

## 650V 40A Trench FS Gen.7 IGBT

### General Description

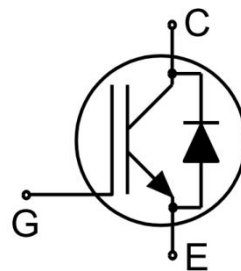
Using NCE's proprietary high density trench gate design and advanced FS (Field Stop) Gen.7 technology, the 650V Trench FS Gen.7 IGBT offers superior conduction and switching performances, and easy parallel operation.

### Features

- Trench field stop Gen.7 Technology Offering
- Low saturation voltage:  $V_{CESat} = 1.50V(Typ.) @ I_C = 40 A$
- High speed switching, low switching losses
- Maximum junction temperature  $T_{vjmax} = 175^{\circ}C$
- Tighten parameter distribution
- High ruggedness, temperature stable behavior
- Pb-free lead plating; RoHS compliant
- AEC-Q101 qualified

### Application

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



Schematic diagram

### Package Marking and Ordering Information

Device	Device Package	Device Marking
NCEA40ED65BT	TO-247-3L	A40ED65BT



TO-247-3L

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

Symbol	Parameter	Value	Units
$V_{CES}$	Collector-Emitter Voltage	650	V
$V_{GES}$	Gate- Emitter Voltage	$\pm 30$	V
$I_C$	Collector Current	80	A
	Collector Current @ $T_C = 100^{\circ}C$	40	A
$I_{Cpuls}$	Pulsed Collector Current, $t_p$ limited by $T_{jmax}$	120	A
-	Turn off safe operating area, $V_{CE}=650V, T_J=175^{\circ}C$	120	A
$I_F$	Diode Continuous Forward Current @ $T_C = 100^{\circ}C$	40	A
$I_{FM}$	Diode Maximum Forward Current	120	A
$P_D$	Power Dissipation @ $T_C = 25^{\circ}C$	245	W
	Power Dissipation @ $T_C = 100^{\circ}C$	123	W
$T_{stg}$	Storage Temperature	-55 to +150	$^{\circ}C$
$T_{vj}$	Operating junction temperature	-40 to +175	$^{\circ}C$
$T_L$	Maximum Temperature for Soldering	260	$^{\circ}C$
$t_{sc}$	Short circuit withstand time $V_{GE}=15V, V_{CC} \leq 400V$ , Allowed number of short circuits < 1000 Time between short circuits: $\geq 1.0s, T_J \leq 150^{\circ}C$	5	us

**Thermal Characteristic**

Symbol	Parameter	Value	Units
R <sub>θJC</sub>	Thermal Resistance, Junction to case for IGBT	0.61	°C/W
R <sub>θJC</sub>	Thermal Resistance, Junction to case for Diode	0.71	°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	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	650	--	--	V	
I <sub>CES</sub>	Collector-Emitter Leakage Current	V <sub>GE</sub> =0V, V <sub>CE</sub> =650V	--	--	5	uA	
I <sub>GES(F)</sub>	Gate to Emitter Forward Leakage	V <sub>GE</sub> =+30V, V <sub>CE</sub> =0V	--	--	100	nA	
I <sub>GES(R)</sub>	Gate to Emitter Reverse Leakage	V <sub>GE</sub> =-30V, V <sub>CE</sub> =0V	--	--	100	nA	
V <sub>CE(sat)</sub>	Collector-Emitter Saturation Voltage	I <sub>C</sub> =20A, T <sub>J</sub> =25°C	--	1.20	--	V	
		V <sub>GE</sub> =15V, T <sub>J</sub> =175°C	--	1.30	--	V	
		I <sub>C</sub> =40A, T <sub>J</sub> =25°C	--	1.50	2.00	V	
		V <sub>GE</sub> =15V, T <sub>J</sub> =175°C	--	1.80	--	V	
V <sub>GE(th)</sub>	Gate Threshold Voltage	I <sub>C</sub> =1mA, V <sub>CE</sub> =V <sub>GE</sub>	4.5	5.25	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	1870	2200	2530	pF	
C <sub>oes</sub>	Output Capacitance		--	71	--		
C <sub>res</sub>	Reverse Transfer Capacitance		--	17	--		
Q <sub>g</sub>	Total Gate Charge	V <sub>CC</sub> =480V, I <sub>C</sub> =40A, V <sub>GE</sub> =15V	--	82	--	nC	
Q <sub>ge</sub>	Gate to Emitter Charge		--	27	--		
Q <sub>gc</sub>	Gate to Collector Charge		--	25	--		
R <sub>g</sub>	Internal Gate Resistance	f=1MHz	--	0.5	--	Ω	
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> ≤5us, T <sub>J</sub> ≤150° C	--	200	--	A	
<b>Switching Characteristics</b>							
t <sub>d(ON)</sub>	Turn-on Delay Time	V <sub>CC</sub> =400V, I <sub>C</sub> =40A, V <sub>GE</sub> =0/15V, R <sub>g</sub> =5.4Ω, Inductive Load	--	45	--	ns	
t <sub>r</sub>	Rise Time		--	16	--		
t <sub>d(OFF)</sub>	Turn-Off Delay Time		--	133	--		
t <sub>f</sub>	Fall Time		--	15	--	mJ	
E <sub>on</sub>	Turn-On Switching Loss		--	1.0	--		
E <sub>off</sub>	Turn-Off Switching Loss		--	0.4	--		
E <sub>ts</sub>	Total Switching Loss		--	1.4	--	mJ	
E <sub>on</sub>	Turn-On Switching Loss		V <sub>CC</sub> =400V, I <sub>C</sub> =40A, V <sub>GE</sub> =0/15V, R <sub>g</sub> =5.4Ω, Inductive Load, T <sub>J</sub> =175°C	--	1.6		--
E <sub>off</sub>	Turn-Off Switching Loss		--	0.8	--		
E <sub>ts</sub>	Total Switching Loss	--	2.4	--			

