

## 650V, 80A, Trench FS II Fast IGBT

### General Description

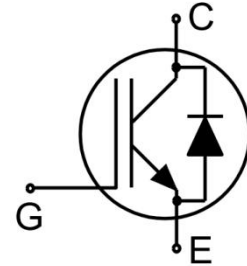
Using NCE's proprietary trench design and advanced FS (Field Stop) second generation technology, the 650V Trench FSII IGBT offers superior conduction and switching performances, and easy parallel operation;

### 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
NCE80TD65BT	TO-247	NCE80TD65BT



TO-247

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

Symbol	Parameter	Value	Units
$V_{CES}$	Collector-Emitter Voltage	650	V
$V_{GES}$	Gate- Emitter Voltage	$\pm 30$	V
	Gate- Emitter Voltage (AC)	$\pm 40$	V
$I_C$	Collector Current	160	A
	Collector Current @ $T_C = 100^\circ\text{C}$	80	A
$I_{Cpuls}$	Pulsed Collector Current, $t_p$ limited by $T_{jmax}$	320	A
-	Turn off safe operating area, $V_{CE}=650\text{V}$ , $T_j=175^\circ\text{C}$	320	A
$I_F$	Diode Continuous Forward Current @ $T_C = 100^\circ\text{C}$	80	A
$I_{FM}$	Diode Maximum Forward Current	320	A
$P_D$	Power Dissipation @ $T_C = 25^\circ\text{C}$	416	W
	Power Dissipation @ $T_C = 100^\circ\text{C}$	208	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 $V_{GE}=15\text{V}$ , $V_{CC}\leq 400\text{V}$ , Allowed number of short circuits<1000Time between short circuits: $\geq 1.0\text{s}$ , $T_j\leq 150^\circ\text{C}$	5	$\mu\text{s}$

**Thermal Characteristic**

Symbol	Parameter	Value	Units
$R_{\theta JC}$	Thermal Resistance, Junction to case for IGBT	0.36	$^{\circ}\text{C}/\text{W}$
$R_{\theta JC}$	Thermal Resistance, Junction to case for Diode	0.44	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	40	$^{\circ}\text{C}/\text{W}$

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

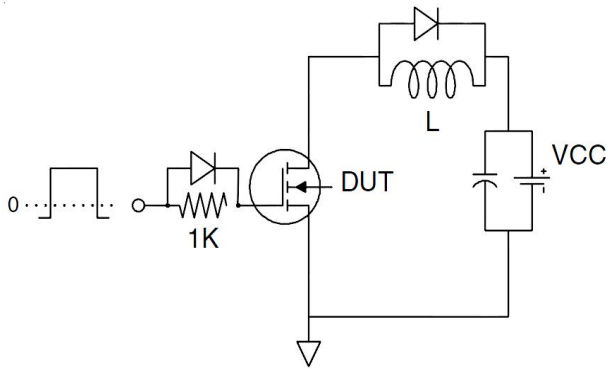
Symbol	Parameter	Conditions	Value			Units	
			Min.	Typ.	Max.		
<b>Static Characteristics</b>							
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	$V_{GE}=0\text{V}, I_{CE}=1\text{mA}$	650	--	--	V	
$I_{CES}$	Collector-Emitter Leakage Current	$V_{GE}=0\text{V}, V_{CE}=650\text{V}$	--	--	75	$\mu\text{A}$	
$I_{GES(F)}$	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	$I_C=80\text{A}$ $V_{GE}=15\text{V}$	$T_j=25^{\circ}\text{C}$	--	1.7	1.9	V
			$T_j=175^{\circ}\text{C}$	--	1.9	--	V
$V_{GE(th)}$	Gate Threshold Voltage	$I_C=1\text{mA}, V_{CE}=V_{GE}$	4.0	5.0	6.0	V	
<b>Dynamic Characteristics</b>							
$C_{ies}$	Input Capacitance	$V_{CE}=25\text{V}, V_{GE}=0\text{V},$ $f=1\text{MHz}$	--	9188	--	pF	
$C_{oes}$	Output Capacitance		--	258	--		
$C_{res}$	Reverse Transfer Capacitance		--	181	--		
$Q_g$	Total Gate Charge	$V_{CC}=480\text{V}, I_C=80\text{A},$ $V_{GE}=15\text{V}$	--	331	--	nC	
$Q_{ge}$	Gate to Emitter Charge		--	74	--		
$Q_{gc}$	Gate to Collector Charge		--	136	--		
$I_{C(SC)}$	Short circuit collector current Max.1000 short circuits Time between short circuits: $\geq 1.0\text{s}$	$V_{GE}=15\text{V}, V_{CC}\leq 400\text{V},$ $t_{SC}\leq 5\mu\text{s}, T_j\leq 150^{\circ}\text{C}$	--	450	--	A	
<b>Switching Characteristics</b>							
$t_{d(ON)}$	Turn-on Delay Time	$V_{CC}=400\text{V}, I_C=80\text{A},$ $V_{GE}=0/15\text{V}, R_g=5\Omega,$ Inductive Load	--	19	--	ns	
$t_r$	Rise Time		--	17	--		
$t_{d(OFF)}$	Turn-Off Delay Time		--	172	--		
$t_f$	Fall Time		--	20	--		
$E_{on}$	Turn-On Switching Loss		--	1.6	--	mJ	
$E_{off}$	Turn-Off Switching Loss		--	1.2	--		
$E_{ts}$	Total Switching Loss		--	2.8	--		
$E_{on}$	Turn-On Switching Loss	$V_{CC}=400\text{V}, I_C=80\text{A},$ $V_{GE}=0/15\text{V}, R_g=5\Omega,$ $T_j=175^{\circ}\text{C}$	--	2.0	--	mJ	
$E_{off}$	Turn-Off Switching Loss		--	1.6	--		
$E_{ts}$	Total Switching Loss		--	3.6	--		

