30\text{V}, V_{CE}=0\text{V}$	--	--	200	nA	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C=40\text{A}$	--	1.70	1.95	V	
		$V_{GE}=15\text{V}$	--	1.95	--	V	
$V_{GE(th)}$	Gate Threshold Voltage	$I_C=1\text{mA}, V_{CE}=V_{GE}$	4.5	--	6.0	V	
<b>Dynamic Characteristics</b>							
$C_{ies}$	Input Capacitance	$V_{CE}=30\text{V}, V_{GE}=0\text{V},$ $f=1\text{MHz}$	--	5590	--	pF	
$C_{oes}$	Output Capacitance		--	177	--		
$C_{res}$	Reverse Transfer Capacitance		--	134	--		
$Q_g$	Total Gate Charge	$V_{CC}=960\text{V}, I_C=40\text{A},$ $V_{GE}=15\text{V}$	--	298	--	nC	
$Q_{ge}$	Gate to Emitter Charge		--	52	--		
$Q_{gc}$	Gate to Collector Charge		--	169	--		
<b>Switching Characteristics</b>							
$t_{d(ON)}$	Turn-on Delay Time	$V_{CE}=600\text{V}, I_C=40\text{A},$ $V_{GE}=0/15\text{V}, R_g=8\Omega$ Inductive Load	--	19	--	ns	
$t_r$	Rise Time		--	17	--		
$t_{d(OFF)}$	Turn-Off Delay Time		--	170	--		
$t_f$	Fall Time		--	18	--		
$E_{on}$	Turn-On Switching Loss		Inductive Load	--	2.2	--	mJ
$E_{off}$	Turn-Off Switching Loss			--	1.3	--	
$E_{ts}$	Total Switching Loss	--		3.5	--		
$E_{on}$	Turn-On Switching Loss	$V_{CE}=600\text{V}, I_C=40\text{A},$ $V_{GE}=0/15\text{V}, R_g=8\Omega$ $T_j=175^{\circ}\text{C}$	--	2.8	--	mJ	
$E_{off}$	Turn-Off Switching Loss		--	1.6	--		
$E_{ts}$	Total Switching Loss		--	4.4	--		

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

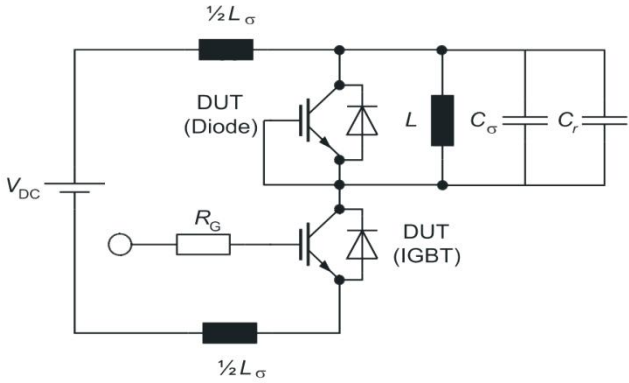
Symbol	Parameter	Conditions	Value			Units	
			Min.	Typ.	Max.		
$V_{FM}$	Diode Forward Voltage	$I_F = 40\text{A}$	$T_j = 25^\circ\text{C}$	--	2.0	2.8	V
			$T_j = 175^\circ\text{C}$	--	1.9	--	V
$T_{rr}$	Reverse Recovery Time	$I_F = 20\text{A},$ $di/dt = 500\text{A}/\mu\text{s}$	--	156	--	ns	
$I_{RRM}$	Diode Peak Reverse Recovery Current		--	9.0	--	A	
$Q_{rr}$	Reverse Recovery Charge		--	1.8	--	$\mu\text{C}$	
$T_{rr}$	Reverse Recovery Time	$I_F = 20\text{A},$ $di/dt = 500\text{A}/\mu\text{s},$ $T_j = 175^\circ\text{C}$	--	280	--	ns	
$I_{RRM}$	Diode Peak Reverse Recovery Current		--	13.5	--	A	
$Q_{rr}$	Reverse Recovery Charge		--	4.3	--	$\mu\text{C}$	