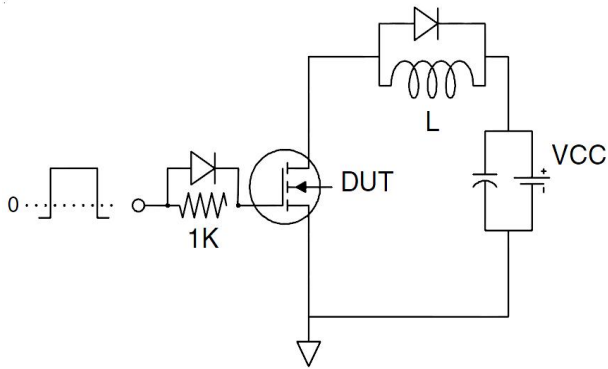
**Electrical Characteristics of the Diode (T<sub>c</sub>= 25°C unless otherwise specified)**

Symbol	Parameter	Conditions	Rating			Units	
			Min.	Typ.	Max.		
V <sub>FM</sub>	Diode Forward Voltage	I <sub>F</sub> =40A	T <sub>j</sub> =25°C	--	1.6	2.3	V
			T <sub>j</sub> =175°C	--	1.4	--	V
T <sub>rr</sub>	Reverse Recovery Time	I <sub>F</sub> =40A, R <sub>g</sub> =5.4Ω	--	100	--	ns	
I <sub>RPM</sub>	Diode Peak Reverse Recovery Current		--	25	--	A	
Q <sub>rr</sub>	Reverse Recovery Charge		--	0.98	--	uC	
E <sub>rec</sub>	Reverse recovery energy		--	0.18	--	mJ	
T <sub>rr</sub>	Reverse Recovery Time	I <sub>F</sub> =40A, R <sub>g</sub> =5.4Ω T <sub>j</sub> =175°C	--	150	--	ns	
I <sub>RPM</sub>	Diode Peak Reverse Recovery Current		--	40	--	A	
Q <sub>rr</sub>	Reverse Recovery Charge		--	2.45	--	uC	
E <sub>rec</sub>	Reverse recovery energy		--	0.27	--	mJ	

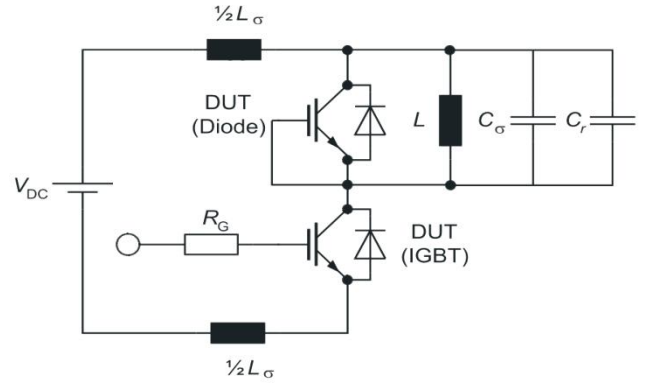
Note: For optimum lifetime and reliability, NCE recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

