

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

**General Description:**

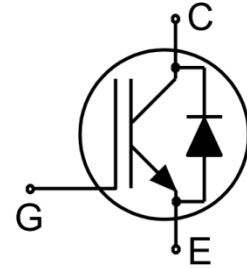
Using NCE's proprietary trench design and advanced FS (Field Stop) second generation technology, the 650V Trench FSII IGBT offers superior conduction and switching performances, and easy parallel operation;

**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 @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$
$t_{sc}$	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: $\geq 1.0\text{s}$ , $T_j \leq 150^\circ\text{C}$	5	$\mu\text{s}$

## Thermal Characteristic

Symbol	Parameter	Value	Units
$R_{\theta JC}$	Thermal Resistance, Junction to case for IGBT	0.32	°C/W
$R_{\theta JC}$	Thermal Resistance, Junction to case for Diode	0.44	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	40	°C/W

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

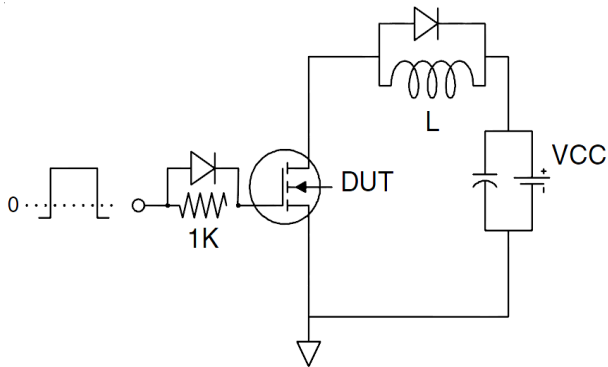
Symbol	Parameter	Conditions	Value			Units	
			Min.	Typ.	Max.		
<b>Static Characteristics</b>							
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	$V_{GE}=0V, I_{CE}=1mA$	650	--	--	V	
$I_{CES}$	Collector-Emitter Leakage Current	$V_{GE}=0V, V_{CE}=650V$	--	--	75	$\mu A$	
$I_{GES(F)}$	Gate to Emitter Forward Leakage	$V_{GE}=+30V, V_{CE}=0V$	--	--	200	nA	
$I_{GES(R)}$	Gate to Emitter Reverse Leakage	$V_{GE}=-30V, V_{CE}=0V$	--	--	200	nA	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C=80A$	$T_j=25^\circ\text{C}$	--	1.7	1.9	V
		$V_{GE}=15V$	$T_j=175^\circ\text{C}$	--	1.9	--	V
$V_{GE(th)}$	Gate Threshold Voltage	$I_C=1mA, V_{CE}=V_{GE}$	4.0	5.0	6.0	V	
<b>Dynamic Characteristics</b>							
$C_{ies}$	Input Capacitance	$V_{CE}=25V, V_{GE}=0V,$ $f=1MHz$	--	9188	--	pF	
$C_{oes}$	Output Capacitance		--	258	--		
$C_{res}$	Reverse Transfer Capacitance		--	181	--		
$Q_g$	Total Gate Charge	$V_{CC}=480V, I_C=80A,$ $V_{GE}=15V$	--	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: $\geq 1.0s$	$V_{GE}=15V, V_{CC} \leq 400V,$ $t_{sc} \leq 5\mu s, T_j \leq 150^\circ\text{C}$	--	450	--	A	
<b>Switching Characteristics</b>							
$t_{d(ON)}$	Turn-on Delay Time	$V_{CC}=400V, I_C=80A,$ $V_{GE}=0/15V, R_g=5\Omega,$ 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		$V_{CC}=400V, I_C=80A,$ $V_{GE}=0/15V, R_g=5\Omega,$ $T_j=175^\circ\text{C}$	--	1.6	--	mJ
$E_{off}$	Turn-Off Switching Loss			--	1.2	--	
$E_{ts}$	Total Switching Loss			--	2.8	--	
$E_{on}$	Turn-On Switching Loss			--	2.0	--	mJ
$E_{off}$	Turn-Off Switching Loss	--	1.6	--			
$E_{ts}$	Total Switching Loss	--	3.6	--			

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

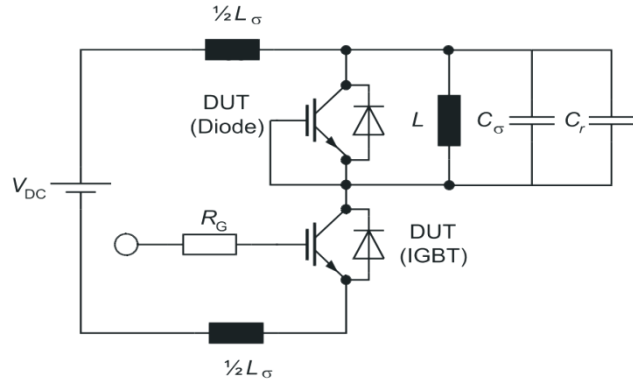
Symbol	Parameter	Conditions	Rating			Units
			Min.	Typ.	Max.	
V <sub>FM</sub>	Diode Forward Voltage	I <sub>F</sub> =80A	--	1.75	2.4	V
T <sub>rr</sub>	Reverse Recovery Time	I <sub>F</sub> =80A, di/dt=200A/us	--	194	--	ns
I <sub>RRM</sub>	Diode Peak Reverse Recovery Current		--	2.8	--	A
Q <sub>rr</sub>	Reverse Recovery Charge		--	0.2	--	uC