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

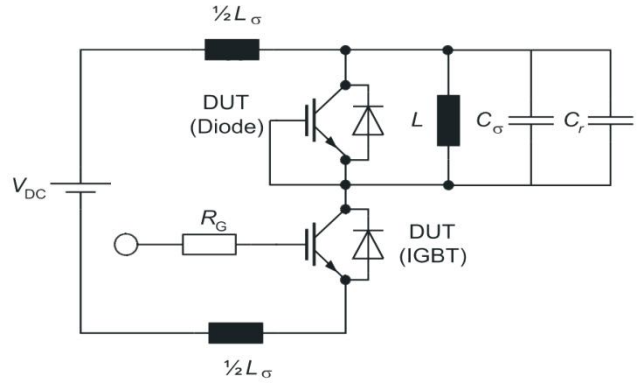
Symbol	Parameter	Conditions	Rating			Units
			Min.	Typ.	Max.	
$V_{FM}$	Diode Forward Voltage	$I_F=80\text{A}$	--	1.75	2.4	V
$T_{rr}$	Reverse Recovery Time	$I_F=80\text{A}$ , $di/dt=200\text{A}/\mu\text{s}$	--	194	--	ns
$I_{RRM}$	Diode Peak Reverse Recovery Current		--	2.8	--	A
$Q_{rr}$	Reverse Recovery Charge		--	0.2	--	$\mu\text{C}$