Test Circuit

1) Gate Charge Test Circuit

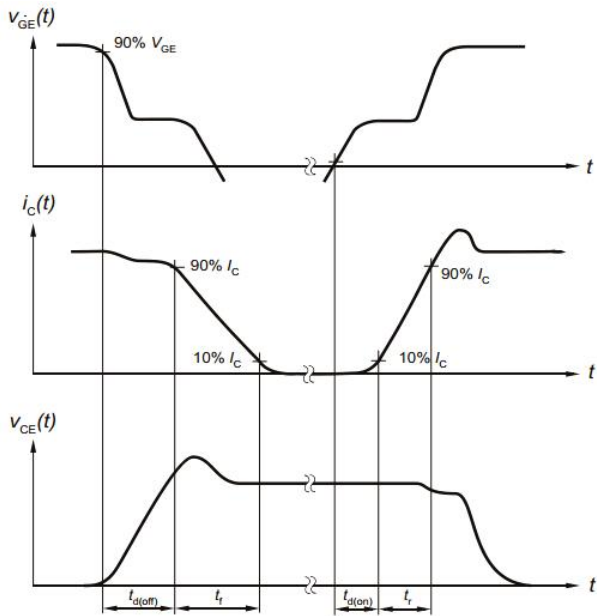


2) Switch Time Test Circuit

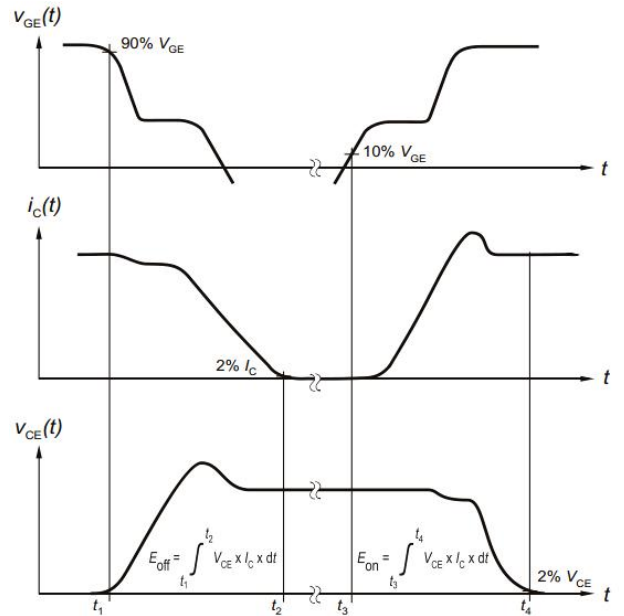


Switching characteristics

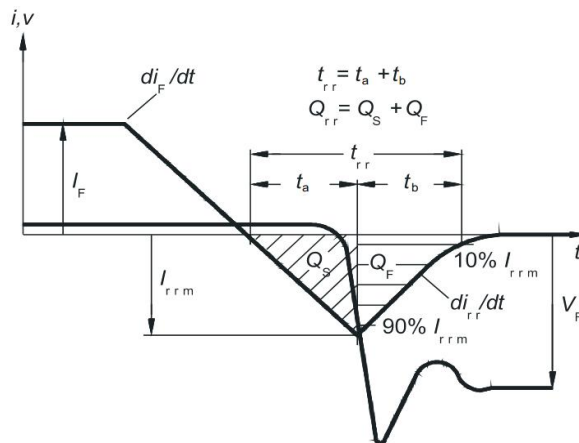
1) Definition of switching times



2) Definition of switching losses

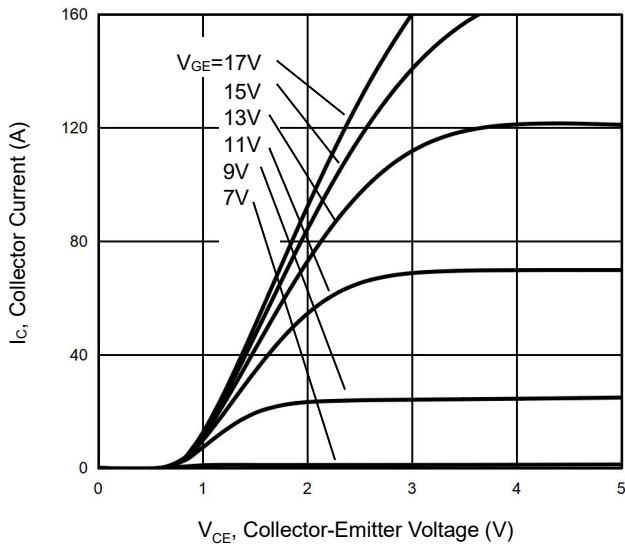


3) Definition of diode switching characteristics

