

## 600V, 20A, Trench FS II Fast IGBT

### General Description

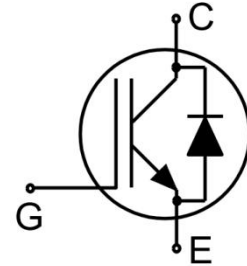
Using NCE's proprietary trench design and advanced FS (Field Stop) second generation technology, the 600V Trench FSII IGBT offers superior conduction and switching performances, and easy parallel operation;

### 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

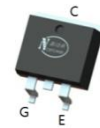
- Air Condition
- Inverters
- Motor drives



Schematic diagram

### Package Marking and Ordering Information

Device	Device Package	Device Marking
NCE20TD60BD	TO-263	NCE20TD60BD



TO-263

### 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	$\pm 30$	V
$I_C$	Collector Current	40	A
	Collector Current @ $T_c = 100^\circ\text{C}$	20	A
$I_{Cpuls}$	Pulsed Collector Current, $t_p$ limited by $T_{jmax}$	60	A
-	turn off safe operating area, $V_{CE}=600\text{V}$ , $T_j=175^\circ\text{C}$	60	A
$I_F$	Diode Continuous Forward Current @ $T_c = 100^\circ\text{C}$	20	A
$I_{FM}$	Diode Maximum Forward Current	60	A
$P_D$	Power Dissipation @ $T_c = 25^\circ\text{C}$	163	W
	Power Dissipation @ $T_c = 100^\circ\text{C}$	81.5	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	us

**Thermal Characteristic**

Symbol	Parameter	Value	Units
$R_{\theta JC}$	Thermal Resistance, Junction to case for IGBT	0.92	°C/W
$R_{\theta JC}$	Thermal Resistance, Junction to case for Diode	1.54	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	62	°C/W

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

Symbol	Parameter	Conditions	Rating			Units
			Min.	Typ.	Max.	
<b>Static Characteristics</b>						
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	$V_{GE}=0V, I_{CE}=1mA$	600	--	--	V
$I_{CES}$	Collector-Emitter Leakage Current	$V_{GE}=0V, V_{CE}=600V$	--	--	40	uA
$I_{GES(F)}$	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	$I_C=20A$ $T_J=25^\circ\text{C}$	--	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	--	6.0	V
<b>Dynamic Characteristics</b>						
$C_{ies}$	Input Capacitance	$V_{CE}=25V, V_{GE}=0V,$ $f=1MHz$	--	2580	--	pF
$C_{oes}$	Output Capacitance		--	48	--	
$C_{res}$	Reverse Transfer Capacitance		--	26	--	
$Q_g$	Total Gate Charge	$V_{CC}=480V, I_C=20A,$ $V_{GE}=15V$	--	97	--	nC
$Q_{ge}$	Gate to Emitter Charge		--	17	--	
$Q_{gc}$	Gate to Collector Charge		--	37	--	
$I_{C(SC)}$	Short circuit collector current Max.1000 short circuits Time between short circuits: $\geq 1.0s$	$V_{GE}=15V, V_{CC}\leq 400V,$ $t_{sc}\leq 5\mu s, T_J\leq 150^\circ\text{C}$	--	130	--	A
<b>Switching Characteristics</b>						
$t_{d(ON)}$	Turn-on Delay Time	$V_{CC}=400V, I_C=20A,$ $V_{GE}=0/15V, R_g=25\Omega,$ Inductive Load	--	18	--	ns
$t_r$	Rise Time		--	16	--	
$t_{d(OFF)}$	Turn-Off Delay Time		--	164	--	
$t_f$	Fall Time		--	15	--	
$E_{on}$	Turn-On Switching Loss		--	0.43	--	mJ
$E_{off}$	Turn-Off Switching Loss		--	0.17	--	
$E_{ts}$	Total Switching Loss		--	0.60	--	