## Test Circuit

### 1) Gate Charge Test Circuit

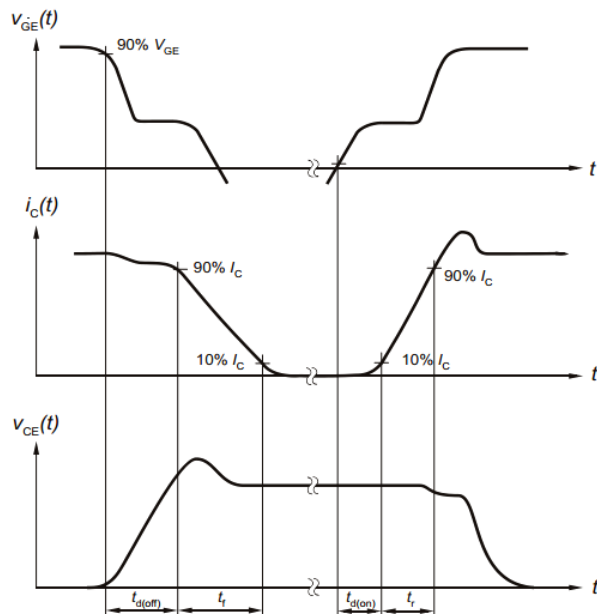


### 2) Switch Time Test Circuit

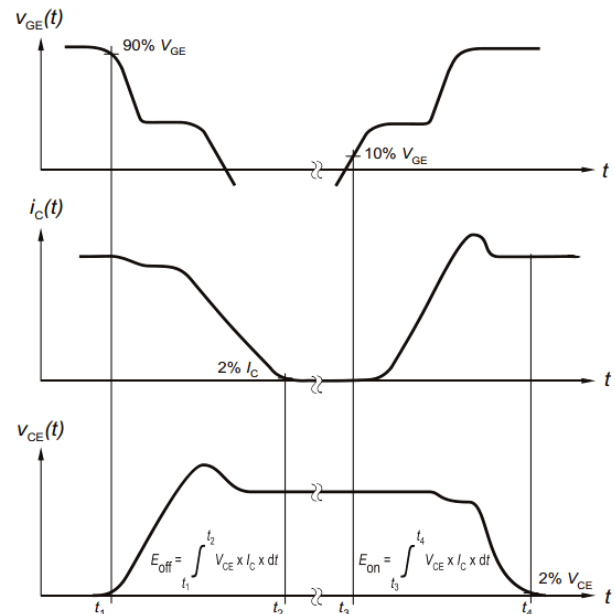


## Switching characteristics

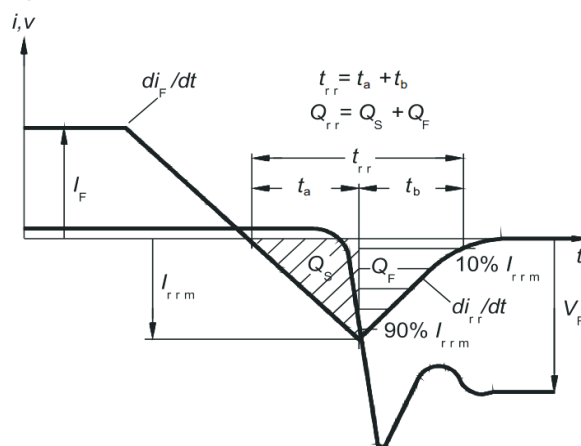
### 1) Definition of switching times



### 2) Definition of switching losses



### 3) Definition of diode switching characteristics



Typical Electrical and Thermal Characteristics