Test Circuit

1) Gate Charge Test Circuit

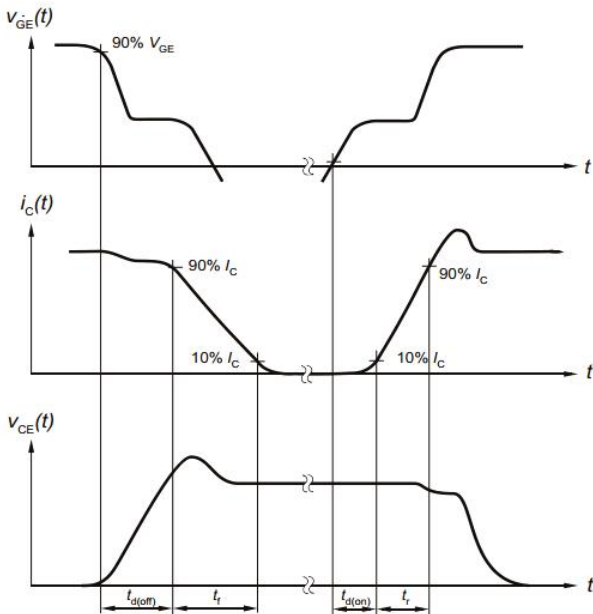


2) Switch Time Test Circuit

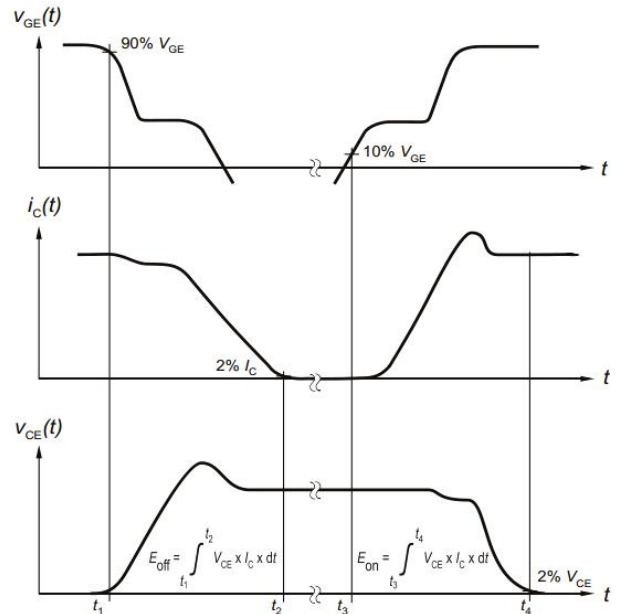


Switching characteristics

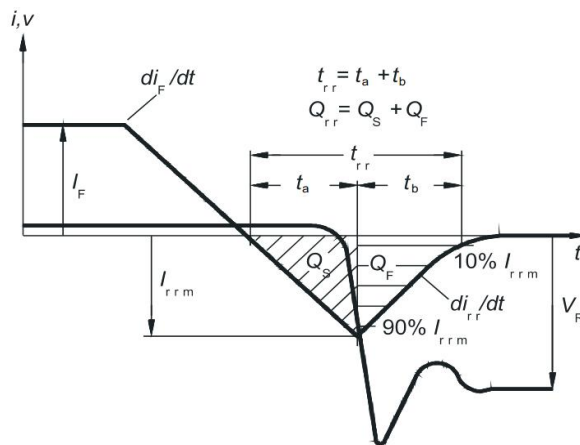
1) Definition of switching times



2) Definition of switching losses

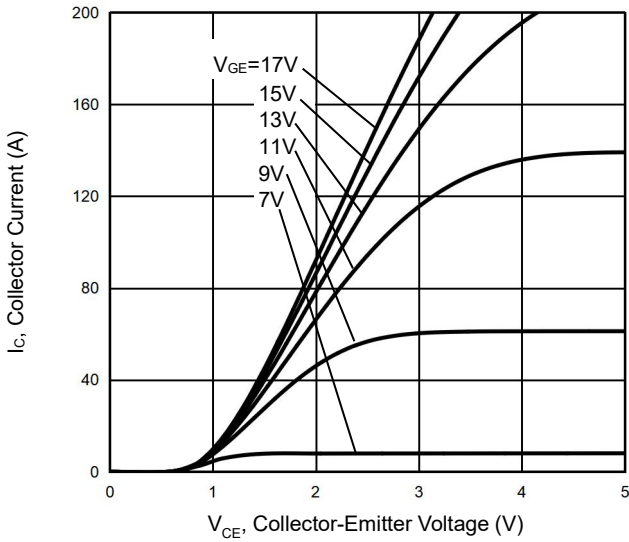


3) Definition of diode switching characteristics

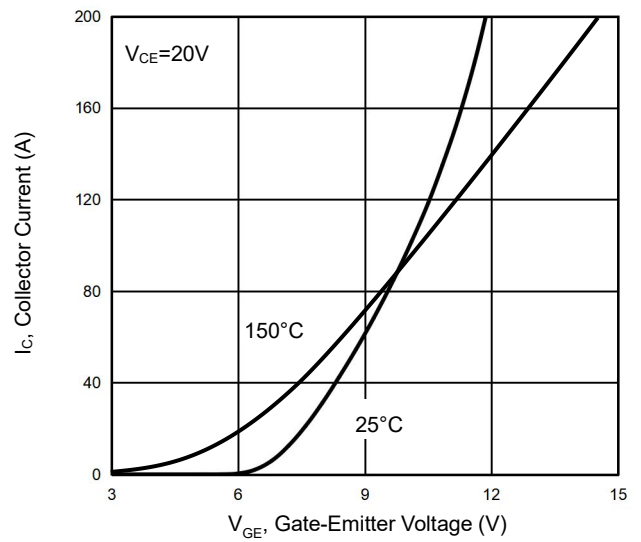