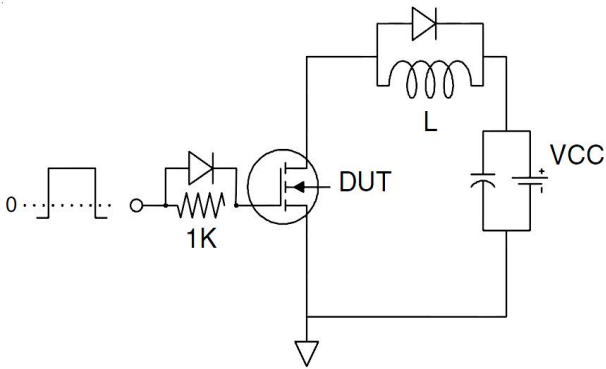
**Electrical Characteristics of the Diode ( $T_c=25^\circ\text{C}$  unless otherwise specified)**

Symbol	Parameter	Conditions	Rating			Units
			Min.	Typ.	Max.	
$V_{FM}$	Diode Forward Voltage	$I_F=20A$	--	1.75	2.40	V
$T_{rr}$	Reverse Recovery Time	$I_F=20A,$ $di/dt=200A/\mu s$	--	182	--	ns
$I_{RRM}$	Diode Peak Reverse Recovery Current		--	5.3	--	A
$Q_{rr}$	Reverse Recovery Charge		--	0.5	--	uC

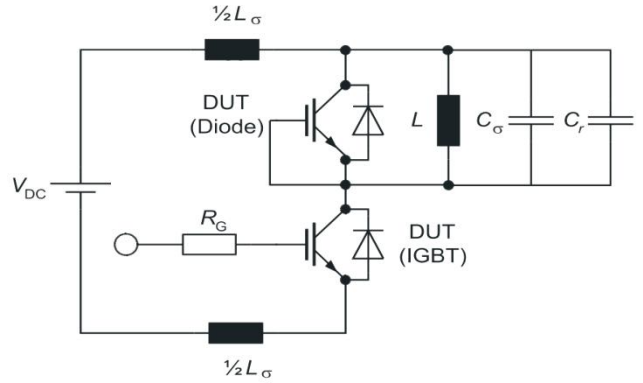
Pulse width  $t_p\leq 380\mu s, \delta\leq 2\%$