Test Circuit

1) Gate Charge Test Circuit

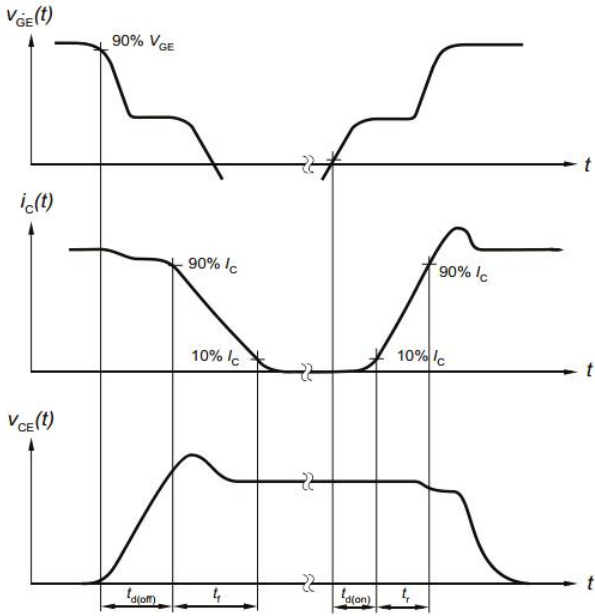


2) Switch Time Test Circuit

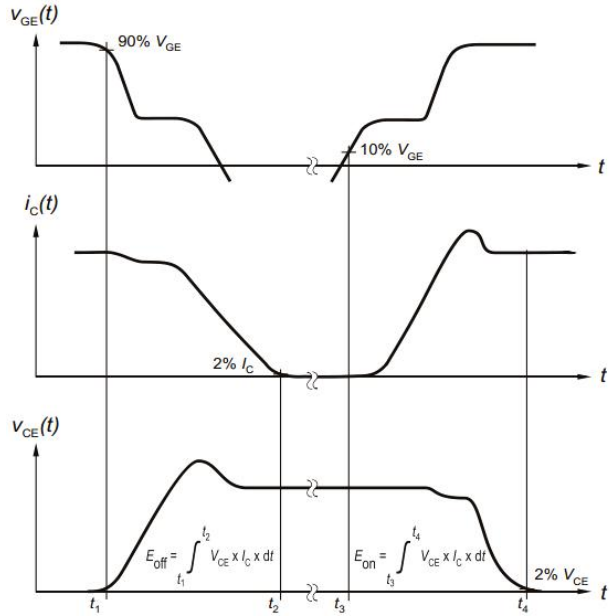


Switching characteristics

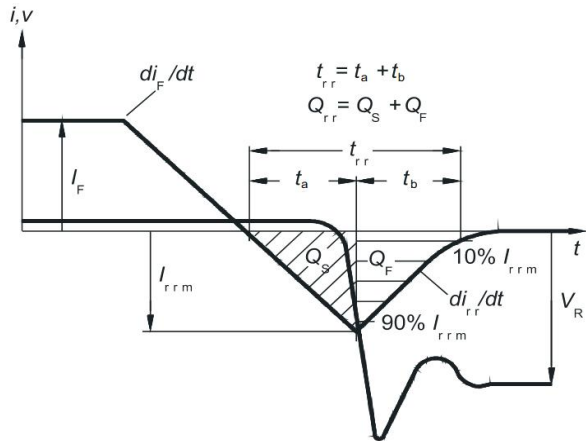
1) Definition of switching times



2) Definition of switching losses



3) Definition of diode switching characteristics



Typical Electrical and Thermal Characteristics

Figure 1 Output Characteristics