## Typical Electrical and Thermal Characteristics

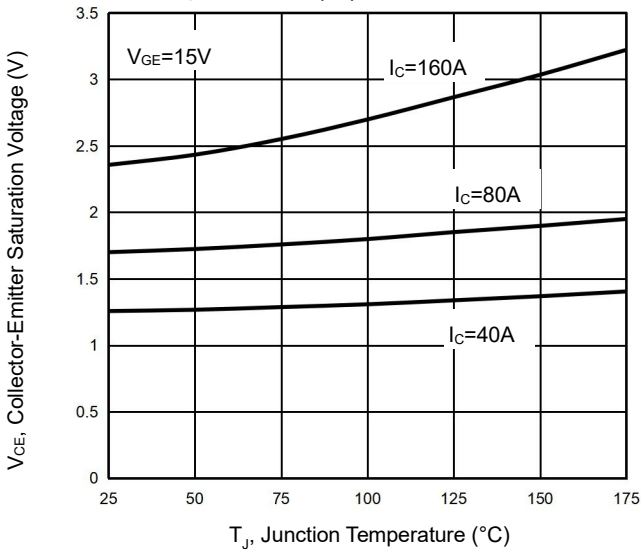
**Figure 1 Output Characteristics**



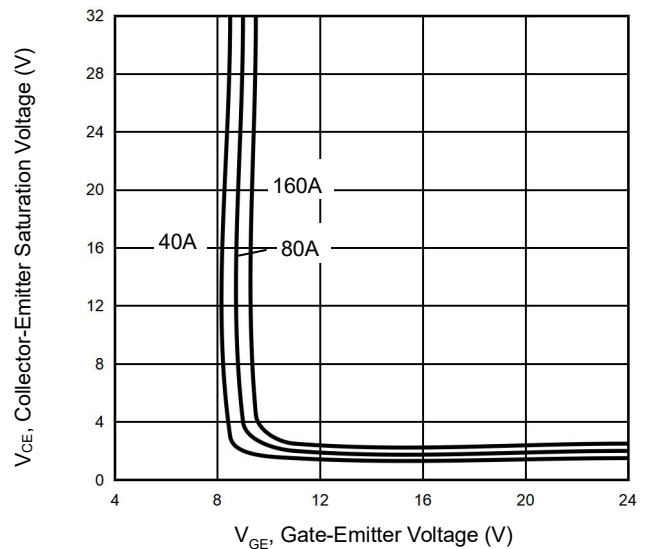
**Figure 2 Transfer Characteristics**



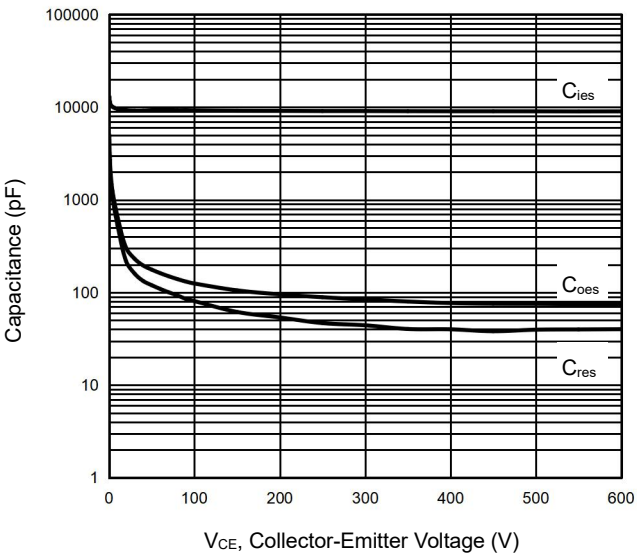
**Figure 3  $V_{CE(sat)}$  vs. Temperature**



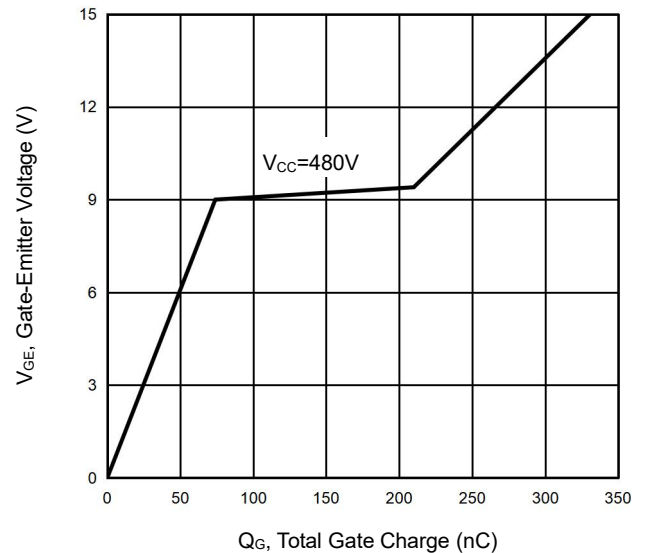
**Figure 4 Saturation Voltage vs.  $V_{GE}$**