Test Circuit

1) Gate Charge Test Circuit

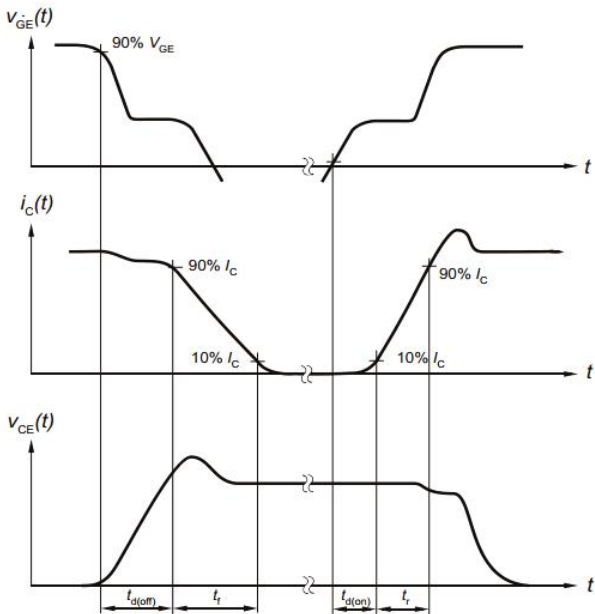


2) Switch Time Test Circuit

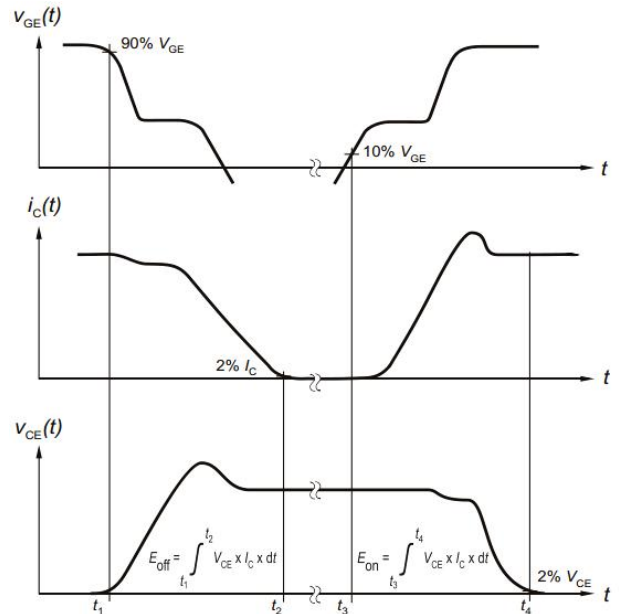


Switching characteristics

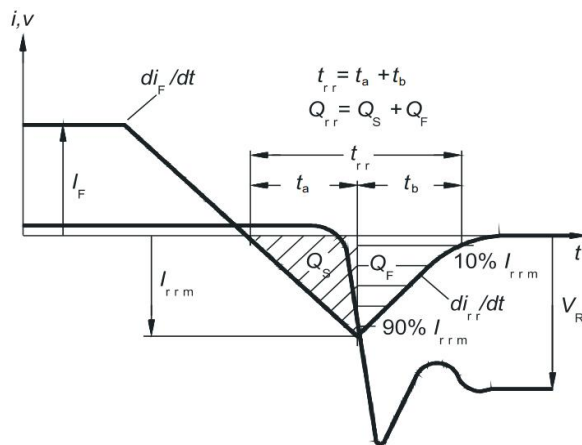
1) Definition of switching times



2) Definition of switching losses

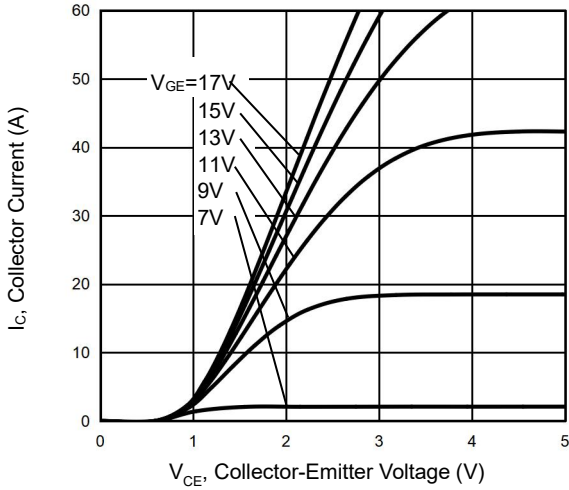


3) Definition of diode switching characteristics

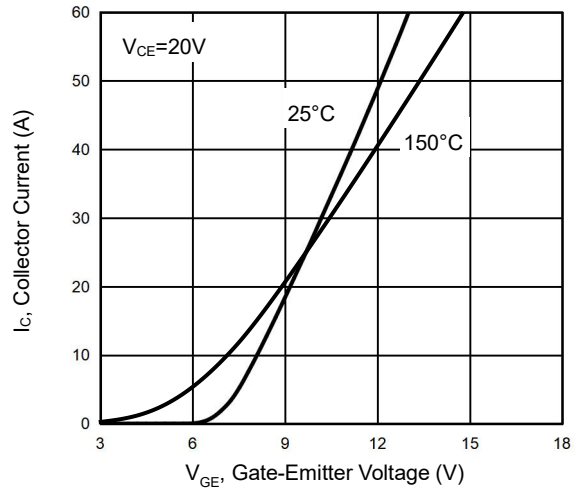


