

600V, 60A, Trench FS II Fast IGBT

General Description

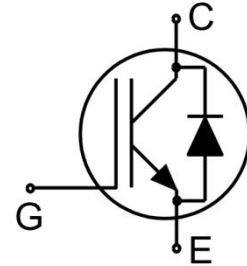
Using NCE's proprietary trench design and advanced FS (Field Stop) second generation technology, the 600V Trench FSII IGBT offers superior conduction and switching performances, and easy parallel operation;

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



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	± 30	V
I_C	Collector Current	120	A
	Collector Current @ $T_C = 100^\circ\text{C}$	60	A
I_{Cpuls}	Pulsed Collector Current, t_p limited by T_{jmax}	240	A
-	turn off safe operating area, $V_{CE}=600\text{V}$, $T_j=175^\circ\text{C}$	240	A
I_F	Diode Continuous Forward Current @ $T_C = 100^\circ\text{C}$	60	A
I_{FM}	Diode Maximum Forward Current	240	A
P_D	Power Dissipation @ $T_C = 25^\circ\text{C}$	319	W
	Power Dissipation @ $T_C = 100^\circ\text{C}$	159	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	us

Thermal Characteristic

Symbol	Parameter	Value	Units
$R_{\theta JC}$	Thermal Resistance, Junction to case for IGBT	0.47	$^{\circ}\text{C}/\text{W}$
$R_{\theta JC}$	Thermal Resistance, Junction to case for Diode	0.98	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	40	$^{\circ}\text{C}/\text{W}$

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

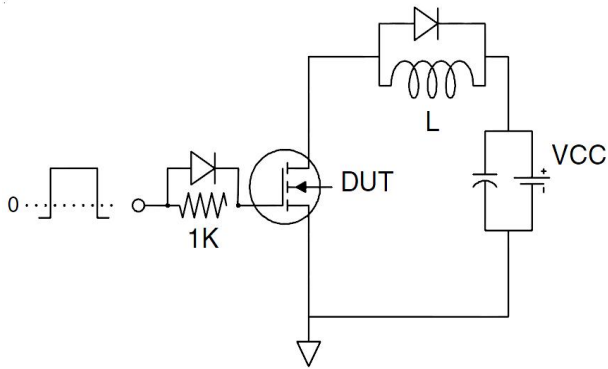
Symbol	Parameter	Conditions	Value			Units
			Min.	Typ.	Max.	
Static Characteristics						
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	$V_{GE}=0\text{V}, I_{CE}=1\text{mA}$	600	--	--	V
I_{CES}	Collector-Emitter Leakage Current	$V_{GE}=0\text{V}, V_{CE}=600\text{V}$	--	--	40	μA
$I_{GES(F)}$	Gate 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	$I_C=60\text{A}$	--	1.7	1.9	V
		$V_{GE}=15\text{V}$	--	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
Dynamic Characteristics						
C_{ies}	Input Capacitance	$V_{CE}=25\text{V}, V_{GE}=0\text{V},$ $f=1\text{MHz}$	--	7018	--	pF
C_{oes}	Output Capacitance		--	199	--	
C_{res}	Reverse Transfer Capacitance		--	138	--	
Q_g	Total Gate Charge	$V_{CC}=480\text{V}, I_C=60\text{A},$ $V_{GE}=15\text{V}$	--	262	--	nC
Q_{ge}	Gate to Emitter Charge		--	60	--	
Q_{gc}	Gate to Collector Charge		--	113	--	
$I_{C(SC)}$	Short circuit collector current Max.1000 short circuits Time between short circuits: $\geq 1.0\text{s}$	$V_{GE}=15\text{V}, V_{CC}\leq 400\text{V},$ $t_{SC}\leq 5\mu\text{s}, T_J\leq 150^{\circ}\text{C}$	--	300	--	A
Switching Characteristics						
$t_{d(ON)}$	Turn-on Delay Time	$V_{CC}=400\text{V}, I_C=60\text{A},$ $V_{GE}=0/15\text{V}, R_g=5\Omega,$ Inductive Load	--	19	--	ns
t_r	Rise Time		--	17	--	
$t_{d(OFF)}$	Turn-Off Delay Time		--	170	--	
t_f	Fall Time		--	18	--	
E_{on}	Turn-On Switching Loss		--	1.1	--	mJ
E_{off}	Turn-Off Switching Loss		--	0.9	--	
E_{ts}	Total Switching Loss		--	2.0	--	
E_{on}	Turn-On Switching Loss	$V_{CC}=400\text{V}, I_C=60\text{A},$ $V_{GE}=0/15\text{V}, R_g=5\Omega,$ $T_J=175^{\circ}\text{C}$	--	1.4	--	mJ
E_{off}	Turn-Off Switching Loss		--	1.3	--	
E_{ts}	Total Switching Loss		--	2.7	--	