**Figure 5 Capacitance Characteristics**



**Figure 6 Gate Charge Wave Form**



Typical Electrical and Thermal Characteristics

Figure 7 Forward Characteristics

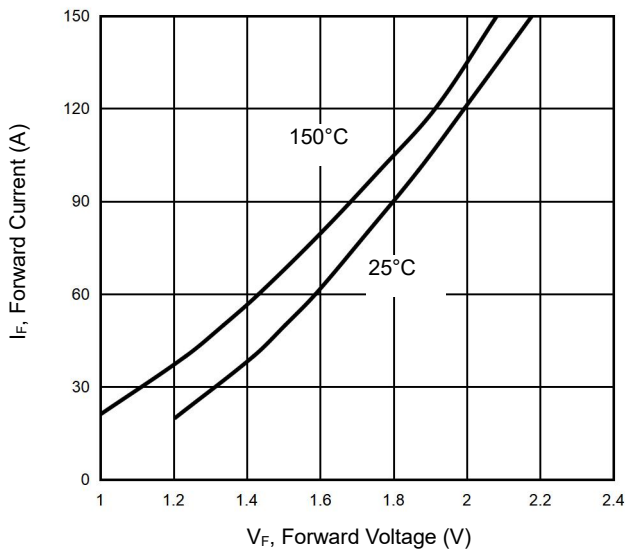


Figure 8  $V_F$  vs. Temperature

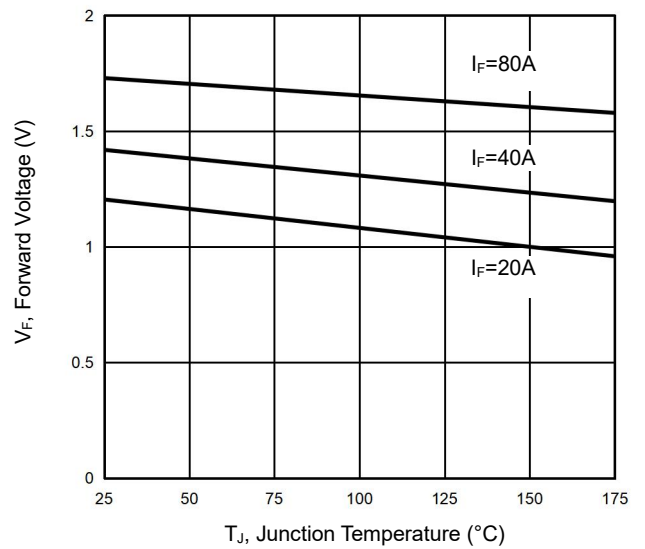


Figure 9  $V_{GE(th)}$  vs. Temperature

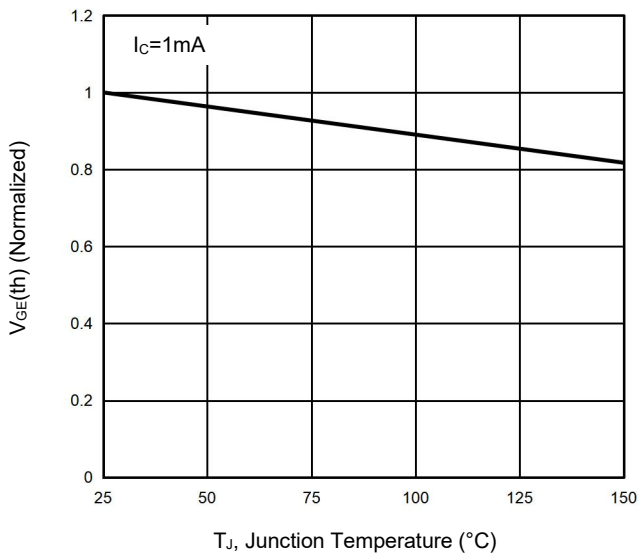


Figure 10  $V_{CE(sat)}$  vs. Collector Current

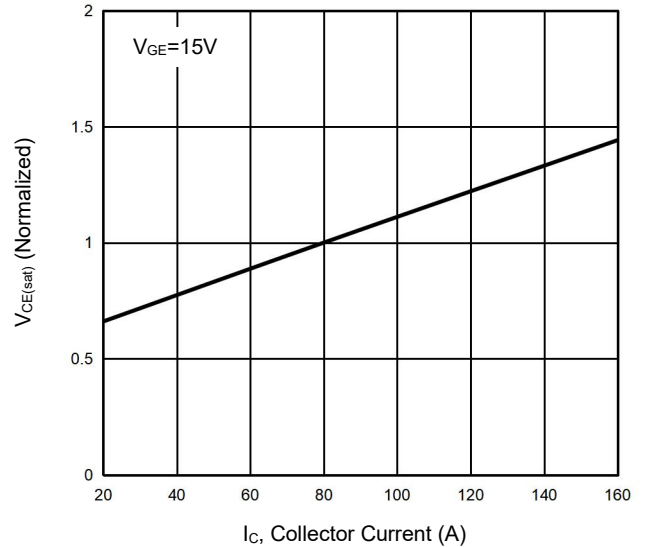


Figure 11  $P_{tot}$  vs. Case Temperature

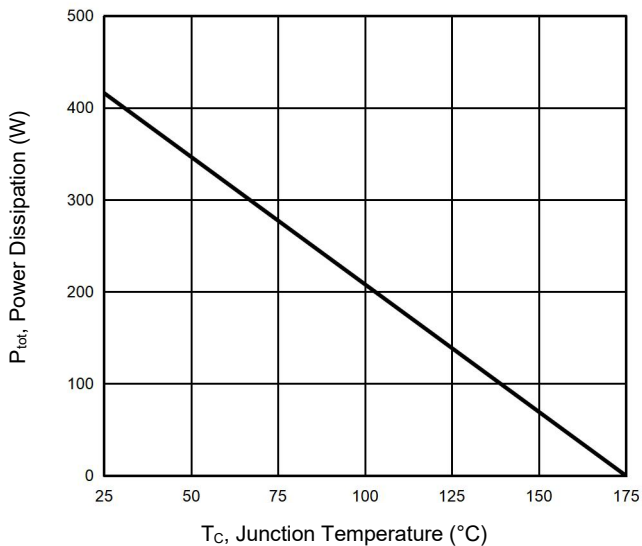
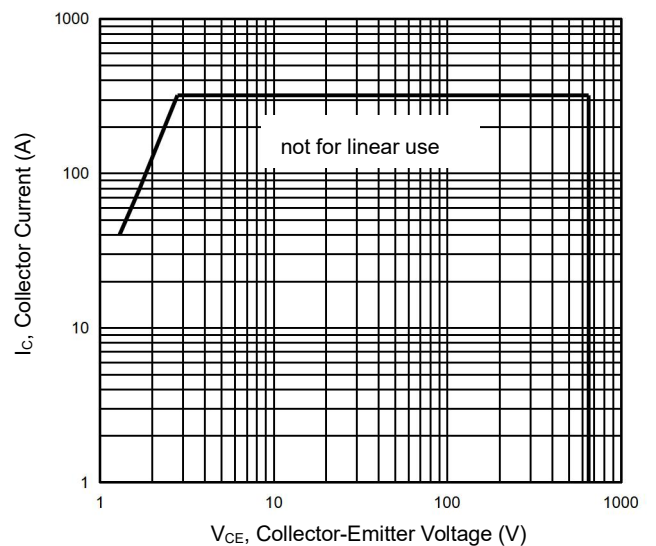