## Typical Electrical and Thermal Characteristics

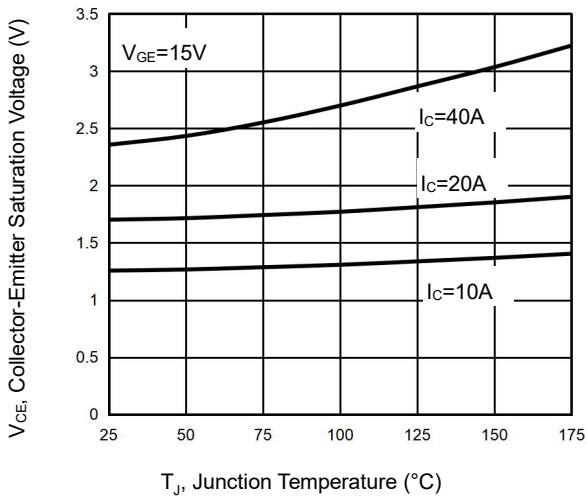
**Figure 1 Output Characteristics**



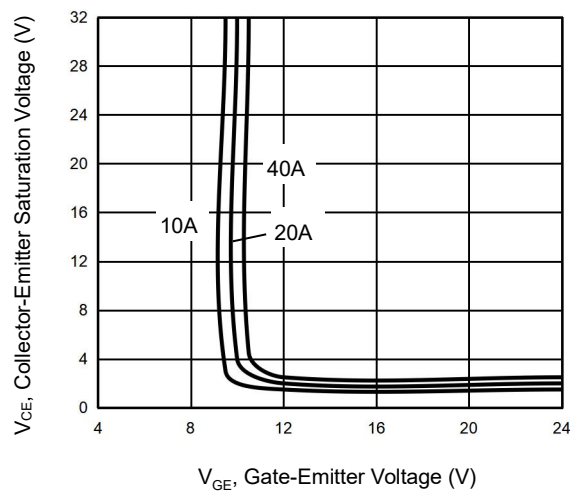
**Figure 2 Transfer Characteristics**



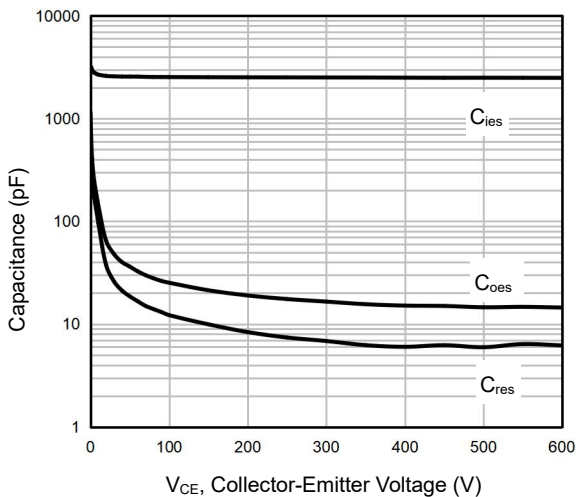
**Figure 3  $V_{CEsat}$  vs. Case Temperature**



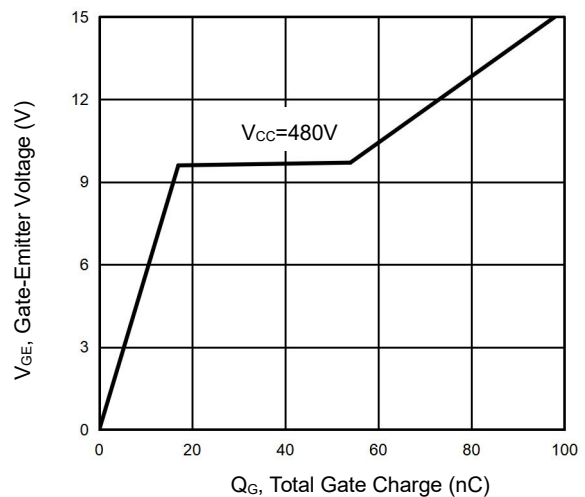
**Figure 4 Saturation Voltage vs.  $V_{GE}$**