Figure 1 Output Characteristics

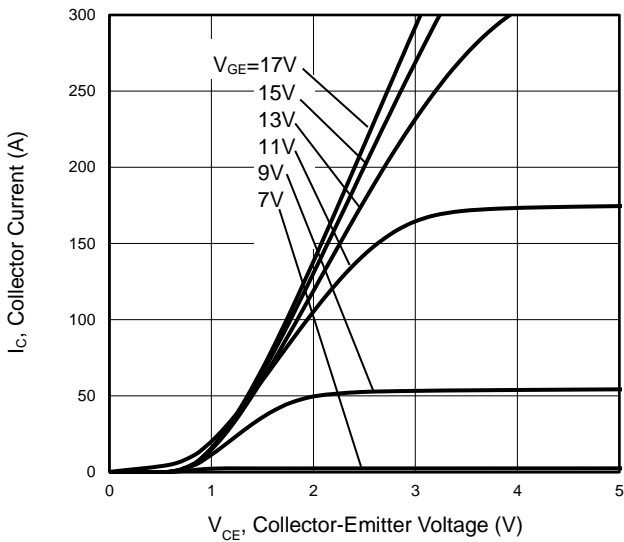


Figure 2 Transfer Characteristics

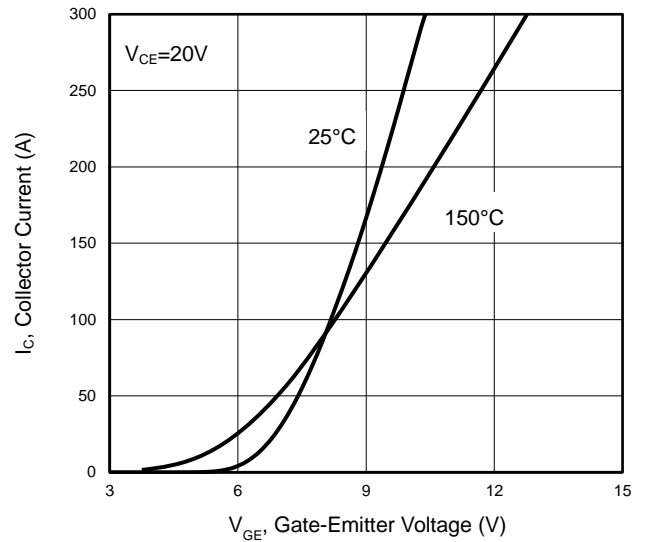


Figure 3  $V_{CE(sat)}$  vs. Temperature

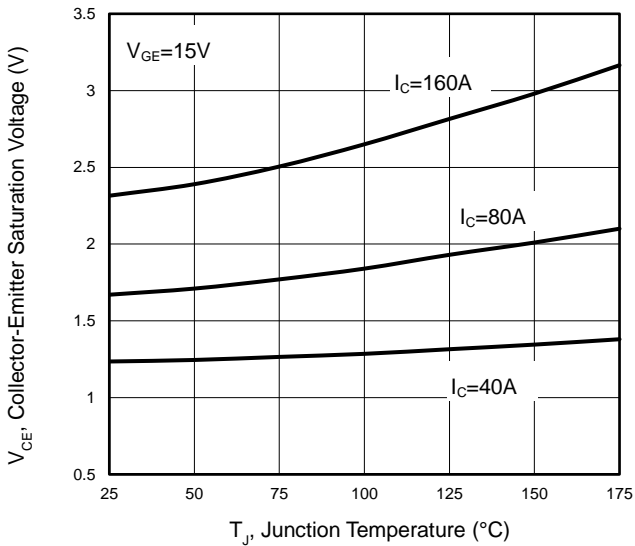


Figure 4 Saturation Voltage vs.  $V_{GE}$

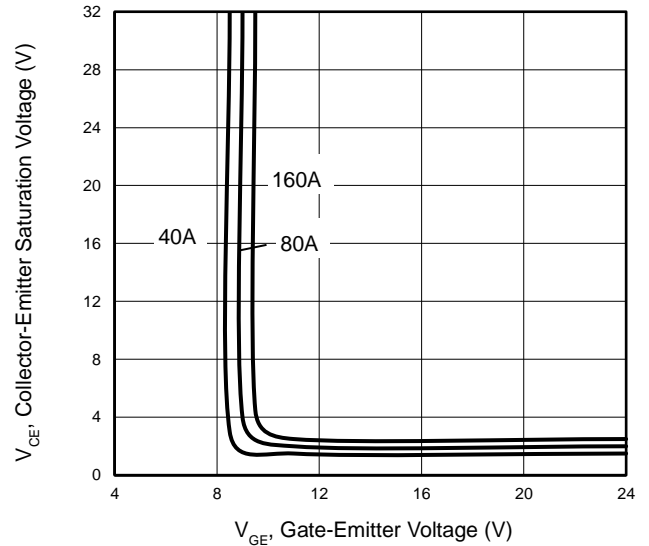


Figure 5 Capacitance Characteristics

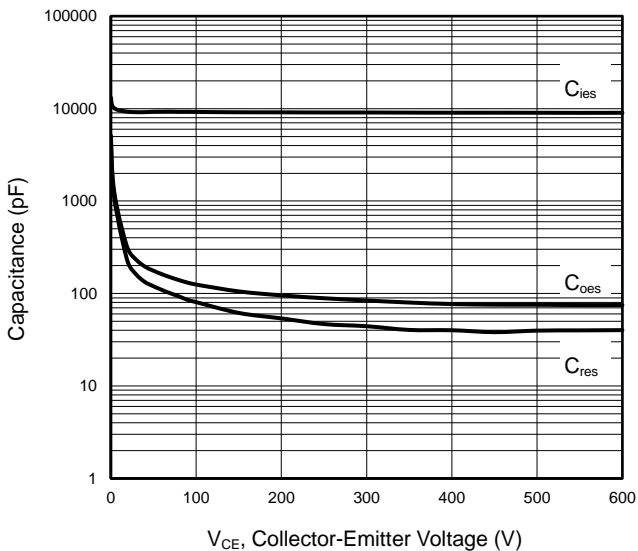
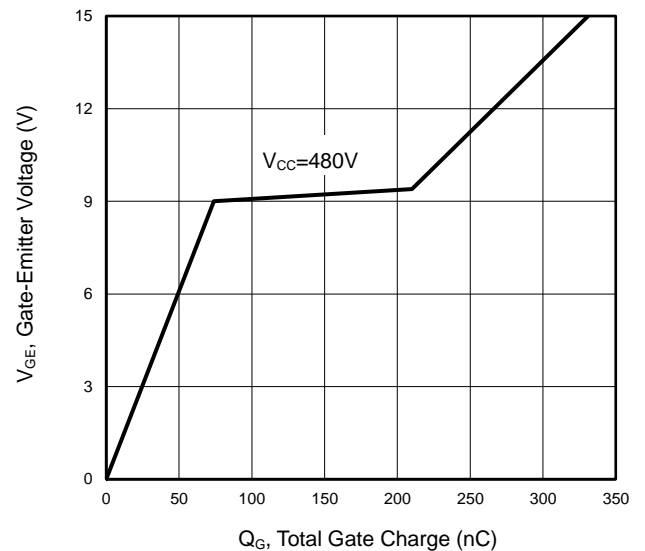