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

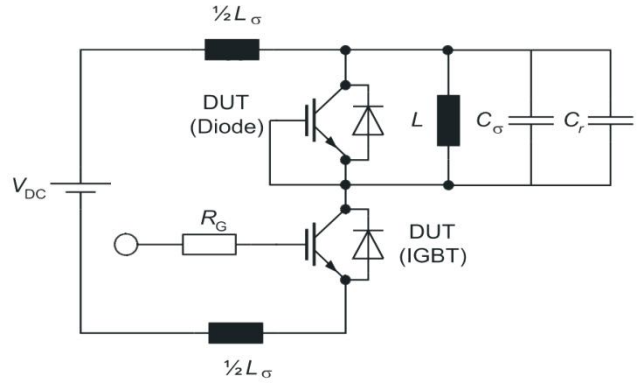
Symbol	Parameter	Conditions	Rating			Units
			Min.	Typ.	Max.	
V_{FM}	Diode Forward Voltage	$I_F=60\text{A}$	--	1.75	2.40	V
T_{rr}	Reverse Recovery Time	$I_F=60\text{A}$, $di/dt=200\text{A}/\mu\text{s}$	--	186	--	ns
I_{RRM}	Diode Peak Reverse Recovery Current		--	3.8	--	A
Q_{rr}	Reverse Recovery Charge		--	0.3	--	μC