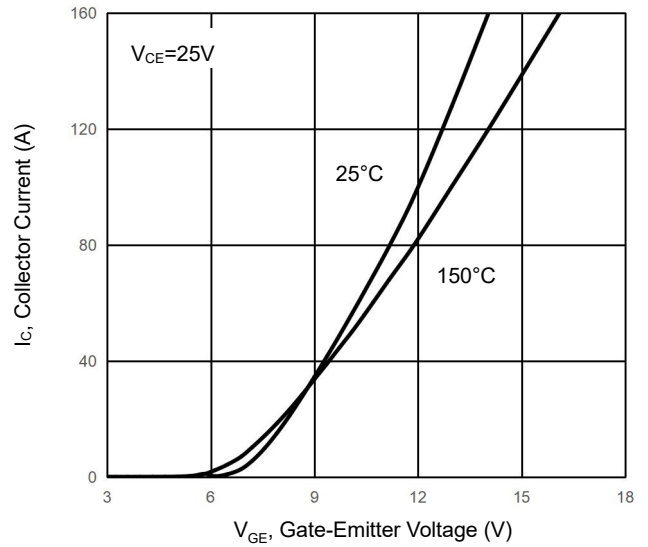


## Typical Electrical and Thermal Characteristics

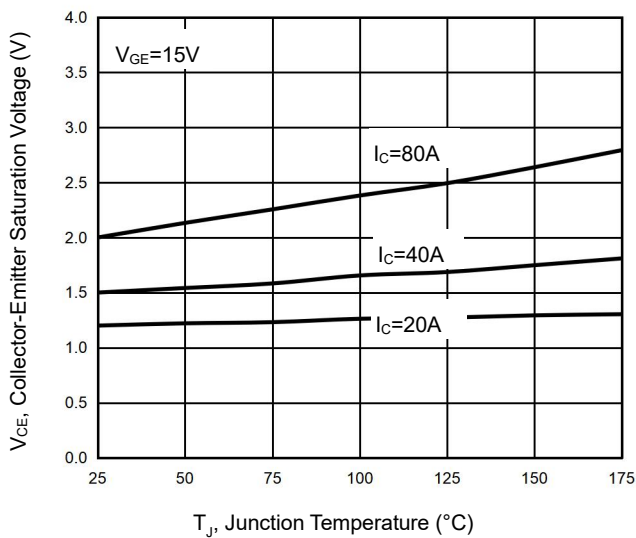
**Figure 1 Output Characteristics**



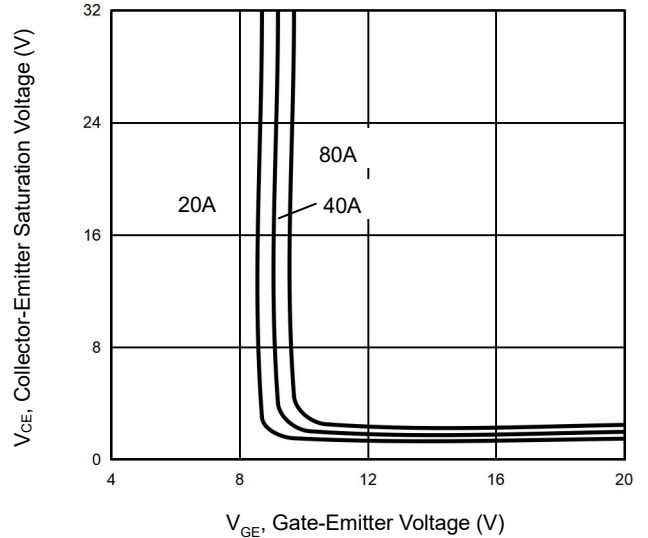
**Figure 2 Transfer Characteristics**



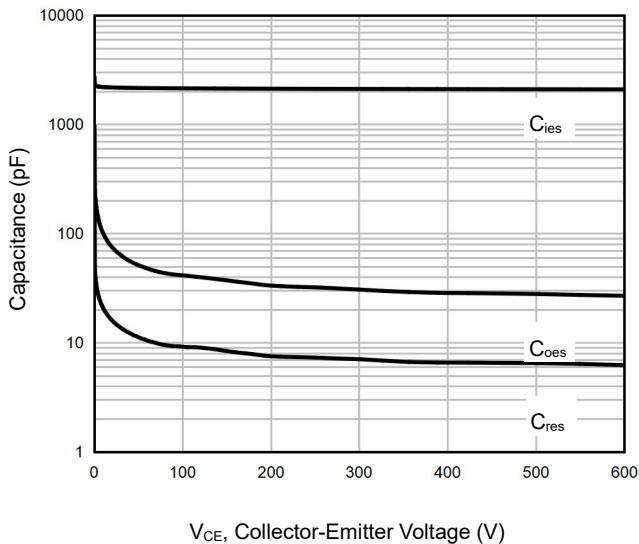
**Figure 3  $V_{CE(sat)}$  vs. Temperature**