Figure 12 Forward Bias Safe Operating Area



Typical Electrical and Thermal Characteristics

Figure 13 Switching Loss vs.  $R_G$

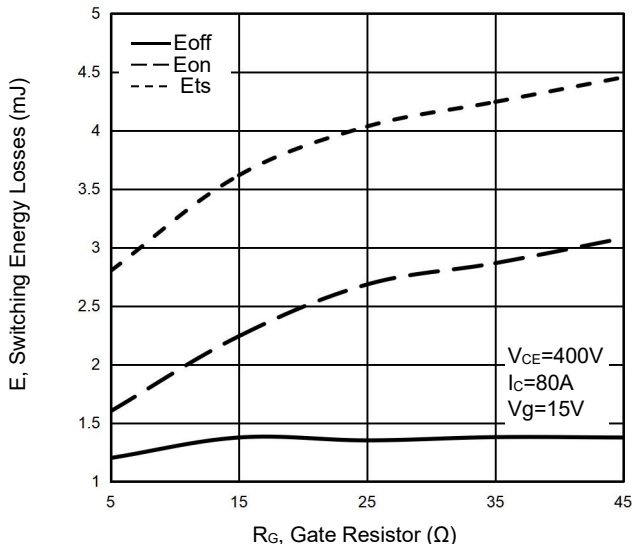


Figure 14 Switching Loss vs. Collector Current

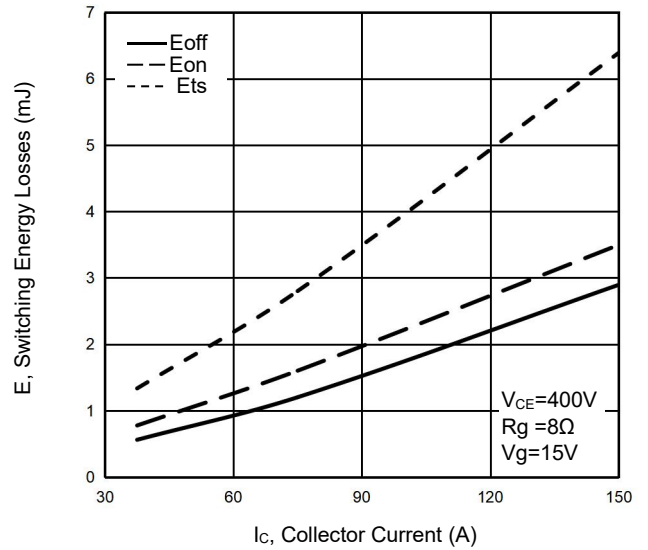


Figure 15 Switching Energy vs. Temperature

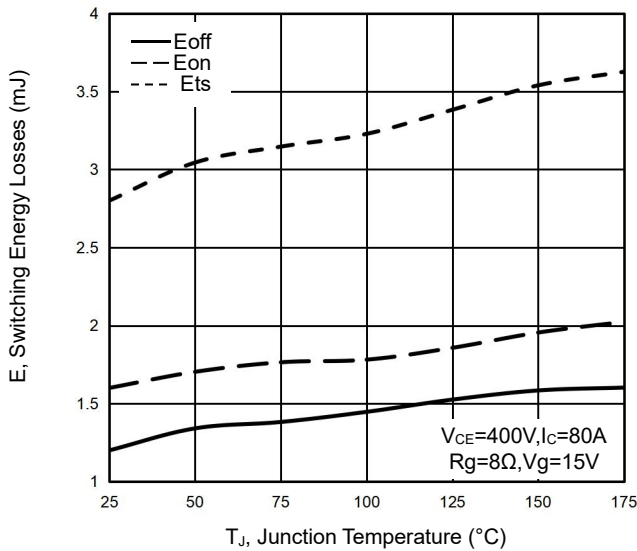