Figure 6 Gate Charge Wave Form



Typical Electrical and Thermal Characteristics

Figure 7 Forward Characteristics

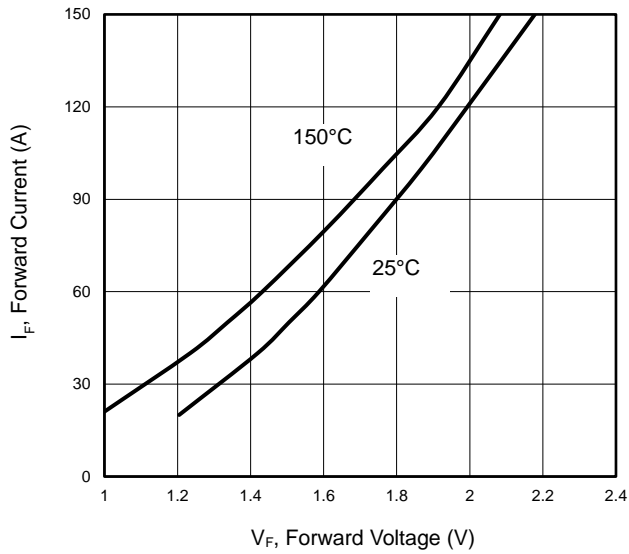


Figure 8  $V_F$  vs. Temperature

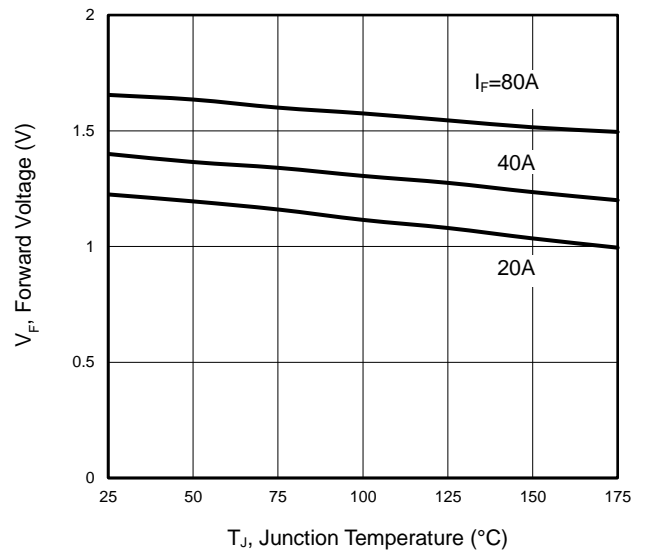


Figure 9  $V_{GE(th)}$  vs. Temperature