Test Circuit

1) Gate Charge Test Circuit

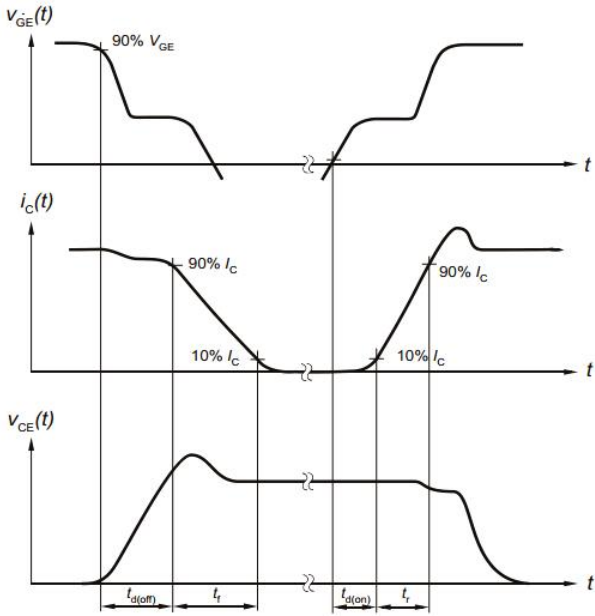


2) Switch Time Test Circuit

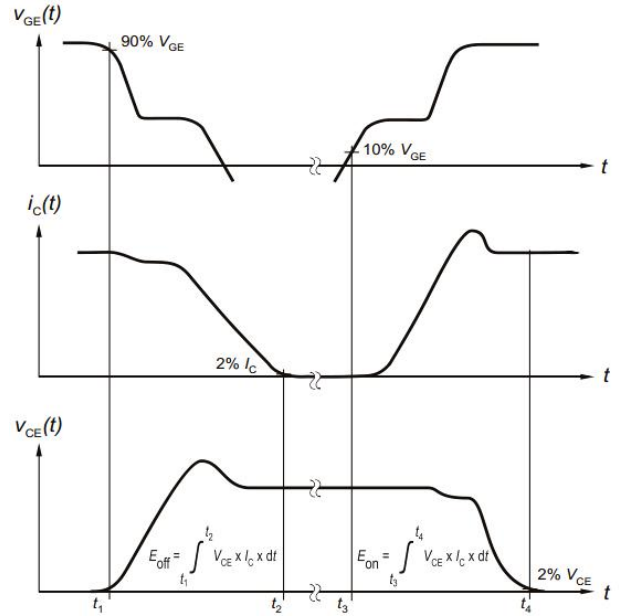


Switching characteristics

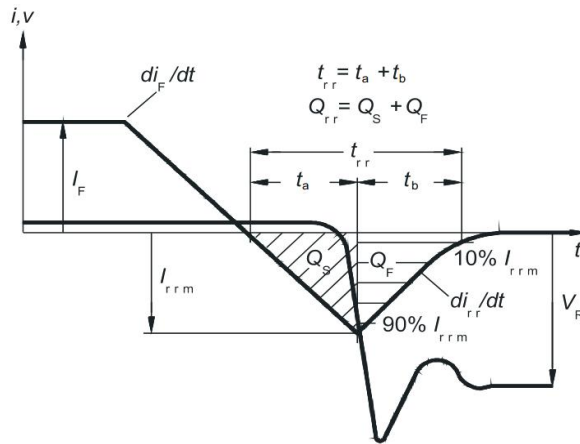
1) Definition of switching times



2) Definition of switching losses



3) Definition of diode switching characteristics



Typical Electrical and Thermal Characteristics