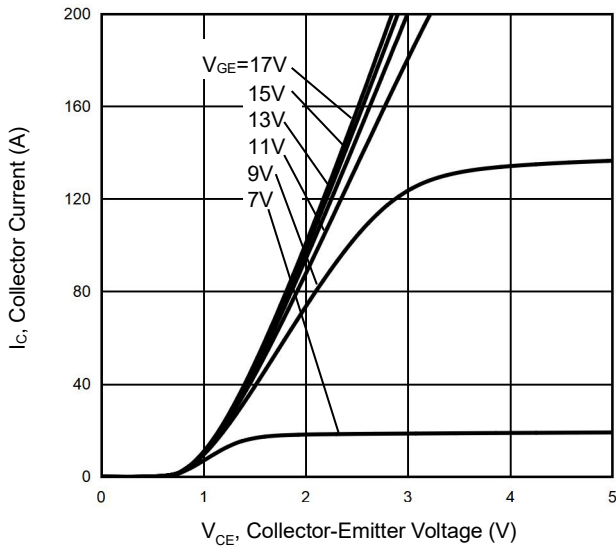


Figure 2 Transfer Characteristics

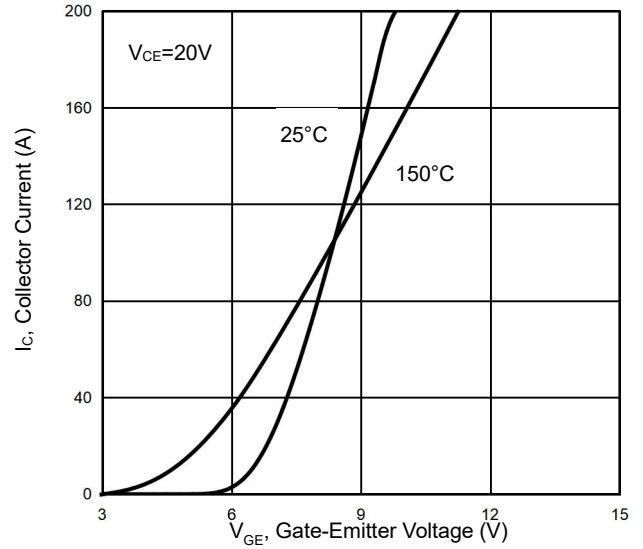


Figure 3  $V_{CE(sat)}$  vs. Case Temperature

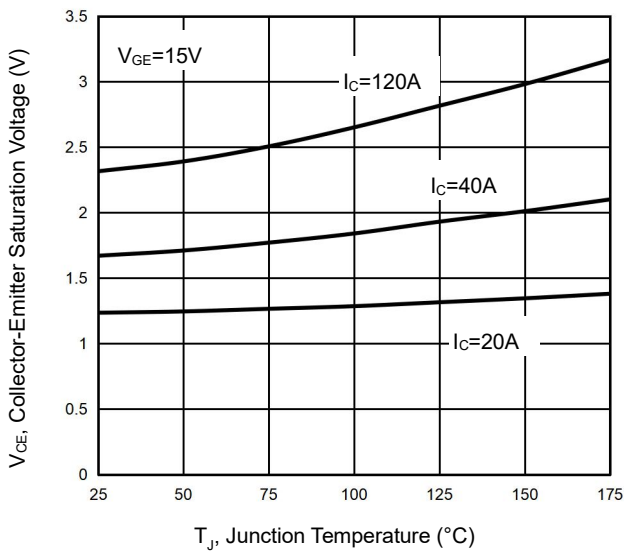


Figure 4 Saturation Voltage vs.  $V_{GE}$

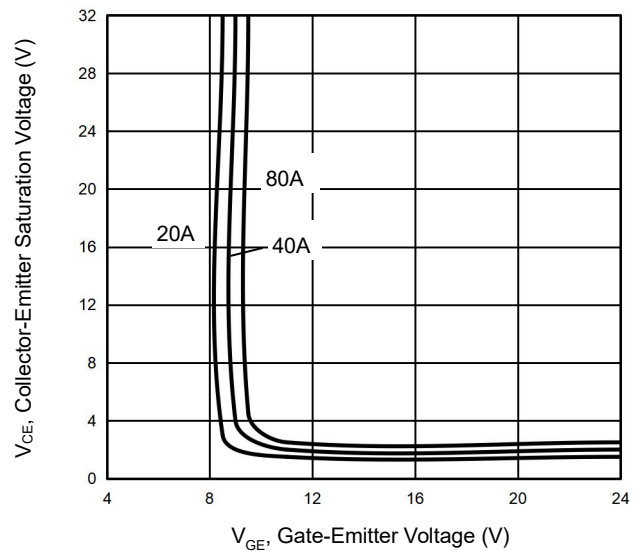


Figure 5 Capacitance Characteristics

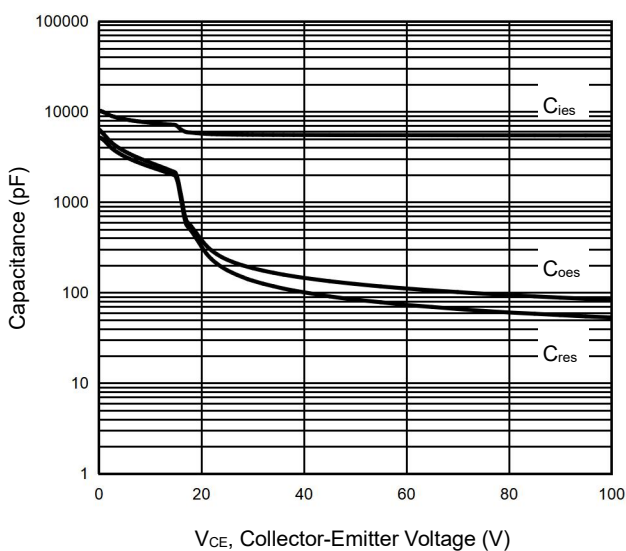
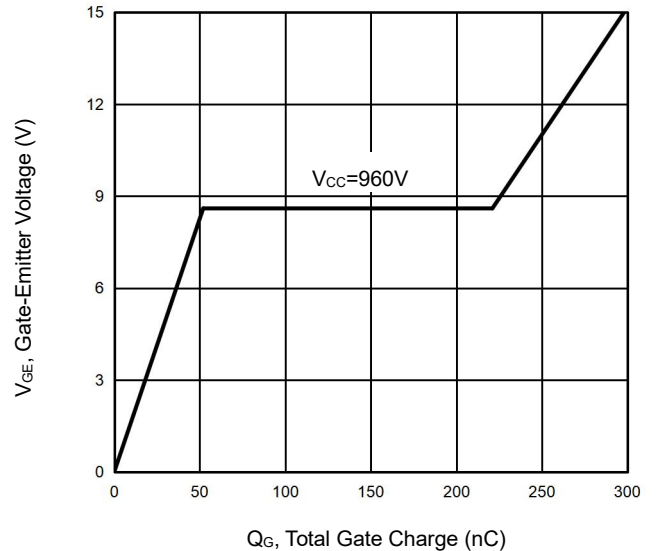