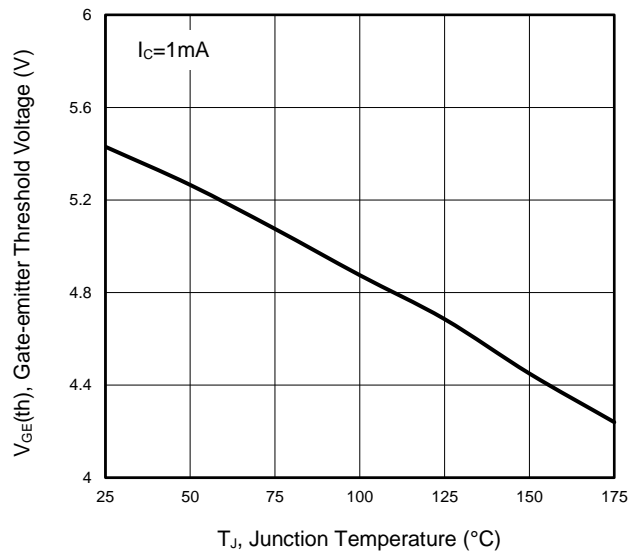


Figure 10  $V_{CE(sat)}$  vs. Collector Current

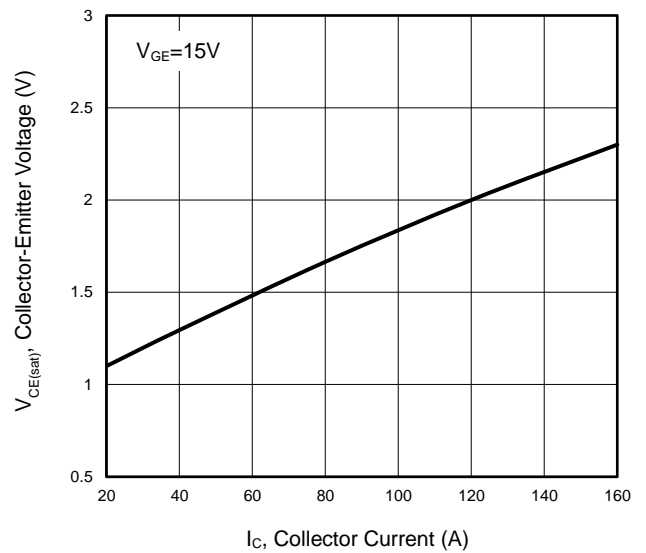


Figure 11  $P_{tot}$  vs. Case Temperature

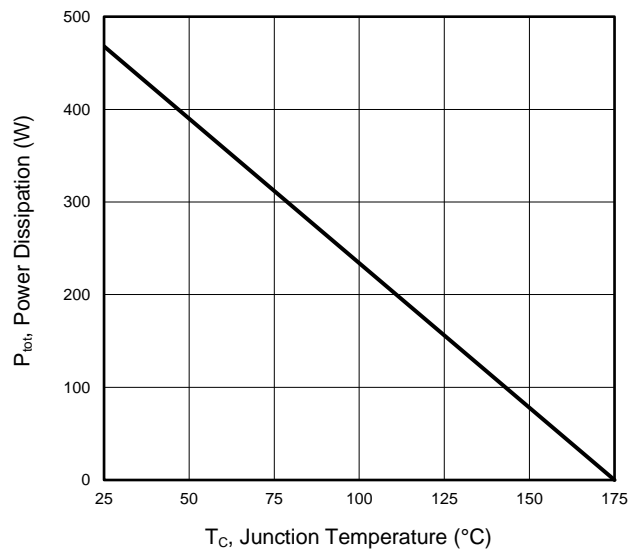
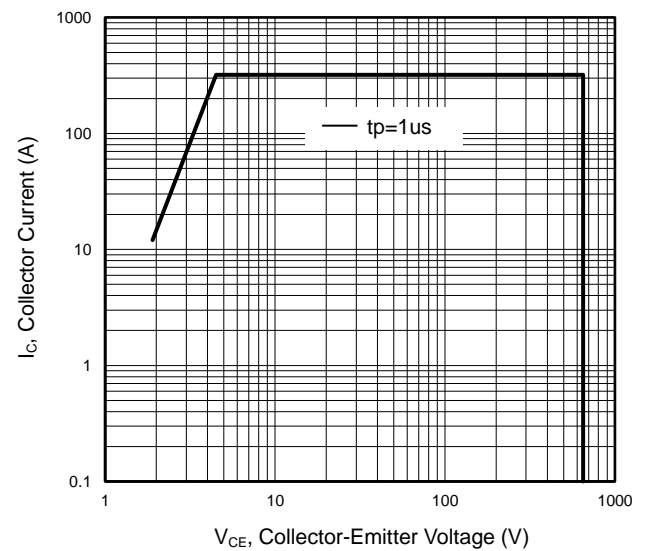