Figure 1 Output Characteristics

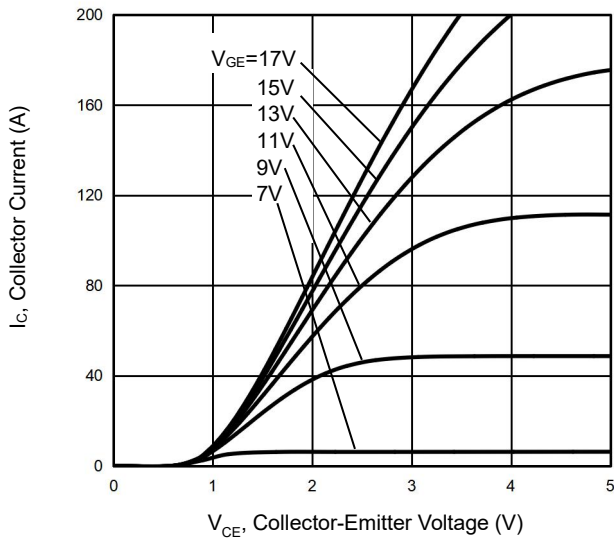


Figure 2 Output Characteristics

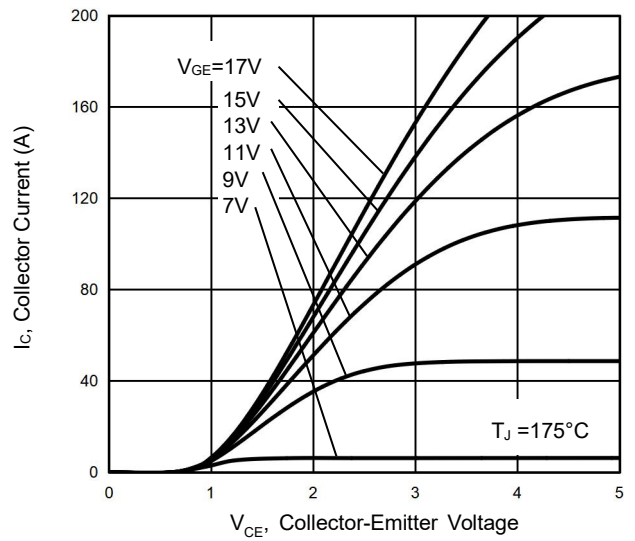


Figure 3 Transfer Characteristics

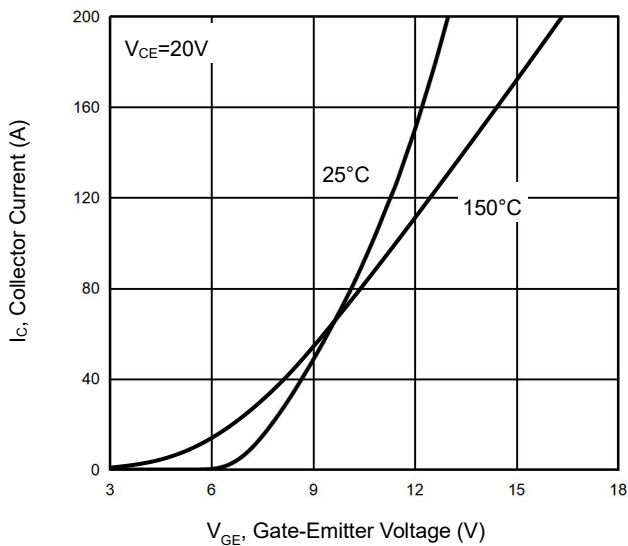


Figure 4 Saturation Voltage vs. Vge

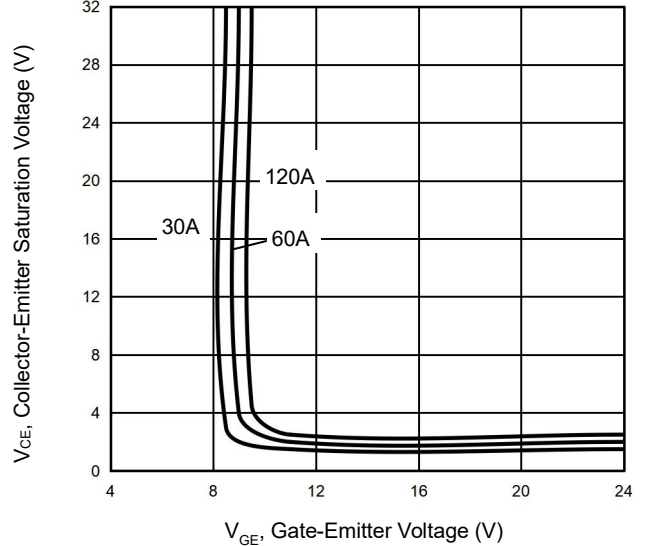


Figure 5 Capacitance Characteristics

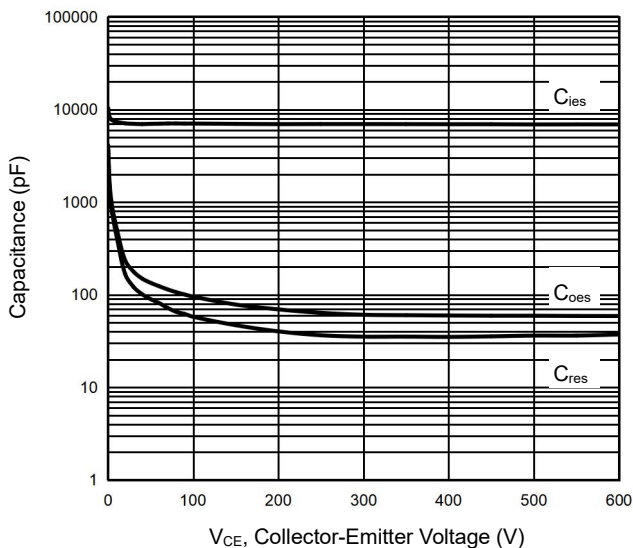
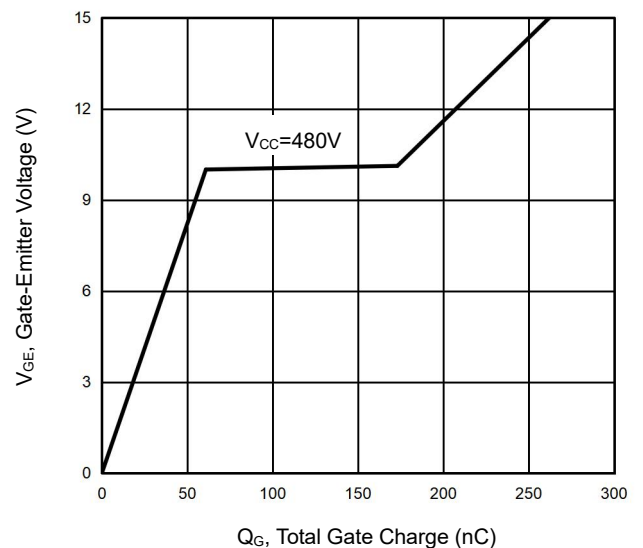


