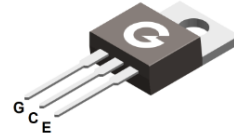
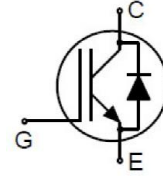


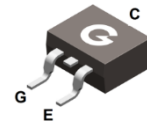
Features

- High breakdown voltage to 650V for improved reliability
- Trench-stop technology offering:
 - High speed switching
 - High ruggedness, temperature stable behavior
 - Short circuit withstand time: 10μs
 - Low $V_{CE(SAT)}$
 - Easy parallel switching capability due to positive temperature coefficient in $V_{CE(SAT)}$
- Enhanced avalanche capability
- RoHS compliant with Halogen-free

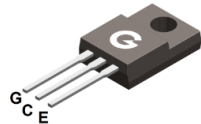
HF



TO-220AB



TO-263



ITO-220AB

Applications

- Air Condition
- Inverters

Mechanical Data

- Case: TO-220AB, TO-263, ITO-220AB
- Molding Compound: UL Flammability Classification Rating 94V-0
- Terminals: Matte tin-plated leads; solderability-per MIL-STD-202, Method 208

Ordering Information

Part Number	Package	Shipping Quantity	Marking Code
GKP15N65ES5	TO-220AB	50 pcs / Tube	KP15N65ES5
GKB15N65ES5	TO-263	50 pcs / Tube or 800 pcs / Tape & Reel	KB15N65ES5
GKF15N65ES5	ITO-220AB	50 pcs / Tube	KF15N65ES5

Maximum Ratings (@ $T_C = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Value	Unit
Collector-to-Emitter Voltage	V_{CES}	650	V
Gate-Emitter Voltage	V_{GES}	± 20	V
DC Collector Current ($T_C = 25^\circ\text{C}$, limited by maximum T_J)	I_C	30	A
DC Collector Current ($T_C = 100^\circ\text{C}$, limited by maximum T_J)		15	
Diode Continuous Forward Current ($T_C = 25^\circ\text{C}$, limited by maximum T_J)	I_F	30	A
Diode Continuous Forward Current ($T_C = 100^\circ\text{C}$, limited by maximum T_J)		15	
Pulsed Collector Current (Pulse width limited by maximum T_J , $V_{GE} = 15\text{V}$)	I_{CM}	60	A
Pulsed Source-Drain Current (Pulse width limited by maximum T_J)	I_{FM}	60	A
Short Circuit Withstand Time ($V_{GE} = 15\text{V}$, $V_{CE} \leq 400\text{V}$)	T_{SC}	10	μs
Soldering Temperature, Wave Soldering 1.6mm (0.063in.) from case for 10s	T_{sold}	260	°C
Power Dissipation ($T_C = 25^\circ\text{C}$, TO-220AB, TO-263)	P_D	49.5	W
Power Dissipation ($T_C = 25^\circ\text{C}$, ITO-220AB)		44.5	
Operating Junction Temperature Range	T_J	-55 ~ +175	°C
Storage Temperature Range	T_{STG}	-55 ~ +150	°C

Thermal Characteristics

Parameter	Symbol	TO-220AB	TO-263	ITO-220AB	Unit
Thermal Resistance Junction-to-Case, IGBT	$R_{\theta JC}$	3.03	3.03	3.37	$^{\circ}\text{C/W}$
Thermal Resistance Junction-to-Case, Diode		3.72	3.72	4.47	
Thermal Resistance Junction-to-Air	$R_{\theta JA}$	23	23	40	$^{\circ}\text{C/W}$

Electrical Characteristics of the IGBT (@ $T_J = 25^{\circ}\text{C}$ unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Static Characteristics						
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	$V_{GE} = 0\text{V}, I_C = 250\mu\text{A}$	650	-	-	V
I_{CES}	Collector-Emitter Leakage Current	$V_{CE} = 650\text{V}, V_{GE} = 0\text{V}$	-	-	1	μA
I_{GES}	Gate to Emitter Leakage Current	$V_{GE} = \pm 20\text{V}, V_{CE} = 0\text{V}$	-	-	± 100	nA
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$V_{GE} = 15\text{V}, I_C = 15\text{A}, T_J = 25^{\circ}\text{C}$	-	1.50	1.80	V
		$V_{GE} = 15\text{V}, I_C = 15\text{A}, T_J = 175^{\circ}\text{C}$	-	1.87	-	V
$V_{GE(th)}$	Gate Threshold Voltage	$V_{CE} = V_{GE}, I_C = 250\mu\text{A}$	4.4	5.2	6.0	V
R_G	Gate Resistance	$V_{GS} = 0\text{V}, f = 1\text{MHz}$	-	8.76	-	Ω
Dynamic Characteristics						
Q_G	Total Gate-Charge	$V_{CC} = 520\text{V}, V_{GE} = 15\text{V}, I_C = 15\text{A}$	-	78	-	nC
C_{ies}	Input Capacitance	$V_{CE} = 25\text{V}$	-	920	-	pF
C_{oes}	Output Capacitance	$V_{GE} = 0\text{V}$	-	44	-	
C_{res}	Reverse Transfer Capacitance	$f = 1\text{MHz}$	-	11	-	
$I_{C(SC)}$	Short Circuit Collector Current	$V_{GE} = 15\text{V}, t_{SC} \leq 10\mu\text{s}$ $V_{CC} = 400\text{V}, T_J = 25^{\circ}\text{C}$	-	78	-	A
Switching Characteristics						
$t_{d(on)}$	Turn-on Delay Time	$V_{CE} = 400\text{V}$ $V_{GE} = 15\text{V}$ $I_C = 15\text{A}$ $R_G = 10\Omega$ $T_J = 25^{\circ}\text{C}$	-	32	-	ns
t_r	Turn-on Rise Time		-	21	-	
$t_{d(off)}$	Turn-Off Delay Time		-	117	-	
t_f	Turn-Off Fall Time		-	107	-	
E_{on}	Turn-On Switching Loss		-	0.28	-	mJ
E_{off}	Turn-Off Switching Loss		-	0.34	-	