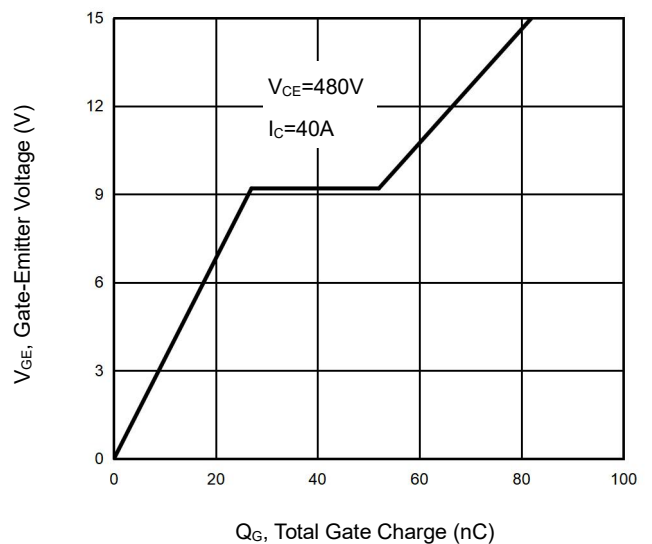
**Figure 4 Saturation Voltage vs.  $V_{GE}$**