Figure 6 Gate Charge Wave Form



Typical Electrical and Thermal Characteristics

Figure 7 Forward Characteristics

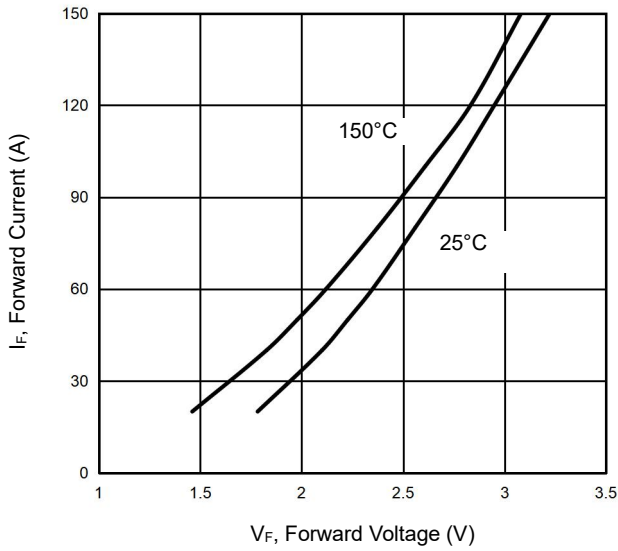


Figure 8  $V_F$  vs. Temperature

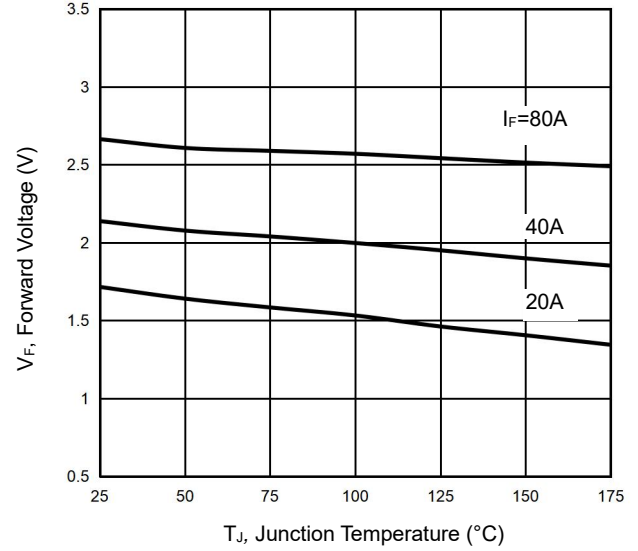


Figure 9 Switching Energy vs. Temperature

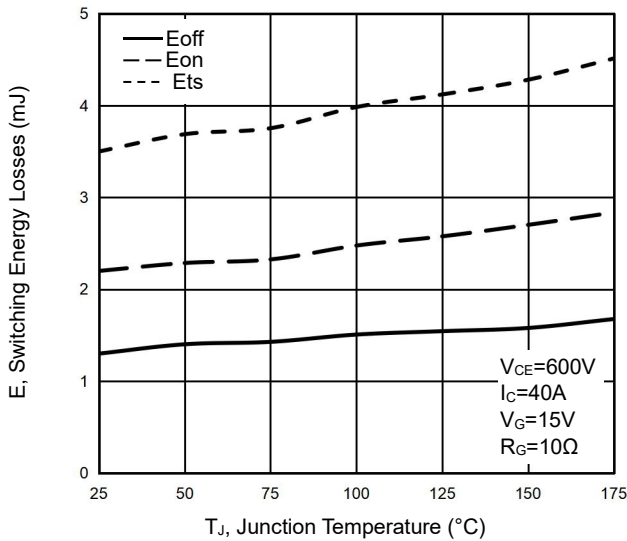


Figure 10 Forward Bias Safe Operating Area

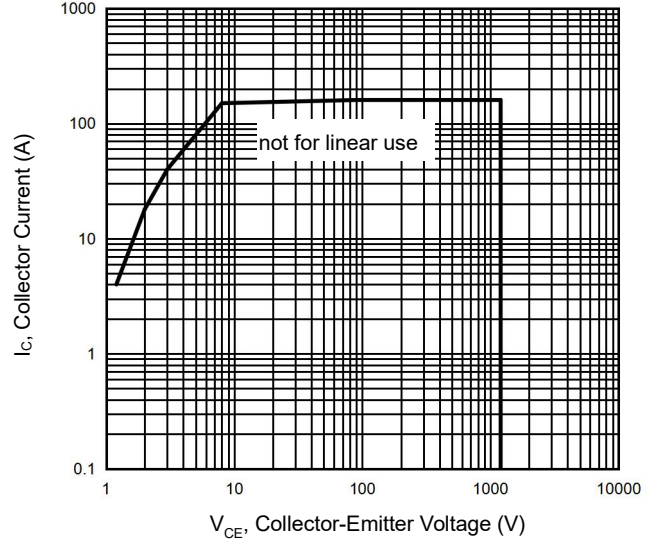


Figure 11 Gate-Emitter Threshold Voltage as a Function of Junction Temperature

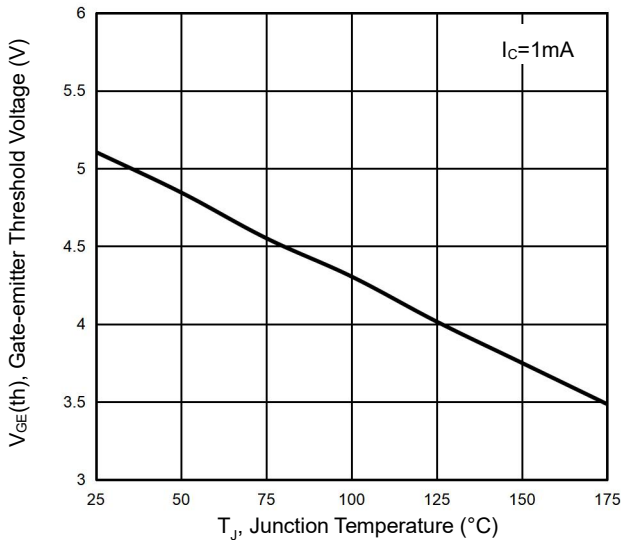
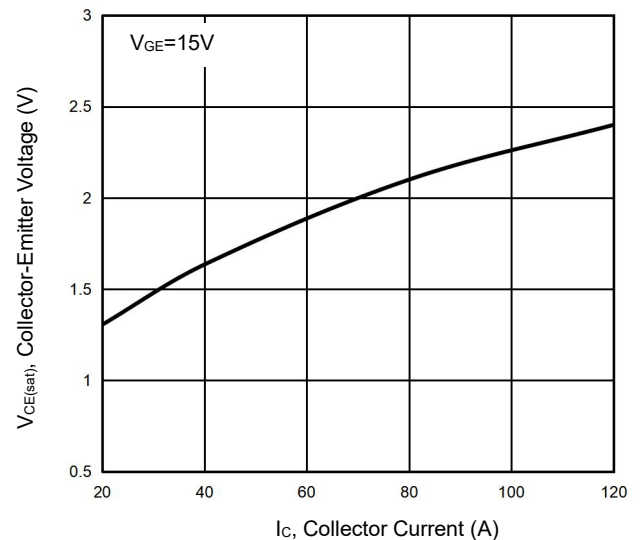


Figure 12 Typical Collector-Emitter Saturation Voltage as a function of Collector Current