Figure 6 Gate Charge Wave Form



Typical Electrical and Thermal Characteristics

Figure 7 Forward Characteristics

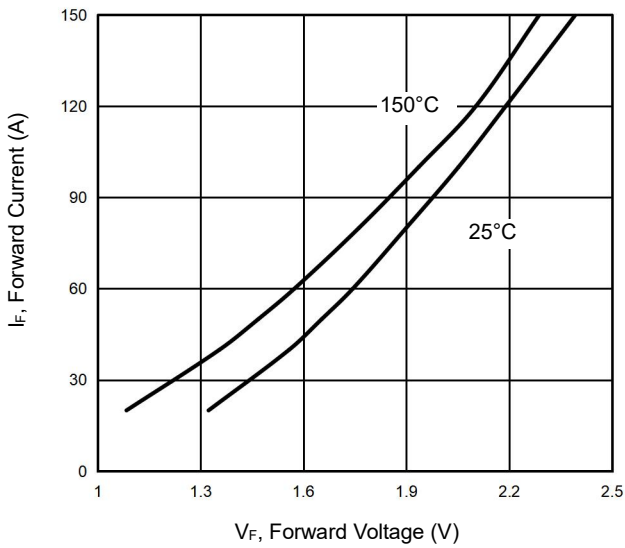


Figure 8 V_F vs. Temperature

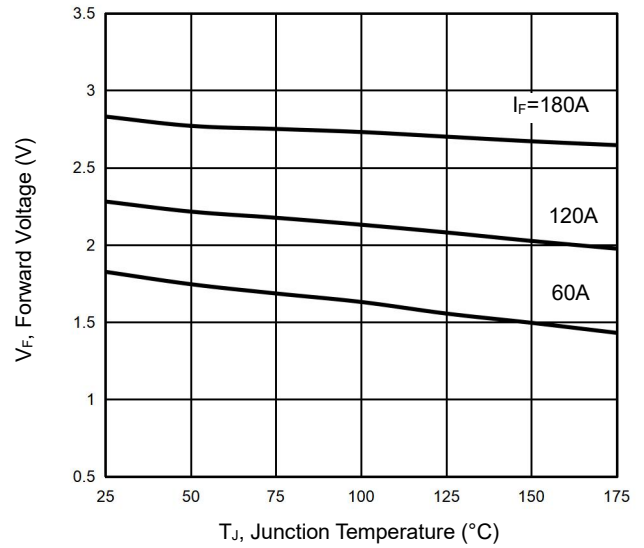


Figure 9 Switching Loss vs. R_G

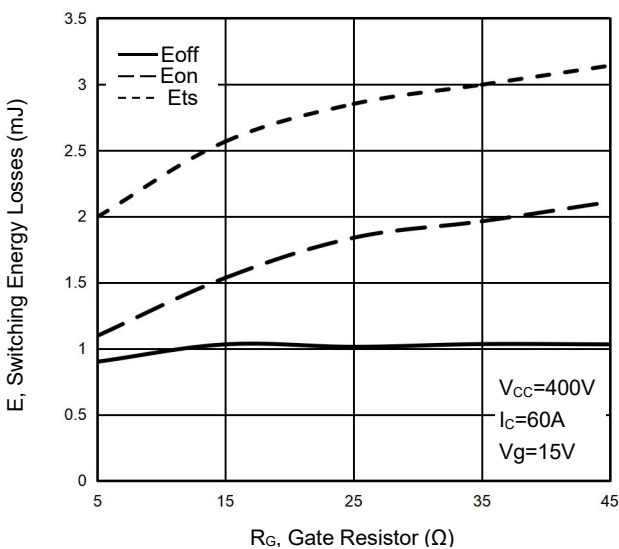


Figure 10 Switching Energy vs. Temperature

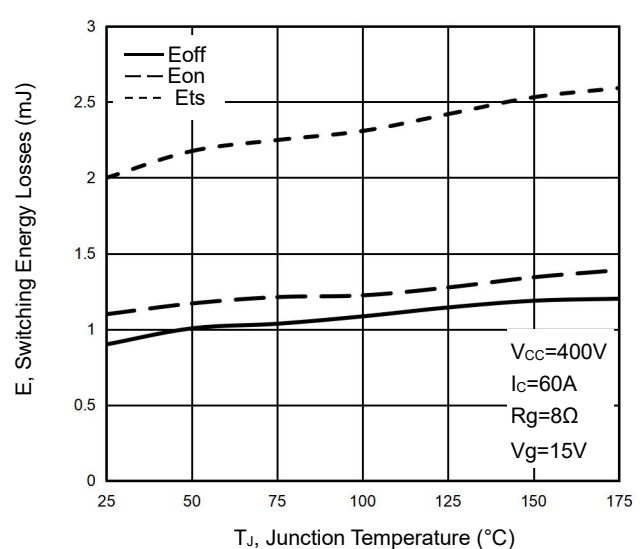


Figure 11 Switching Loss vs. Collector Current

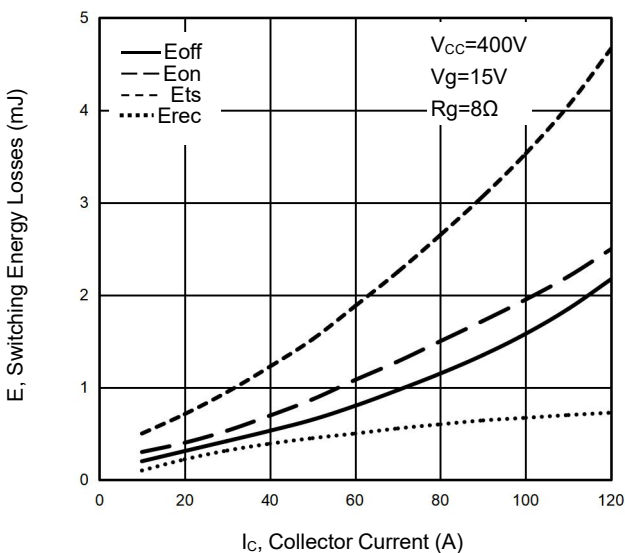
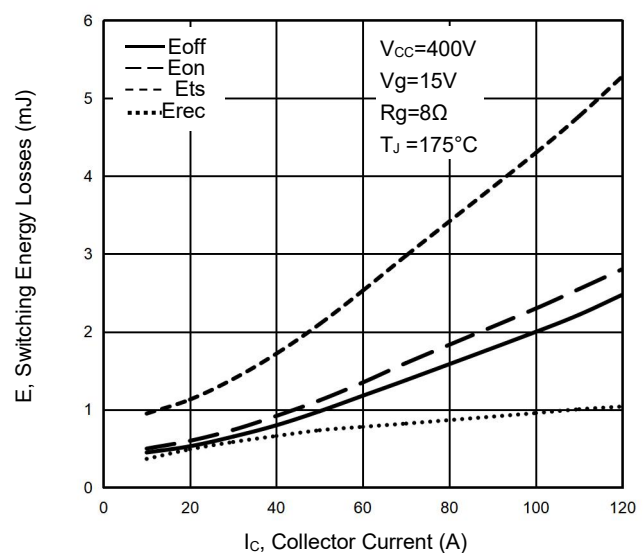