Figure 12 Forward Bias Safe Operating Area



Typical Electrical and Thermal Characteristics

Figure 13 Switching Loss vs.  $R_G$

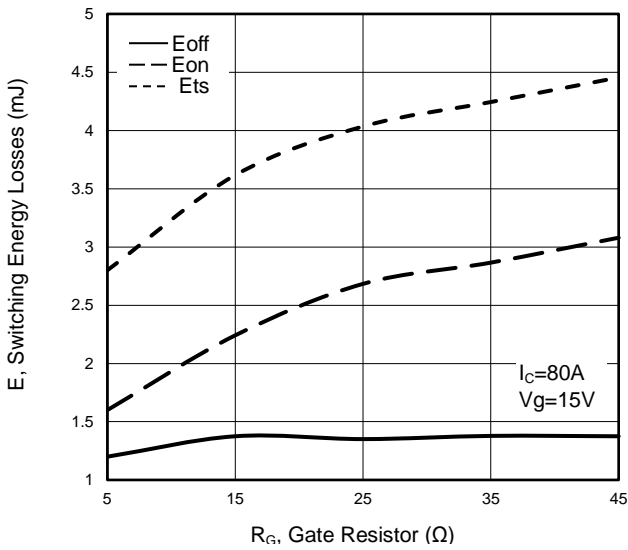


Figure 14 Switching Loss vs. Collector Current

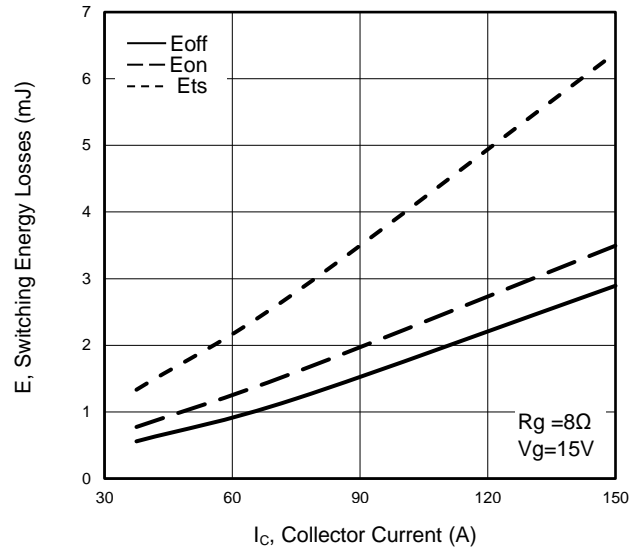


Figure 15 Switching Energy vs. Temperature

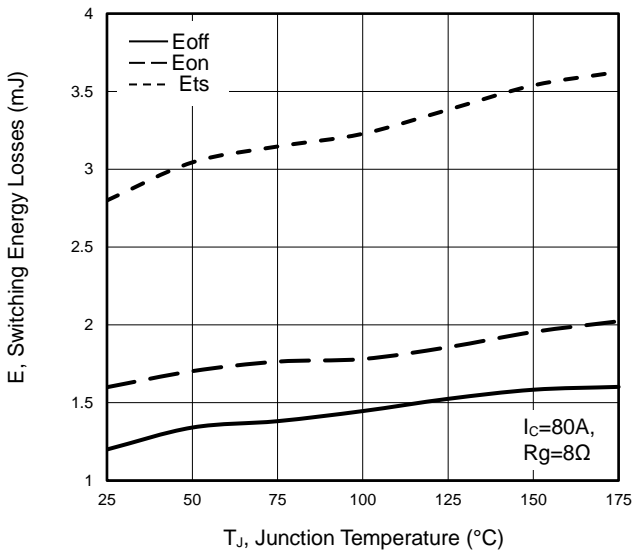


Figure 16 Switching Loss vs. Collector Current

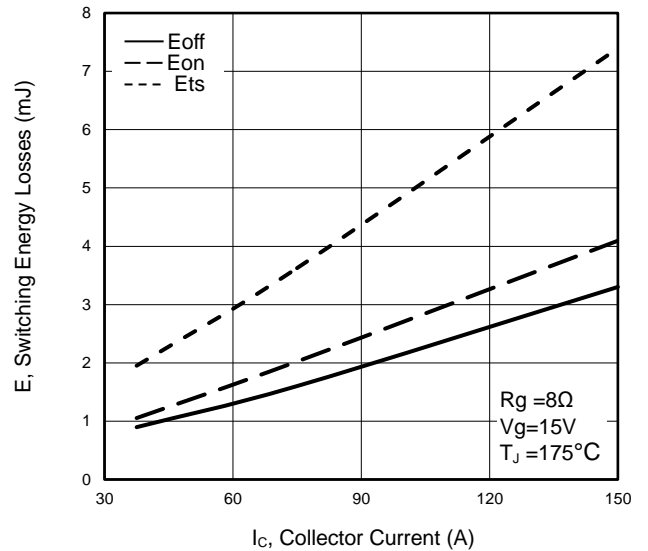


Figure 17 V<sub>CEs</sub> vs. Case Temperature

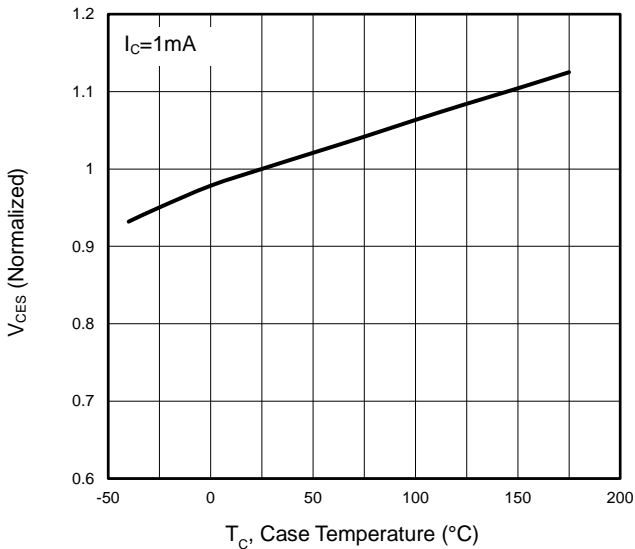
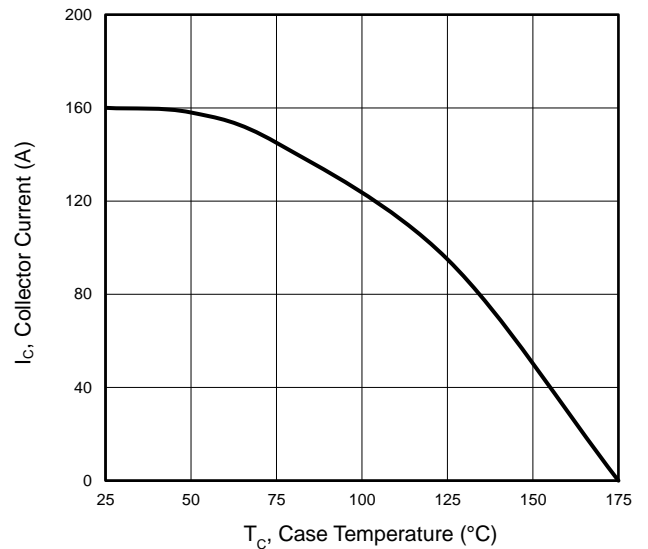