Typical Electrical and Thermal Characteristics

Figure 13 Switching Loss vs.  $R_G$

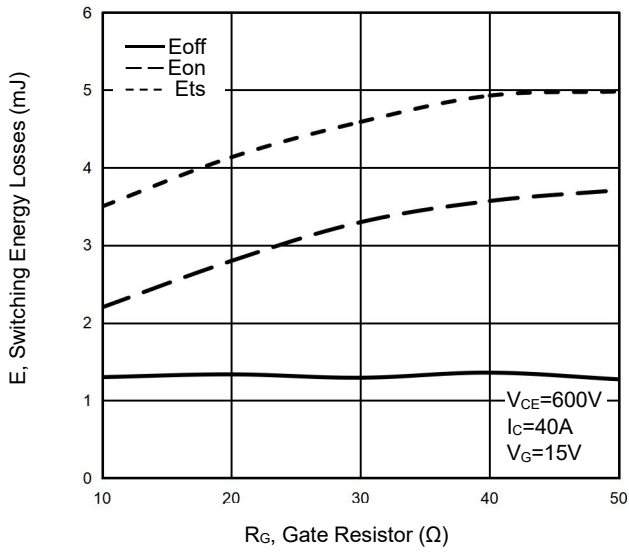


Figure 14 Switching Loss vs. Collector Current

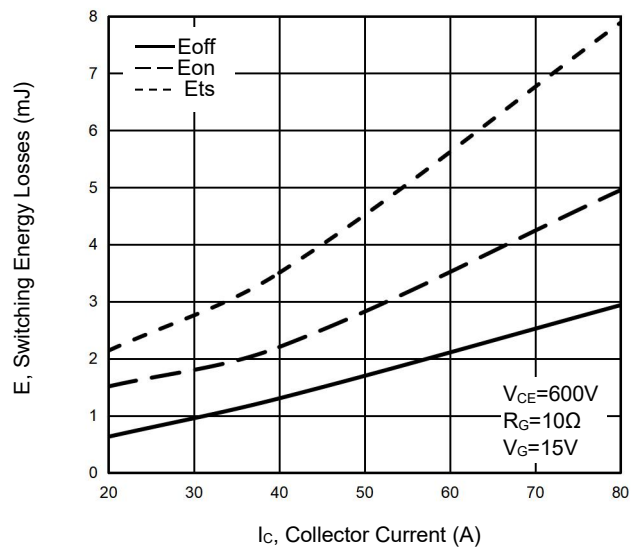


Figure 15 Switching Loss vs. Collector Current

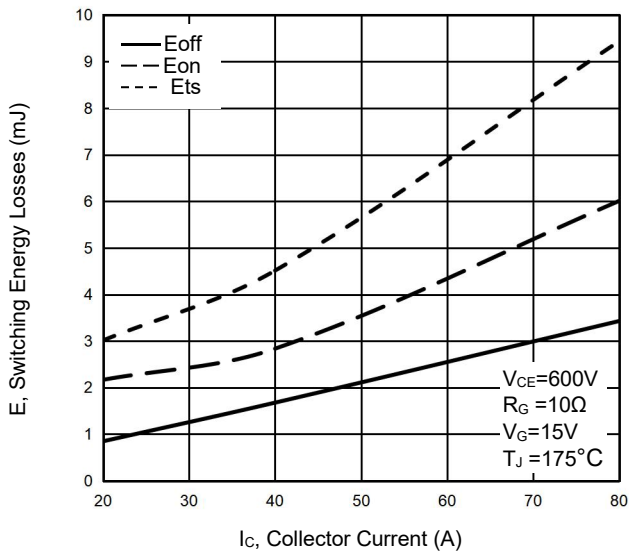


Figure 16  $P_{tot}$  vs. Case Temperature

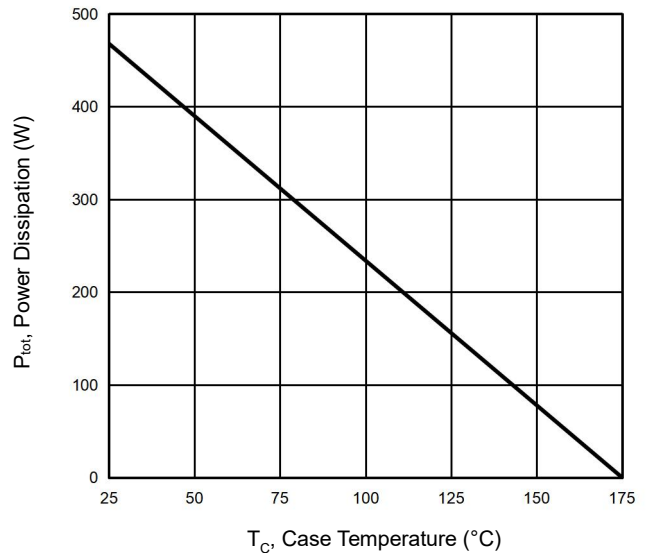


Figure 17  $V_{CES}$  vs. Temperature

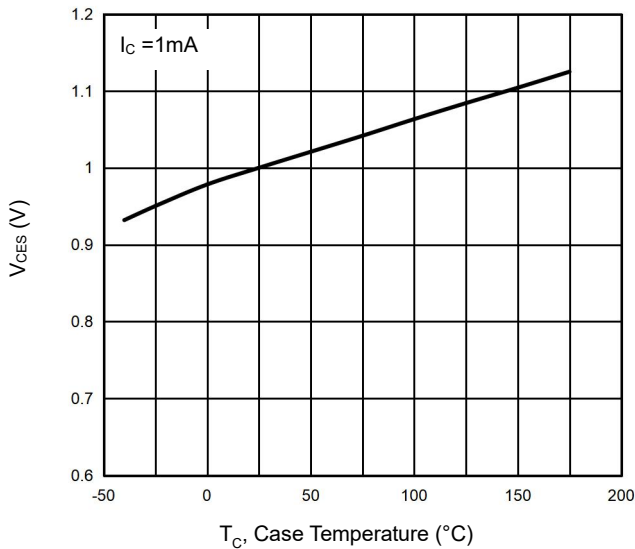
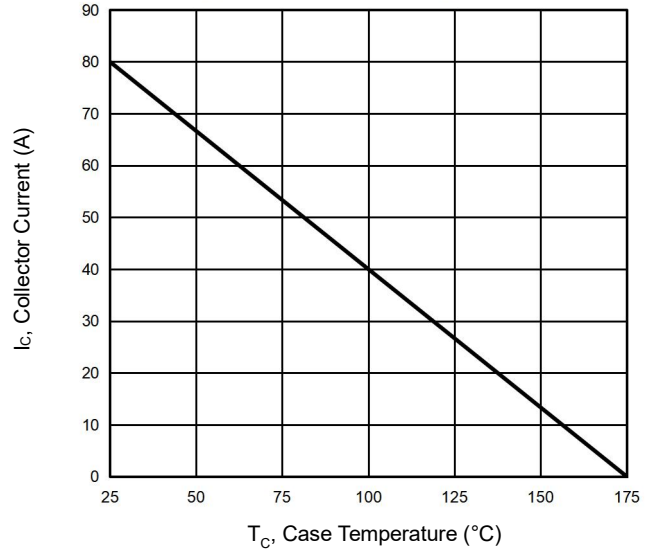