Figure 12 Switching Loss vs. Collector Current



Typical Electrical and Thermal Characteristics

Figure 13 $V_{GE(th)}$ vs. Junction Temperature

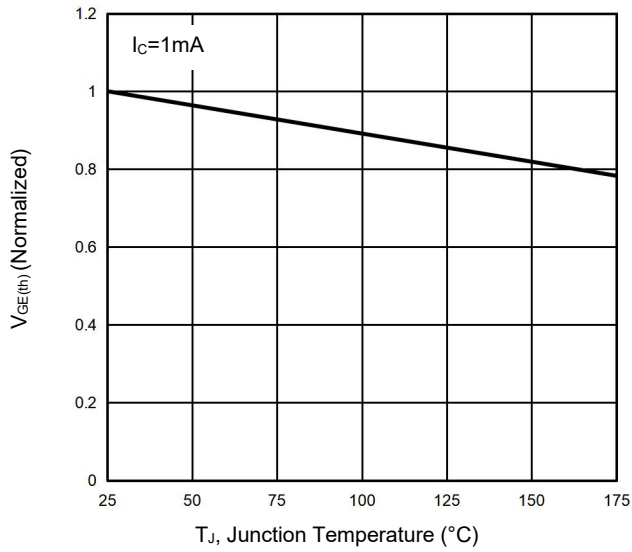


Figure 14 $V_{CE(sat)}$ vs. Collector Current

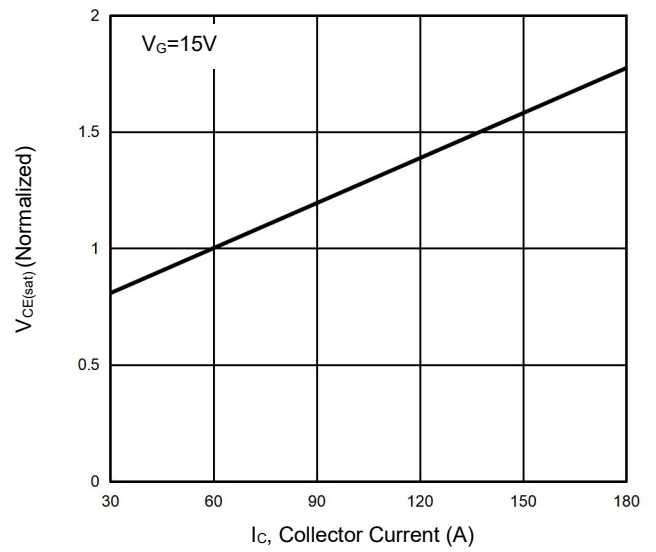


Figure 15 Forward Bias Safe Operating Area

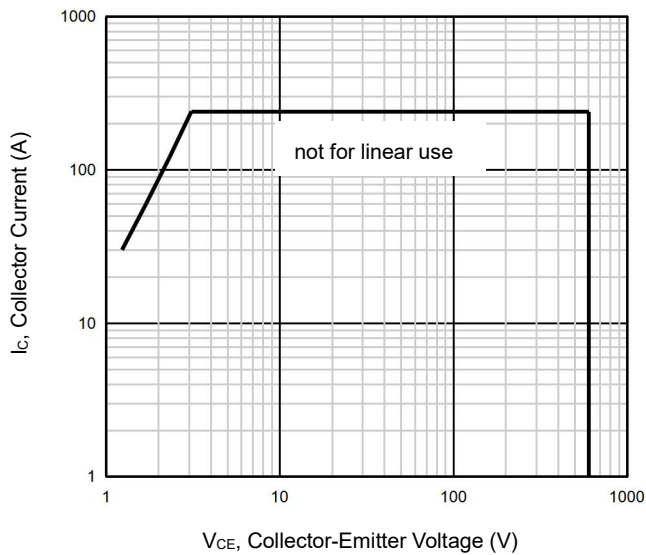


Figure 16 P_{tot} vs. Case Temperature

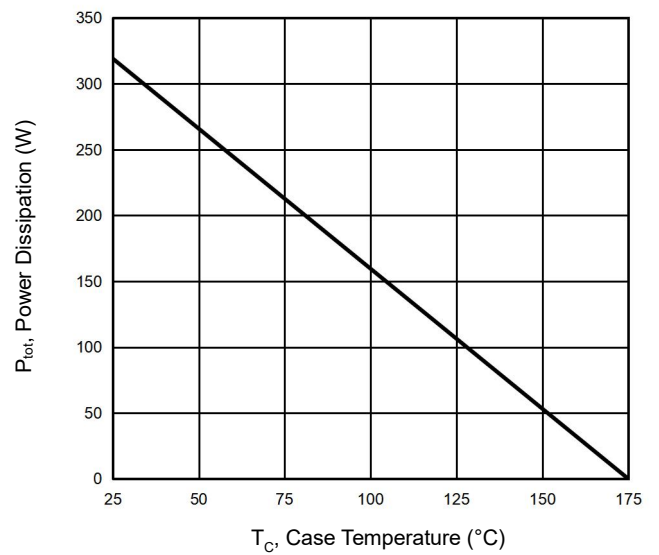


Figure 17 V_{CES} vs. Temperature

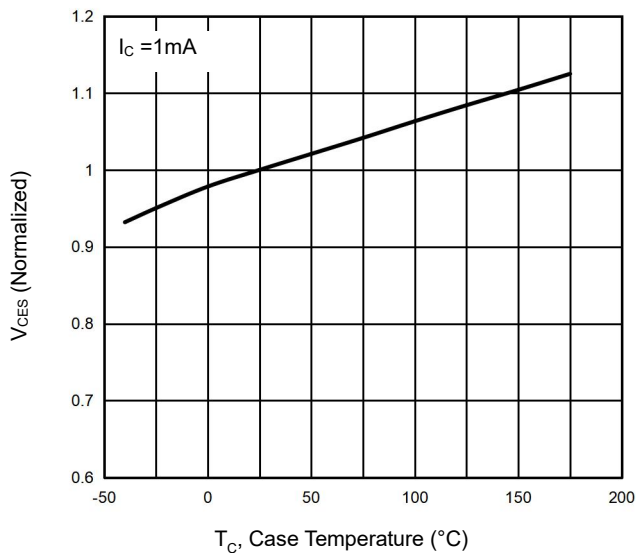
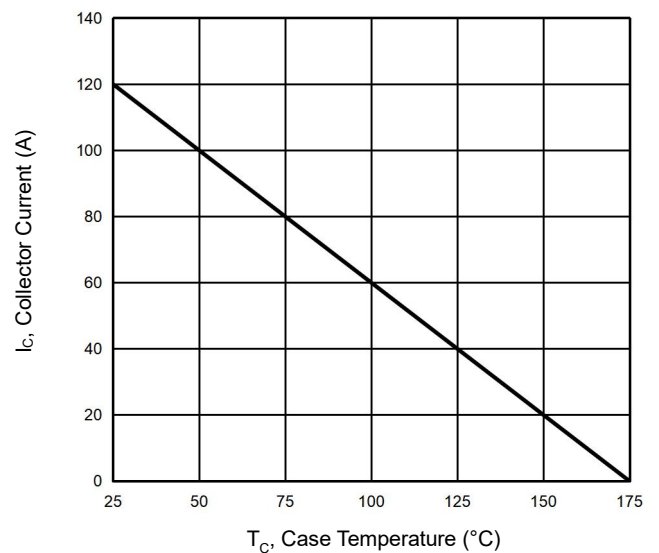