**Figure 5 Capacitance Characteristics**

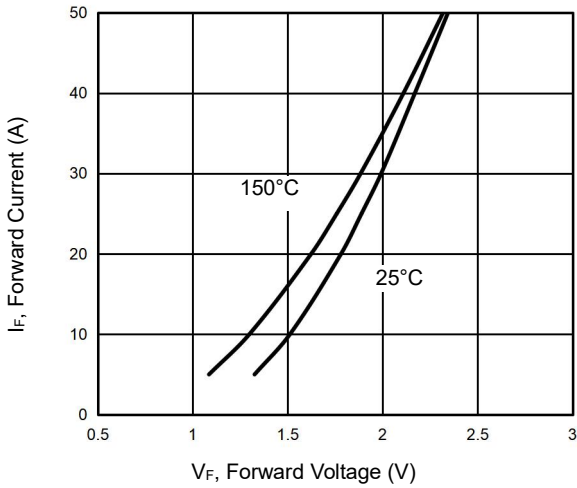


**Figure 6 Gate Charge Wave Form**

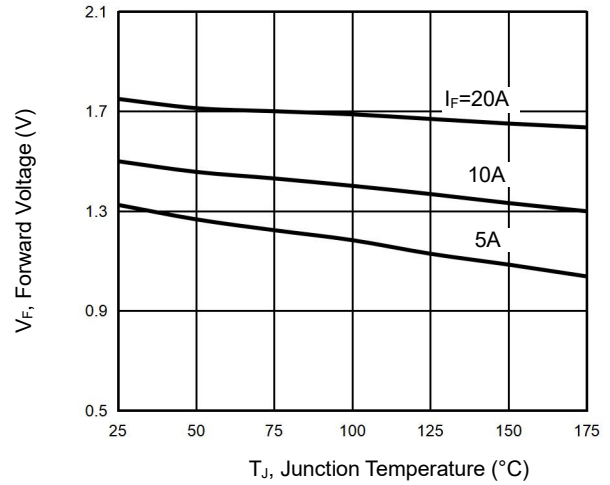


## Typical Electrical and Thermal Characteristics

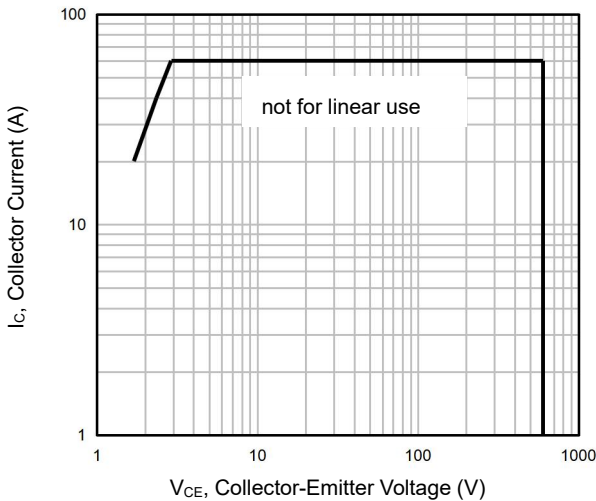
**Figure 7 Forward Characteristics**



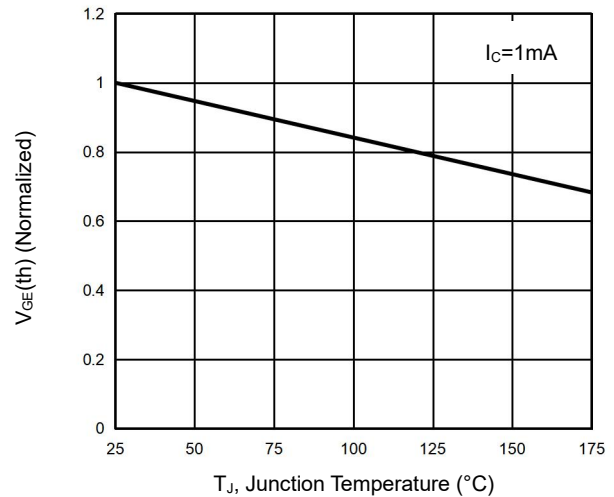
**Figure 8  $V_F$  vs. Temperature**



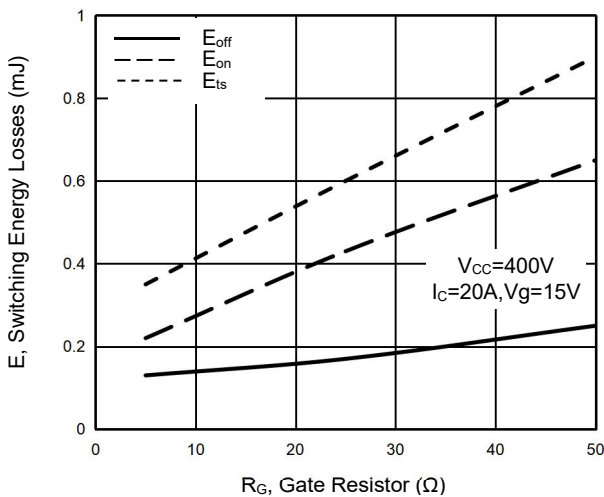
**Figure 9 Forward Bias Safe Operating**