Figure 18  $I_C$  vs. Temperature



Typical Electrical and Thermal Characteristics

Figure 19 Switching Time vs.  $I_C$

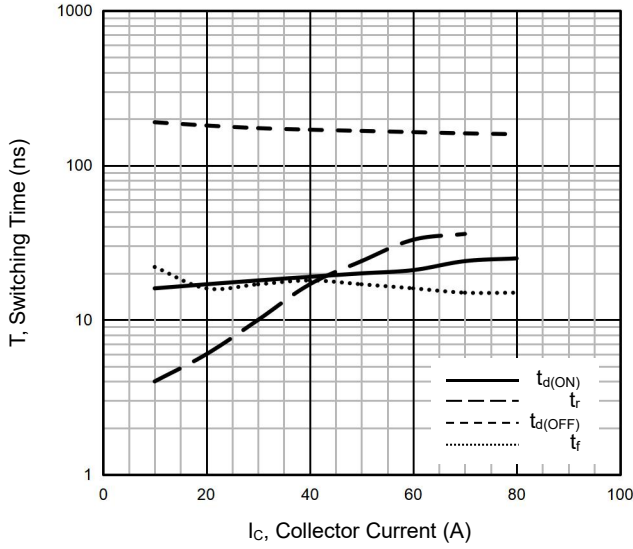


Figure 20 Switching Time vs.  $R_G$

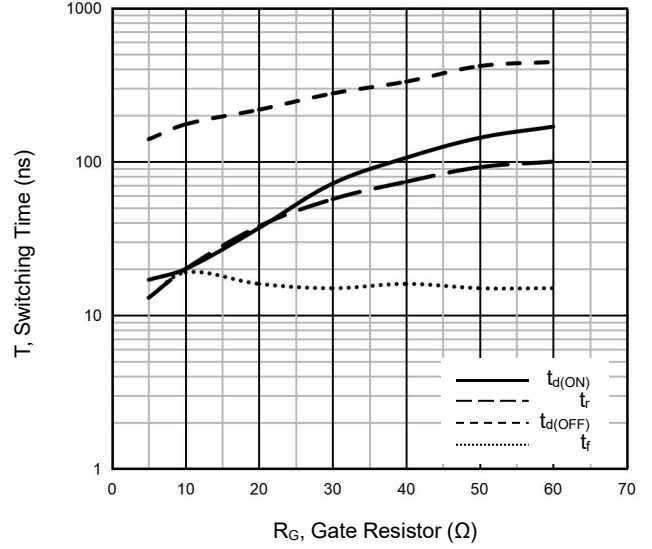


Figure 21  $V_{CE(sat)}$  vs. Collector Current