Figure 18 I_C vs. Temperature



Typical Electrical and Thermal Characteristics

Figure 19 Switching Time vs. IC

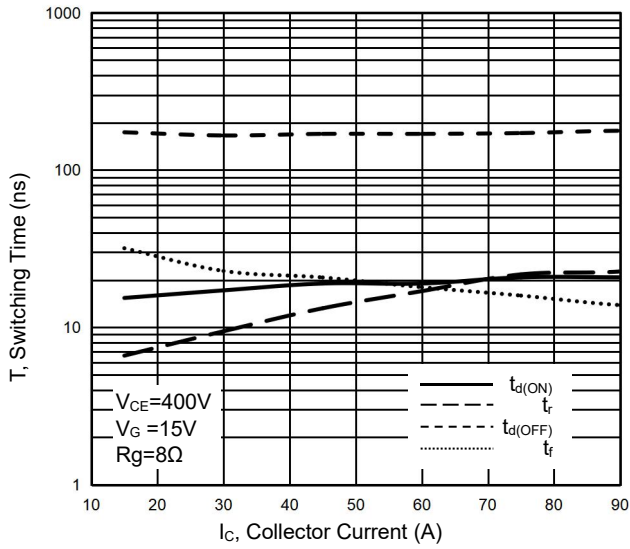


Figure 20 Switching Time vs. RG

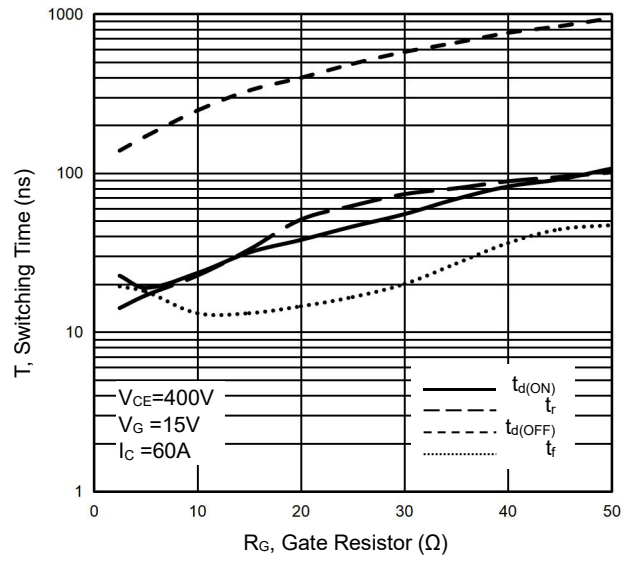
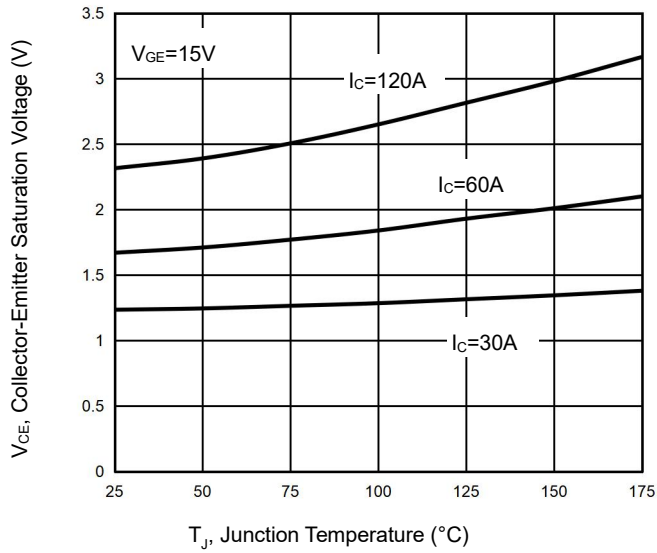
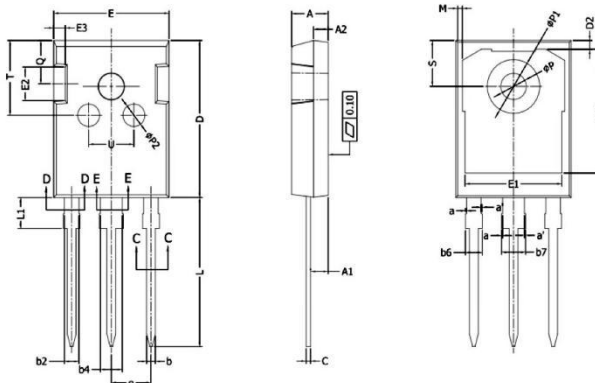