**Figure 5 Capacitance Characteristics**



**Figure 6 Gate Charge Wave Form**



Typical Electrical and Thermal Characteristics

Figure 7 Forward Characteristics

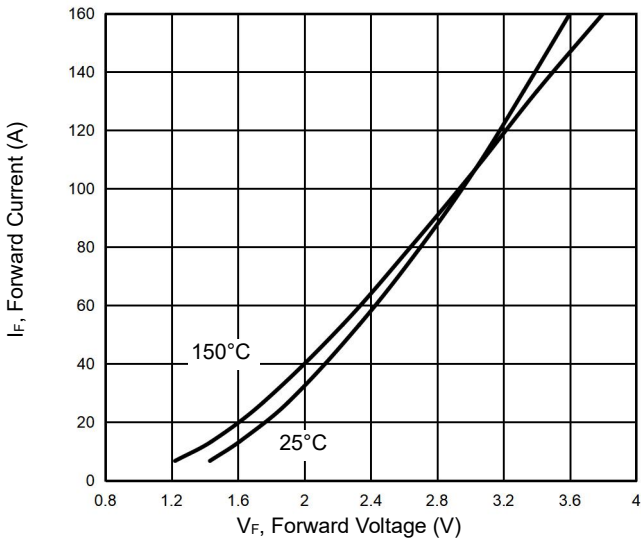


Figure 8  $V_F$  vs. Temperature

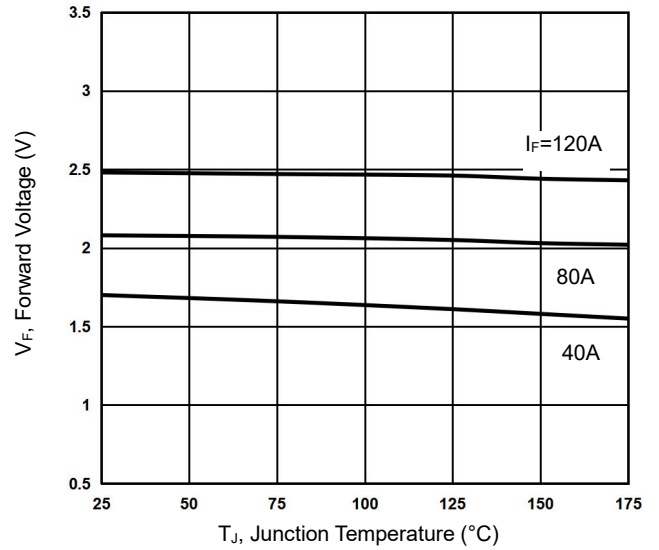


Figure 9 Switching Loss vs.  $R_G$

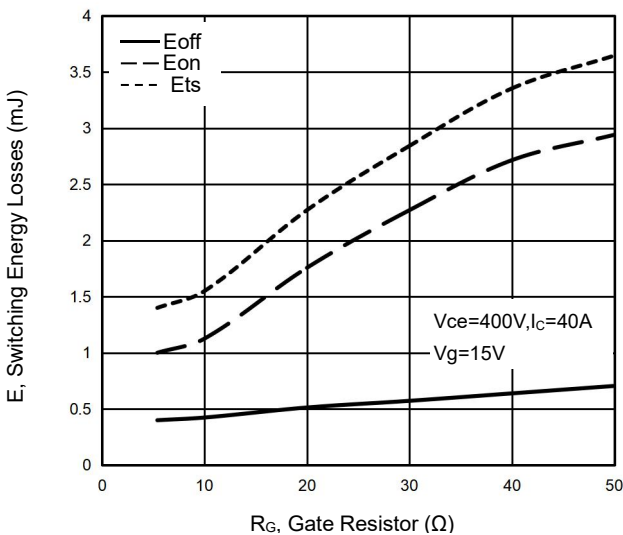


Figure 10 Switching Loss vs. Collector Current

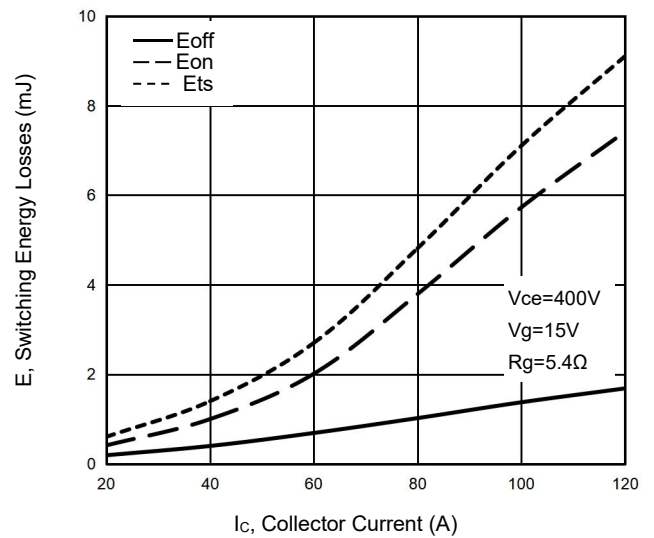


Figure 11 Gate-Emitter Threshold Voltage as a Function of Junction Temperature(Normalized)

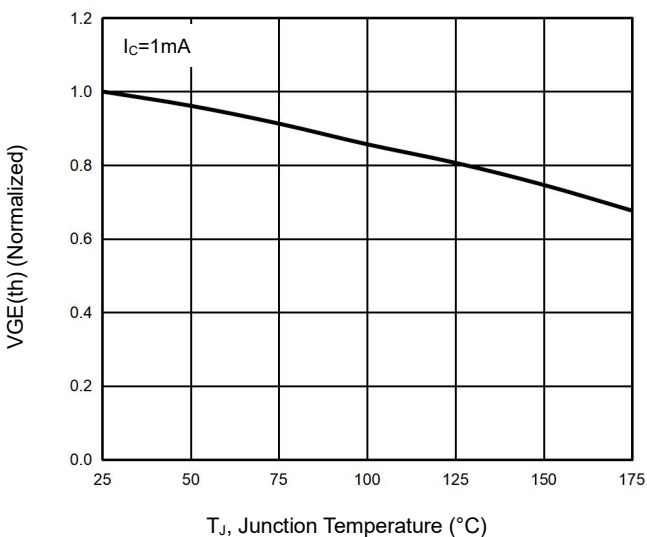
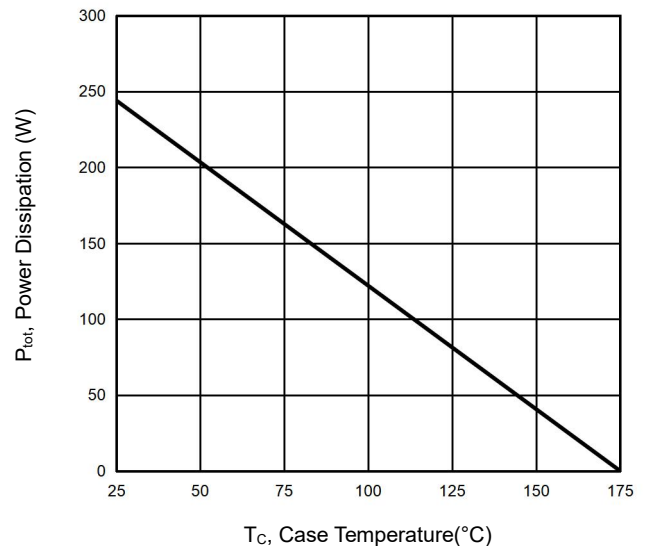