Figure 16 Switching Loss vs. Collector Current

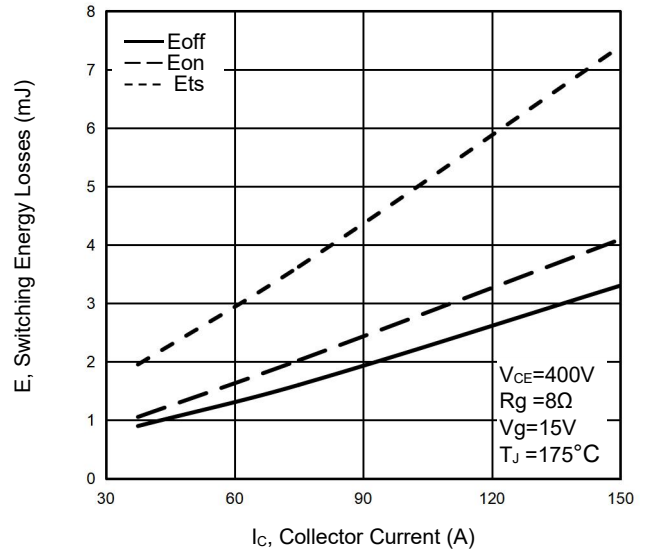


Figure 17  $V_{CES}$  vs. Case Temperature

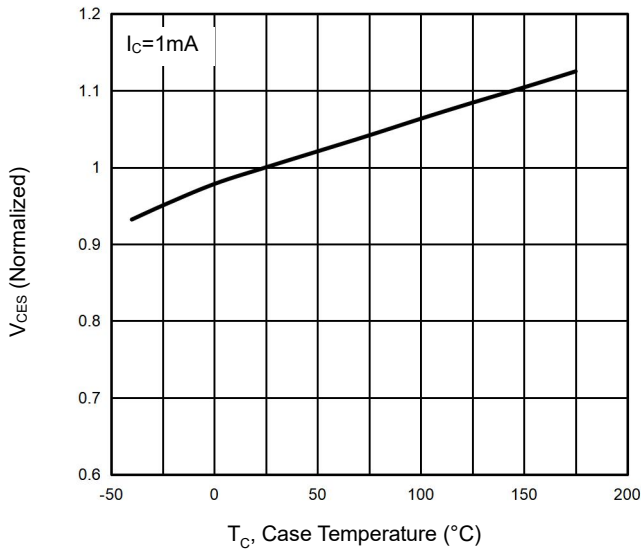
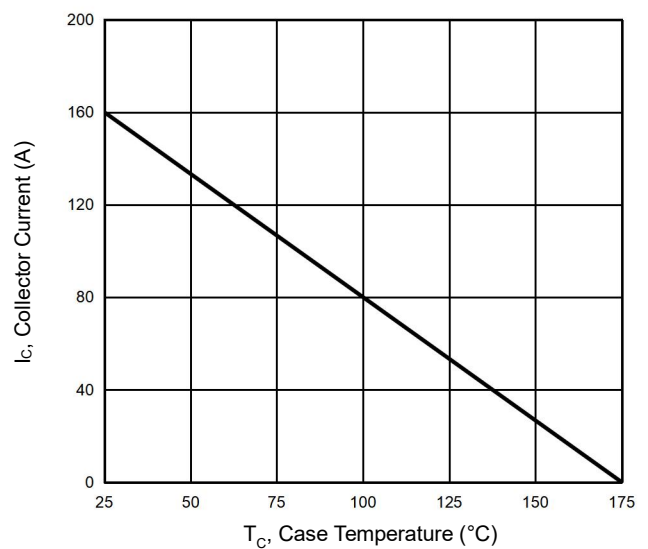
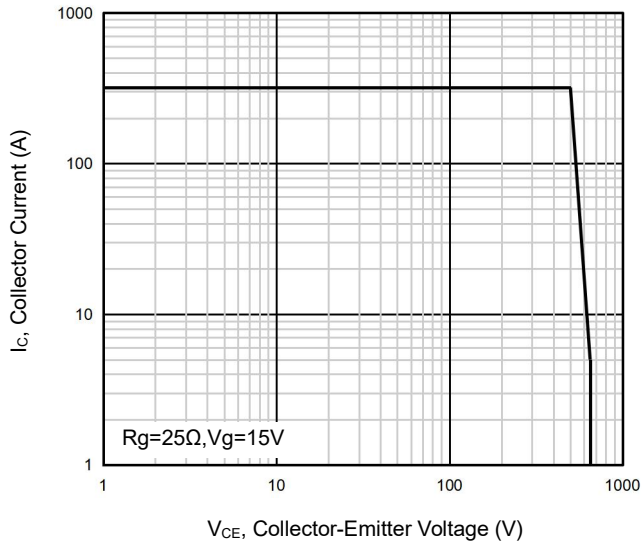


Figure 18  $I_C$  vs. Temperature



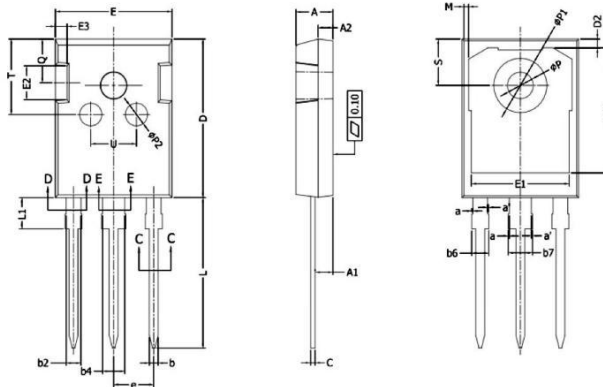
### Typical Electrical and Thermal Characteristics