Figure 21 Switching Loss vs. IC

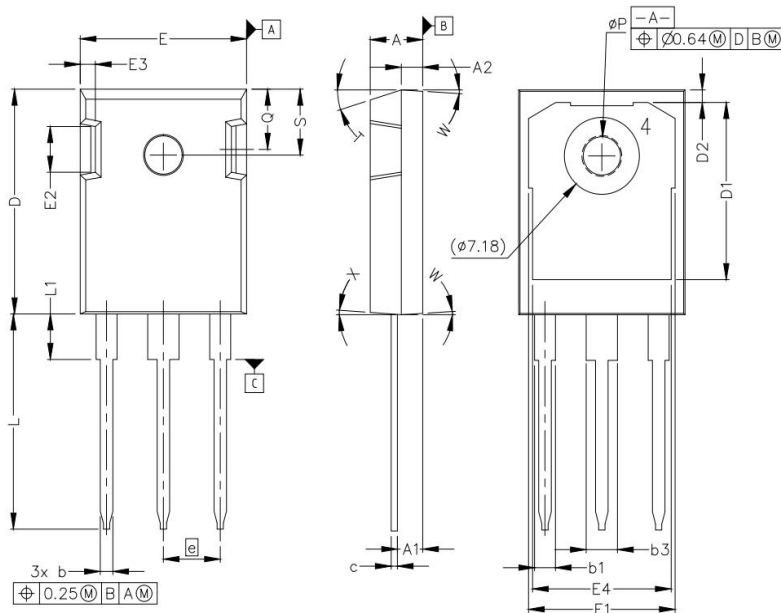


TO-247-P Package Information



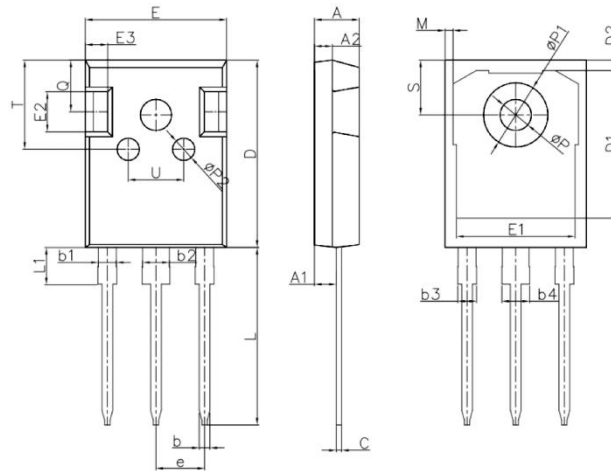
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.90	5.10	0.19	0.20
A1	2.31	2.51	0.09	0.10
A2	1.90	2.10	0.08	0.09
a	0.00	0.15	0.00	0.01
a'	0.00	0.15	0.00	0.01
b	1.16	1.26	0.05	0.06
b2	1.96	2.06	0.08	0.09
b4	2.96	3.06	0.12	0.13
b6	-	2.25	-	0.09
b7	-	3.25	-	0.13
C	0.59	0.66	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



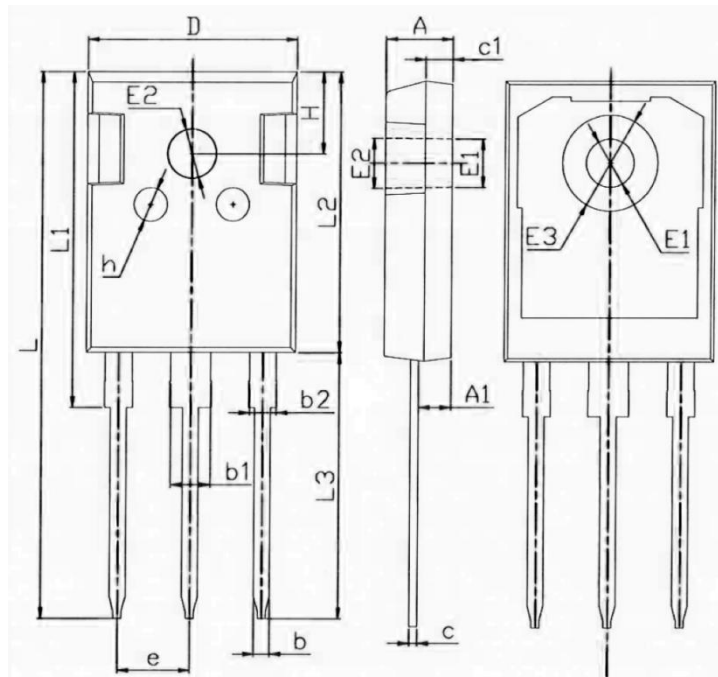
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.83	5.21	0.19	0.21
A1	2.29	2.54	0.09	0.10
A2	1.91	2.16	0.08	0.09
b	1.07	1.33	0.04	0.05
b1	1.91	2.41	0.08	0.10
b3	2.87	3.38	0.11	0.13
c	0.55	0.68	0.02	0.03
D	20.80	21.10	0.82	0.83
D1	16.25	17.65	0.64	0.70
D2	0.95	1.25	0.04	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

TO-247-L Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.80	5.20	0.19	0.20
A1	2.26	2.56	0.09	0.10
b	1.10	1.30	0.04	0.05
b1	2.85	3.15	0.11	0.12
b2	1.85	2.15	0.07	0.08
c	0.50	0.70	0.02	0.03
c1	1.85	2.15	0.07	0.08
D	15.60	16.00	0.61	0.63
E1	3.45	3.75	0.14	0.15
E2	3.55	3.85	0.14	0.15
E3	7.04	7.34	0.28	0.29
L	40.67	41.17	1.60	1.62
L1	24.80	25.10	0.98	0.99
L2	20.80	21.20	0.82	0.83
L3	19.72	20.12	0.78	0.79
e	5.29	5.59	0.21	0.22
H	6.00	6.30	0.24	0.25
h	2.35	2.65	0.09	0.10

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