Figure 12  $P_{tot}$  vs. Case Temperature



Typical Electrical and Thermal Characteristics

Figure 13 Switching Loss vs. Temperature

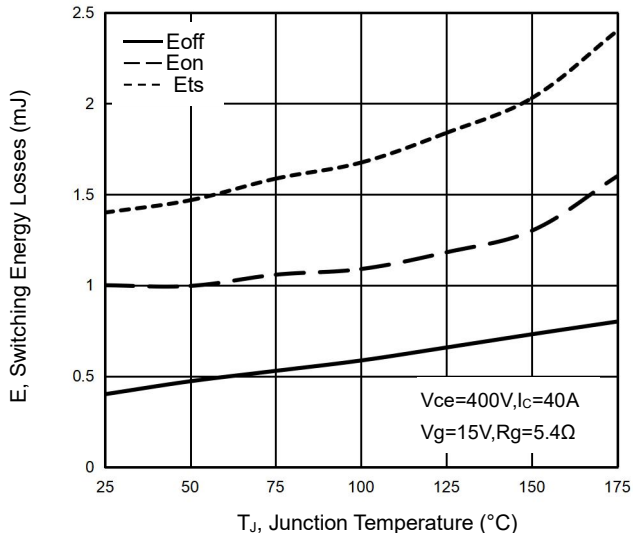


Figure 14 Switching Loss vs. V<sub>CE</sub>

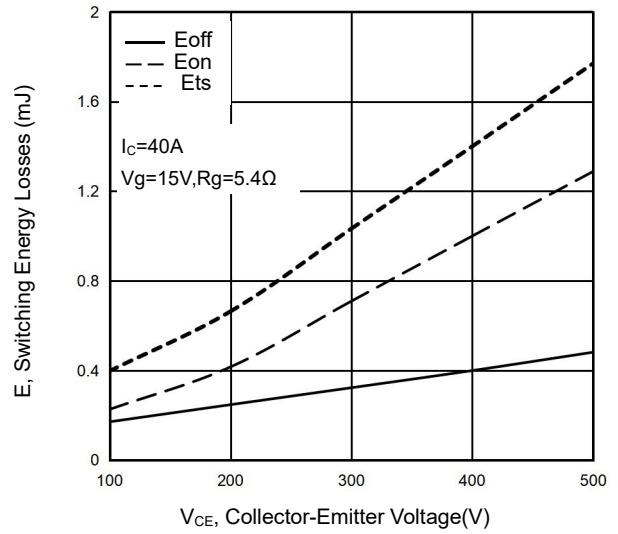


Figure 15 Gate-Emitter Threshold Voltage as a Function of Junction Temperature(Normalized)

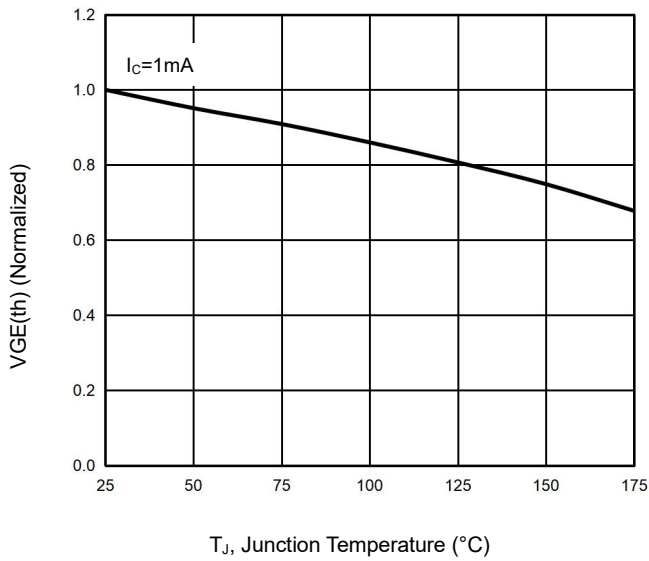


Figure 16 Typical Collector-Emitter Saturation Voltage as a Function of Collector Current(Normalized)