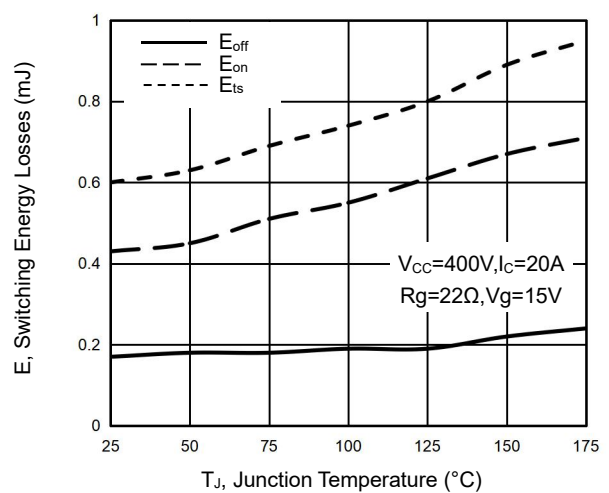
**Figure 10 Gate-emitter Threshold Voltage as a Function of Junction Temperature**



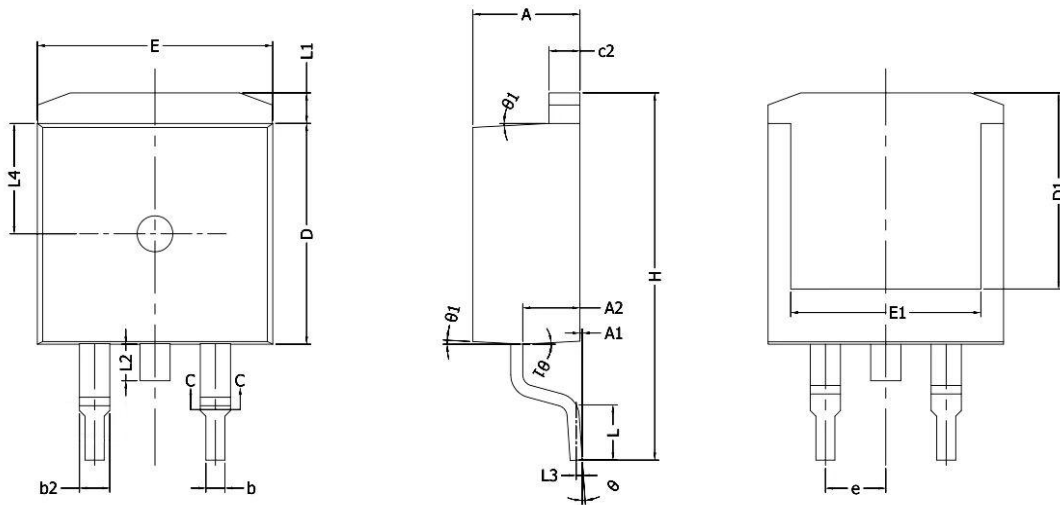
**Figure 11 Typical Switching Times as a Function of Gate Resistor**



**Figure 12 Typical Switching Times as a Function of Junction Temperature**



## TO-263-P Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.40	4.60	0.17	0.18
A1	0.00	0.25	0.00	0.01
A2	2.20	2.60	0.09	0.10
b	0.76	0.89	0.03	0.04
b2	1.23	1.37	0.04	0.05
C	0.47	0.60	0.01	0.02
c2	1.25	1.35	0.05	0.06
D	9.10	9.30	0.35	0.36
D1	8.00	-	0.31	-
E	9.80	10.00	0.38	0.39
E1	7.80	-	0.31	-
e	2.54BSC		0.10BSC	
H	14.90	15.70	0.59	0.62
L	2.00	2.60	0.08	0.10
L1	1.17	1.40	0.05	0.06
L2	-	1.75	-	0.07
L3	0.25BSC		0.01BSC	
L4	4.60REF		0.18REF	
θ	0°	8°	0°	8°
θ1	1°	5°	1°	5°

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