Figure 18 I<sub>C</sub> vs. Temperature



Typical Electrical and Thermal Characteristics

Figure 19 Switching Time vs.  $I_C$

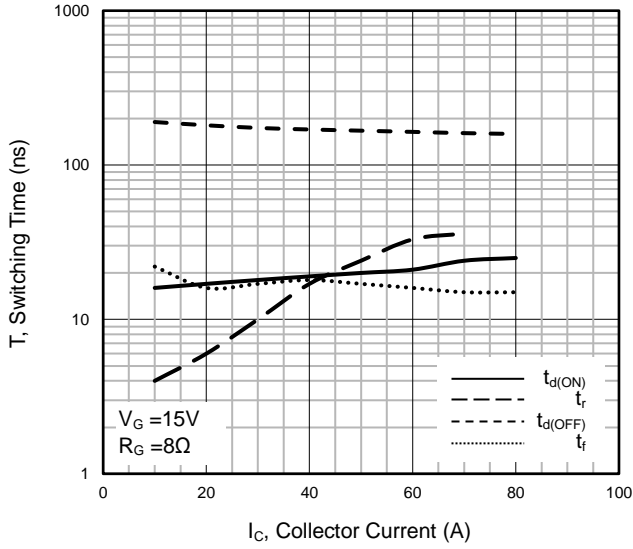


Figure 20 Switching Time vs.  $R_G$

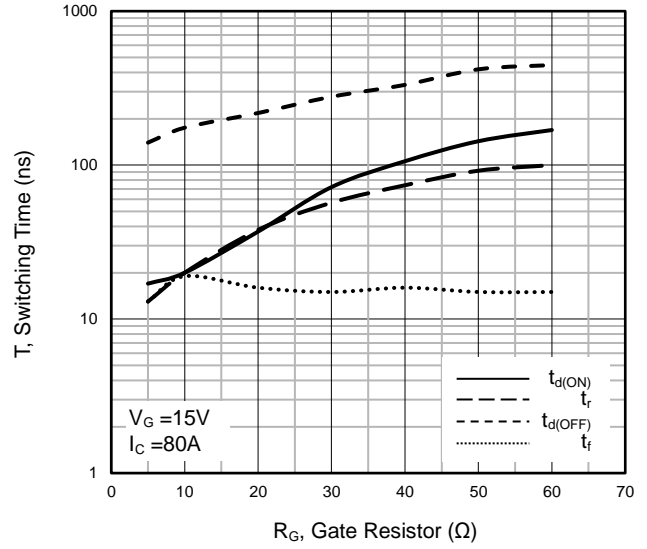


Figure 21 Switching Time vs.  $I_C$

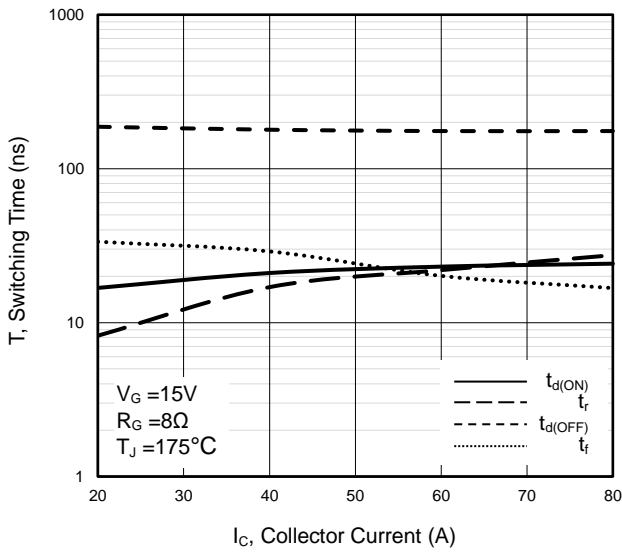
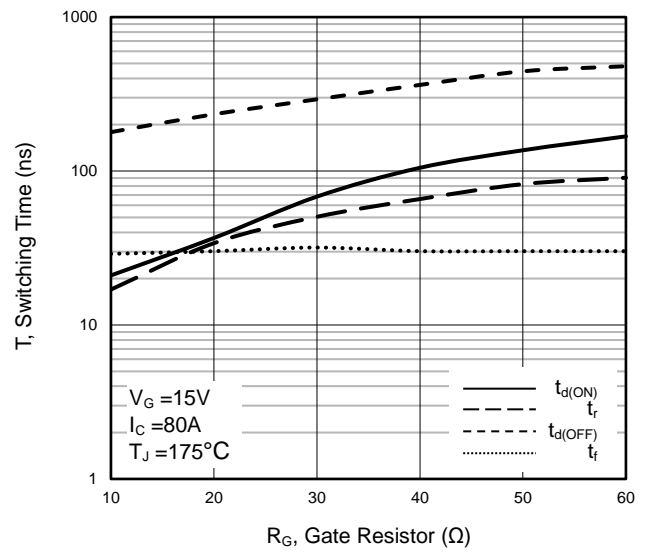
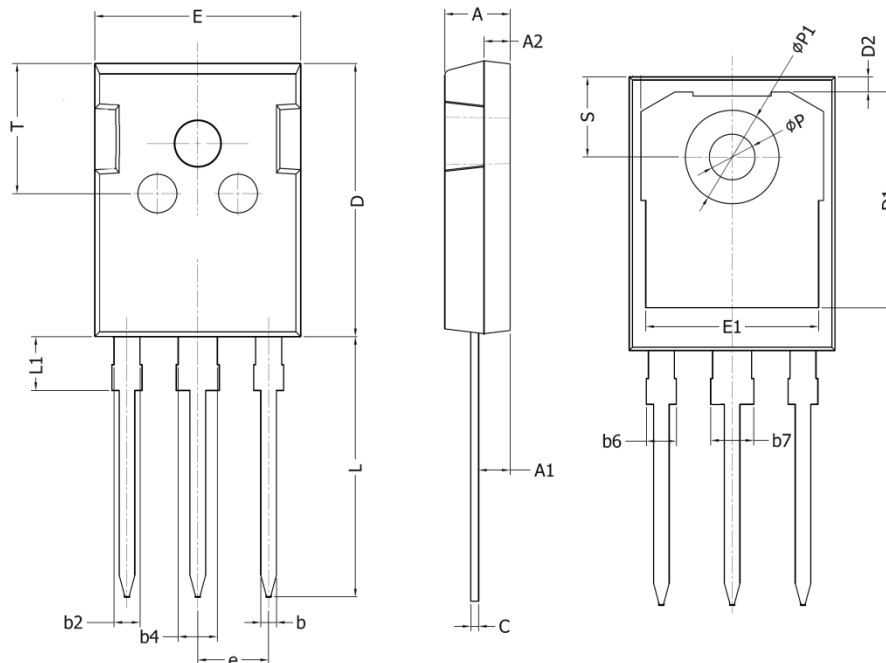


Figure 22 Switching Time vs.  $R_G$



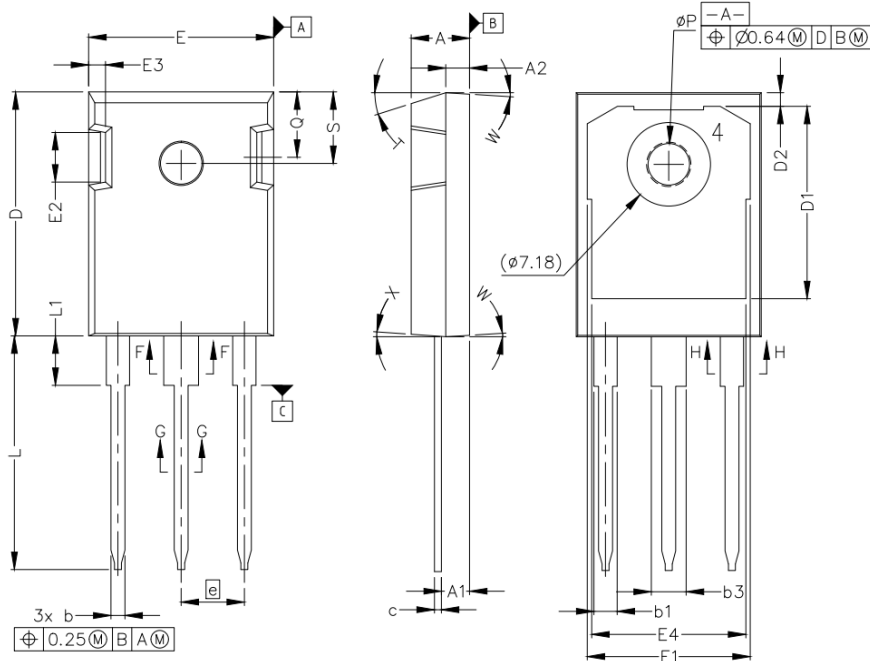


## TO-247-P Package Information



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	1.9	2.1	0.075	0.083
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
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
L1	-	4.30	-	0.169
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-247-B Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.83	5.21	0.190	0.205
A1	2.29	2.54	0.090	0.100
A2	1.91	2.16	0.075	0.085
b	1.07	1.33	0.042	0.052
b1	1.91	2.41	0.075	0.095
b3	2.87	3.38	0.113	0.133
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.25	0.037	0.049
E	15.75	16.13	0.620	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	1.90	0.039	0.075
E4	12.38	13.43	0.487	0.529
e	5.44 BSC		0.214 BSC	
N	3.00		0.118	
L	19.81	20.32	0.780	0.800
L1	4.10	4.40	0.161	0.173
P	3.51	3.65	0.138	0.144
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248