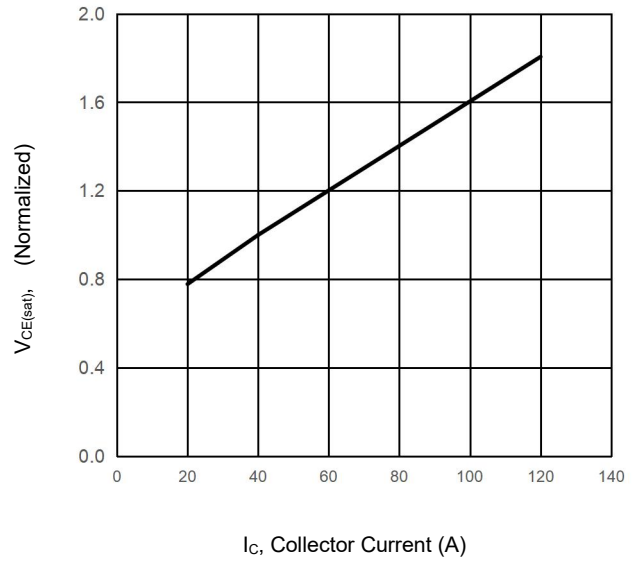


Figure 17 V<sub>(BR)CES</sub> vs. Temperature

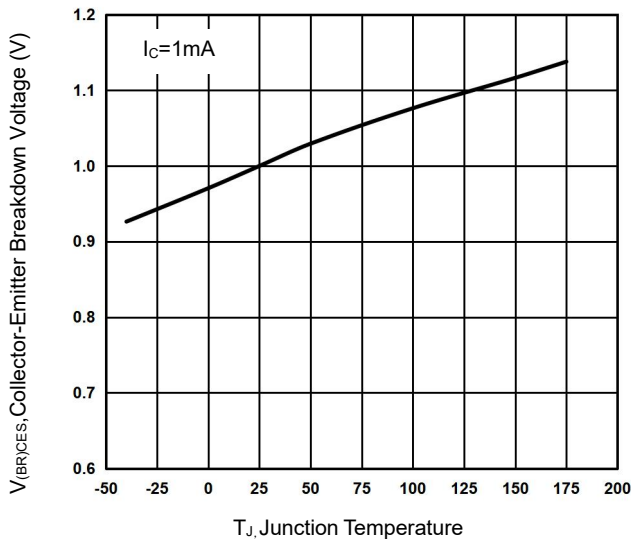
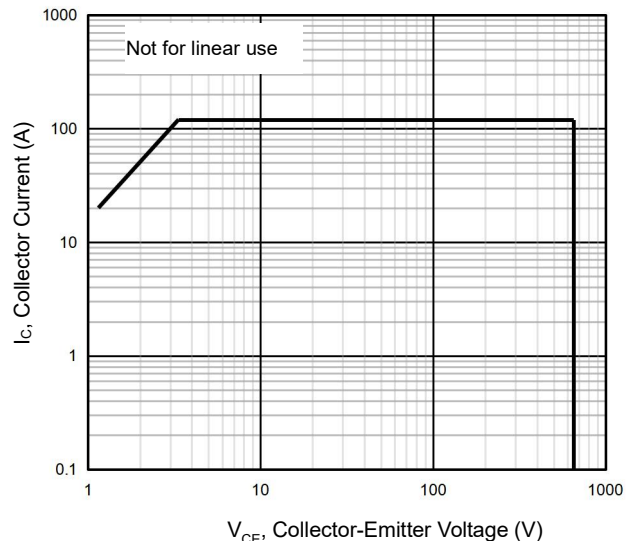
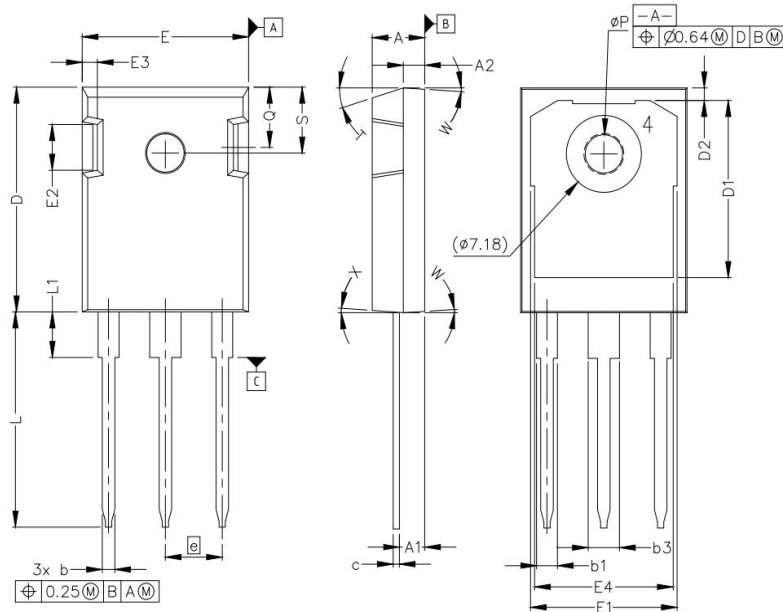


Figure 18 Forward Bias Safe Operating Area



## TO-247-3L(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			



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