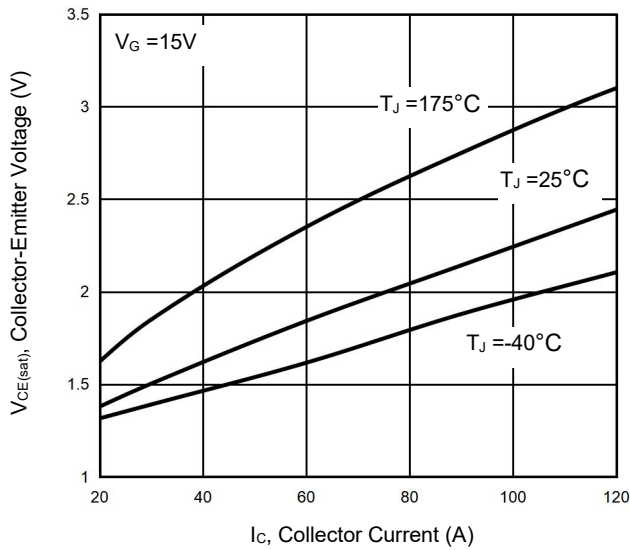


Figure 22 Switching Loss vs.  $V_{CE}$

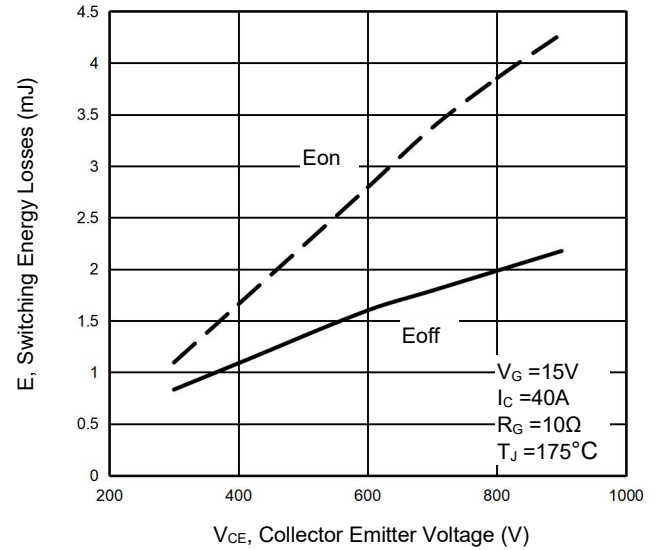


Figure 23 Switching Time vs.  $I_C$

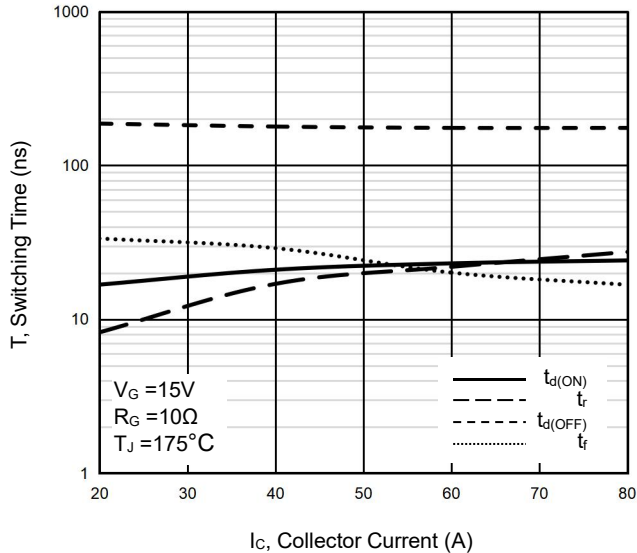
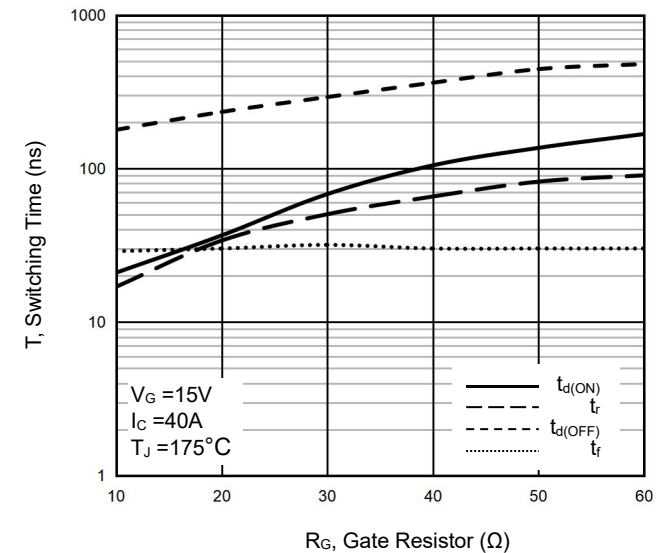
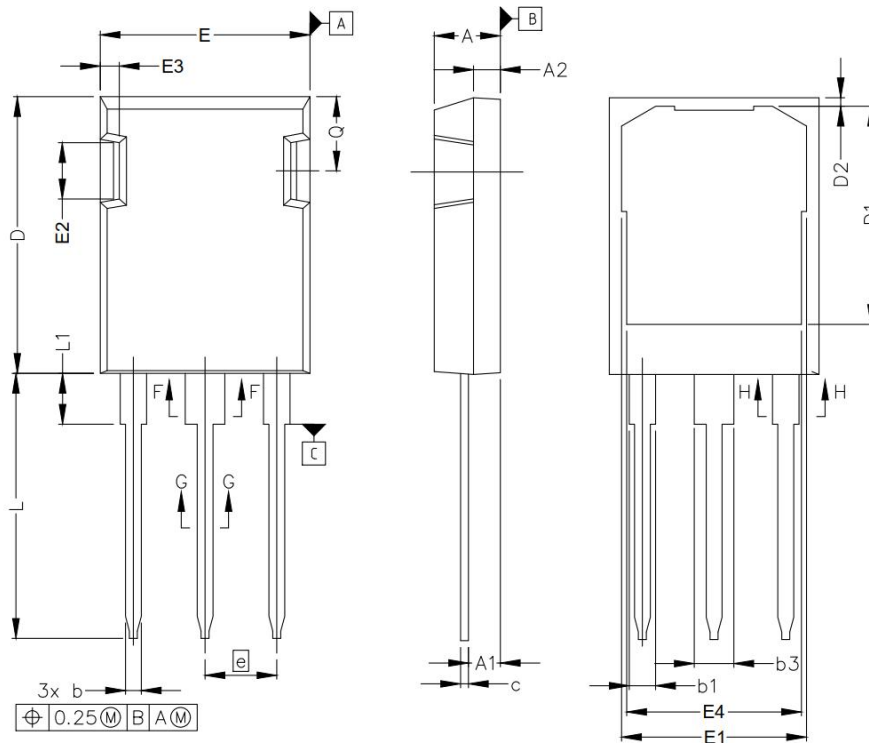