Figure 19 Reverse Bias SOA



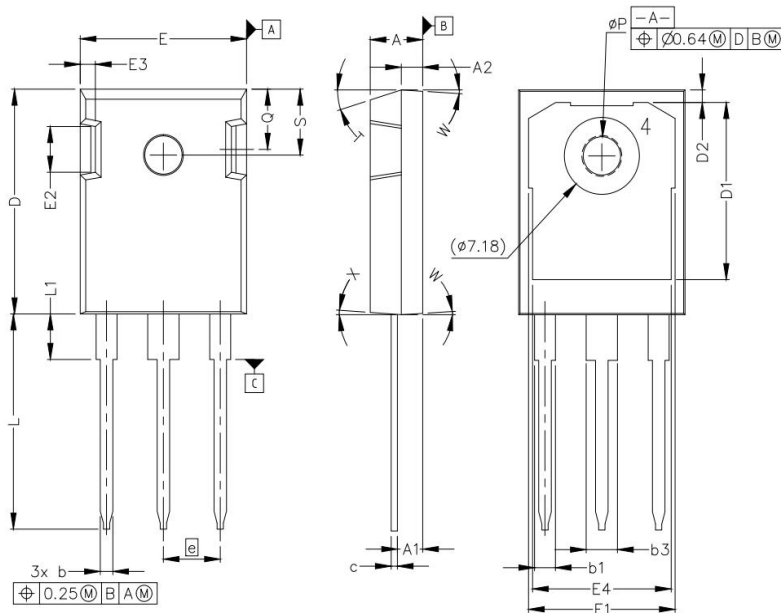


## TO-247-P Package Information



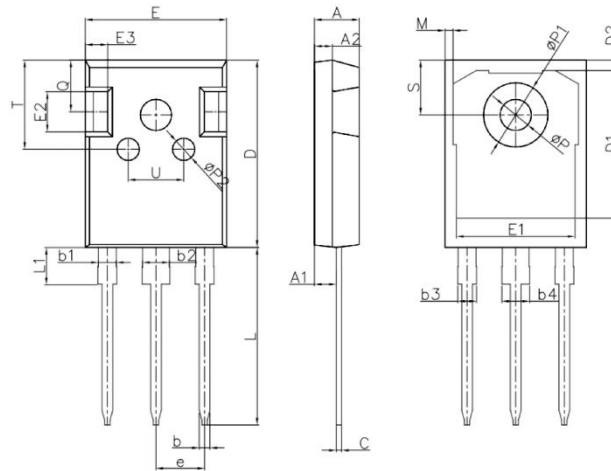
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.90	5.10	0.19	0.20
A1	2.31	2.51	0.09	0.10
A2	1.90	2.10	0.08	0.09
a	0.00	0.15	0.00	0.01
a'	0.00	0.15	0.00	0.01
b	1.16	1.26	0.05	0.06
b2	1.96	2.06	0.08	0.09
b4	2.96	3.06	0.12	0.13
b6	-	2.25	-	0.09
b7	-	3.25	-	0.13
C	0.59	0.66	0.02	0.03
D	20.90	21.10	0.82	0.83
D1	16.25	16.85	0.64	0.66
D2	1.05	1.35	0.04	0.05
E	15.70	15.90	0.62	0.63
E1	13.10	13.50	0.52	0.53
E2	4.40	4.60	0.17	0.18
E3	2.40	2.60	0.09	0.10
e	5.436 BSC		0.214 BSC	
L	19.80	20.10	0.78	0.79
L1	-	4.30	-	0.17
M	0.35	0.95	0.01	0.04
P	3.40	3.60	0.13	0.14
P1	7.00	7.40	0.28	0.29
P2	2.40	2.60	0.09	0.10
Q	5.60	6.00	0.22	0.24
S	6.05	6.25	0.24	0.25
T	9.80	10.20	0.39	0.40
U	6.00	6.40	0.24	0.25

## TO-247-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	0.10
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	0.70
D2	0.95	1.25	0.04	0.05
E	15.75	16.13	0.62	0.64
E1	13.10	14.15	0.52	0.56
E2	3.68	5.10	0.15	0.20
E3	1.00	1.90	0.04	0.08
E4	12.38	13.43	0.49	0.53
e	5.44 BSC		0.21 BSC	
L	19.81	20.32	0.78	0.80
L1	4.10	4.40	0.16	0.17
ØP	3.51	3.65	0.14	0.15
Q	5.49	6.00	0.22	0.24
S	6.04	6.30	0.24	0.25
T	17.5° REF			
W	3.5° REF			
X	4° REF			

## TO-247-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	1.16	1.26	0.05	0.06
b1	1.96	2.06	0.08	0.09
b2	2.96	3.06	0.12	0.13
b3	--	2.25	--	0.09
b4	--	3.25	--	0.13
c	0.59	0.66	0.02	0.03
D	20.90	21.10	0.82	0.83
D1	16.25	16.85	0.64	0.66
D2	1.05	1.35	0.04	0.05
E	15.70	15.90	0.62	0.63
E1	13.10	13.50	0.52	0.53
E2	4.40	4.60	0.17	0.18
E3	2.40	2.60	0.09	0.10
e	5.436 BSC		0.214 BSC	
L	19.80	20.10	0.78	0.79
L1	--	4.30	--	0.17
M	0.35	0.95	0.01	0.04
P	3.40	3.60	0.13	0.14
P1	7.00	7.40	0.28	0.29
P2	2.40	2.60	0.09	0.10
Q	5.60	6.00	0.22	0.24
S	6.05	6.25	0.24	0.25
T	9.80	10.20	0.39	0.40
U	6.00	6.40	0.24	0.25

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