Figure 24 Switching Time vs.  $R_G$



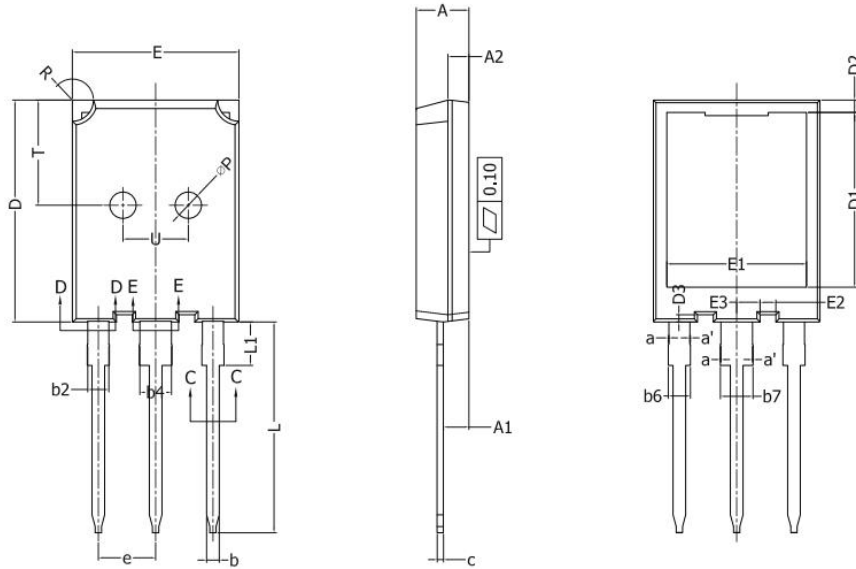


## TO-247P-B Package Information



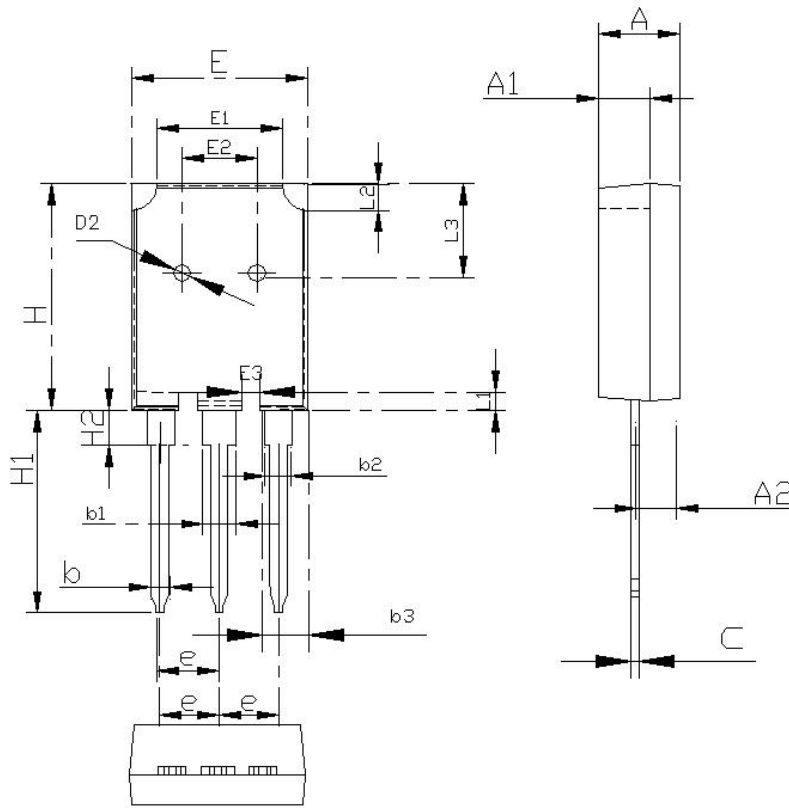
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.83	5.21	0.19	0.21
A1	2.29	2.54	0.09	0.10
A2	1.91	2.16	0.08	0.09
b	1.07	1.33	0.04	0.05
b1	1.91	2.41	0.08	0.09
b3	2.87	3.38	0.11	0.13
c	0.55	0.68	0.02	0.03
D	20.80	21.10	0.82	0.83
D1	16.25	17.65	0.64	0.69
D2	0.50	0.80	0.02	0.03
E	15.75	16.13	0.62	0.64
E1	13.10	14.15	0.52	0.56
E2	3.68	5.10	0.14	0.20
E3	1.00	1.90	0.04	0.07
E4	12.38	13.43	0.49	0.53
e	5.44BSC		0.21	
N	3.00		0.12	
L	19.81	20.32	0.78	0.80
L1	3.70	4.00	0.15	0.16
Q	5.49	6.00	0.22	0.24

## TO-247P-P Package Information



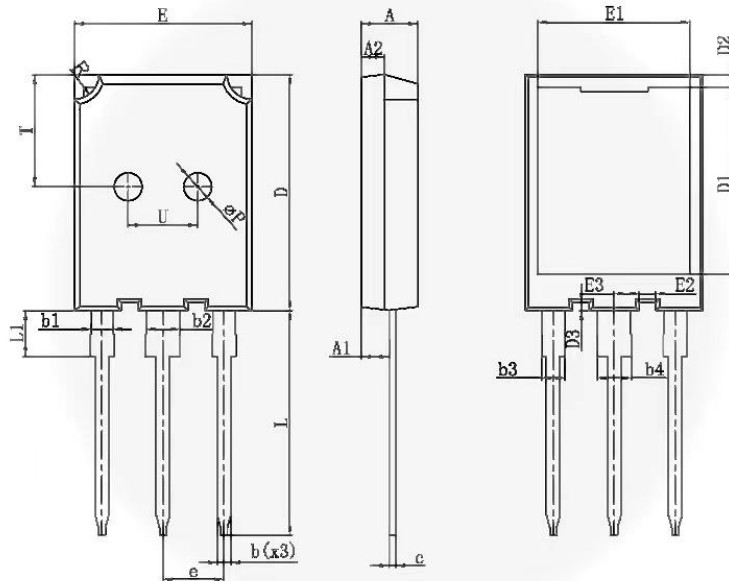
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.90	5.10	0.193	0.201
A1	2.31	2.51	0.091	0.099
A2	1.90	2.10	0.075	0.083
a、a'	0.00	0.15	0.000	0.006
b	1.16	1.26	0.046	0.050
b2	1.96	2.06	0.077	0.081
b4	2.96	3.06	0.117	0.120
b6	-	2.25	-	0.089
b7	-	3.25	-	0.128
c	0.59	0.66	0.023	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
D3	0.58	0.78	0.023	0.031
E	15.70	15.90	0.618	0.626
E1	13.10	13.50	0.516	0.531
E2	1.40	1.60	0.055	0.063
E3	2.12	2.32	0.083	0.091
e	5.436 BSC		0.214 BSC	
L	19.80	20.10	0.780	0.791
L1	-	4.30	-	0.169
P	2.40	2.60	0.094	0.102
R	1.90	2.10	0.075	0.083
T	9.80	10.20	0.386	0.402
U	6.00	6.40	0.236	0.252

## TO-247P-d Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.80	5.20	0.189	0.205
A1	2.80	3.20	0.110	0.126
A2	1.80	2.20	0.071	0.087
b	1.00	1.40	0.039	0.055
b1	2.90	3.30	0.114	0.130
b2	1.90	2.30	0.075	0.091
b3	3.90	4.30	0.154	0.169
c	0.45	0.75	0.018	0.030
e	5.25	5.65	0.207	0.222
E	15.60	16.00	0.614	0.630
E1	10.20	11.00	0.402	0.433
E2	6.30	6.90	0.248	0.272
E3	1.60	2.00	0.063	0.079
L1	0.35	0.65	0.014	0.026
L2	1.80	2.20	0.071	0.087
L3	9.50	10.50	0.374	0.413
H	20.50	21.50	0.807	0.846
H1	19.50	20.50	0.768	0.807
H2	3.50	4.50	0.138	0.177

## TO-247P-E Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.90	5.10	0.19	0.20
A1	2.31	2.51	0.09	0.10
A2	1.90	2.10	0.07	0.08
b	1.10	1.30	0.04	0.05
b1	1.90	2.10	0.07	0.08
b2	2.90	3.10	0.11	0.12
b3	--	2.25	--	0.09
b4	--	3.25	--	0.13
c	0.55	0.65	0.02	0.03
D	20.90	21.10	0.82	0.83
D1	16.55	17.15	0.65	0.68
D2	1.05	1.35	0.04	0.05
D3	0.58	0.78	0.02	0.03
E	15.70	15.90	0.62	0.63
E1	13.40	13.80	0.53	0.54
E2	1.40	1.60	0.06	0.06
E3	2.12	2.32	0.08	0.09
e	5.436 BSC		0.21 BSC	
L	19.90	20.10	0.78	0.79
L1	3.94	4.30	0.16	0.17
∅ P	2.40	2.60	0.09	0.10
R	2.10	2.30	0.08	0.09
T	9.80	10.20	0.39	0.40
U	6.00	6.40	0.24	0.25

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