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

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Dynamic Characteristics						
V_{FM}	Diode Forward Voltage	$I_F = 15\text{A}, V_{GE} = 0\text{V}$	-	1.45	-	V
t_{rr}	Reverse recovery time	$V_{GE} = 0\text{V}, I_F = 15\text{A}$ $di/dt = 300\text{A}/\mu\text{s}$	-	109	-	ns
Q_{rr}	Reverse recovery charge		-	302	-	nC
I_{rrm}	Peak Reverse Recovery Current		-	5.17	-	A

Ratings and Characteristics Curves (@ $T_A = 25^\circ\text{C}$ unless otherwise specified)

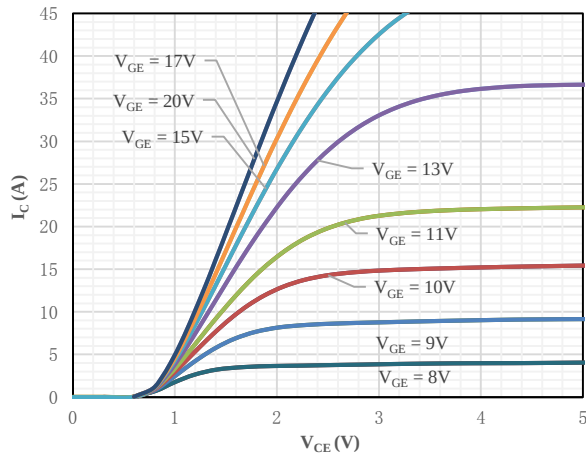


Fig 1 Typical Output Characteristics

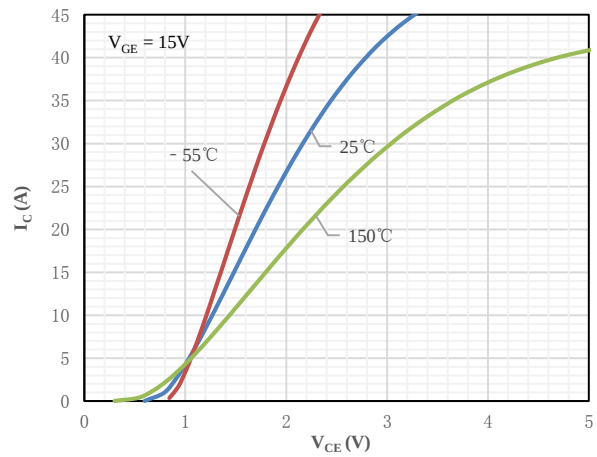


Fig 2 Saturation Voltage Characteristics

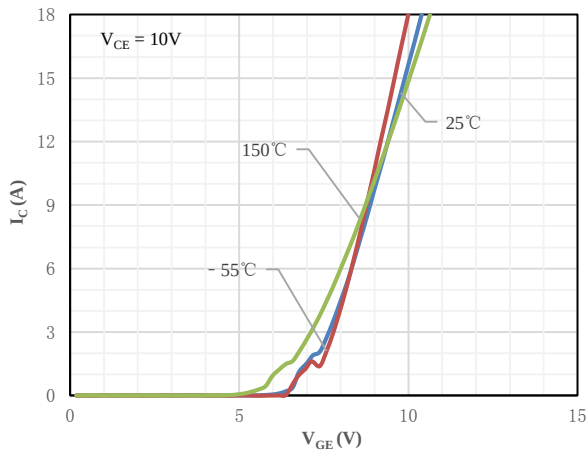


Fig 3 Transfer Characteristics

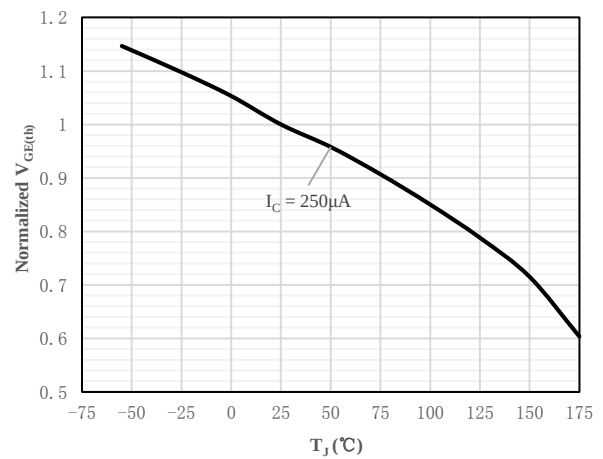


Fig 4 Normalized $V_{GE(th)}$ vs. Junction Temperature

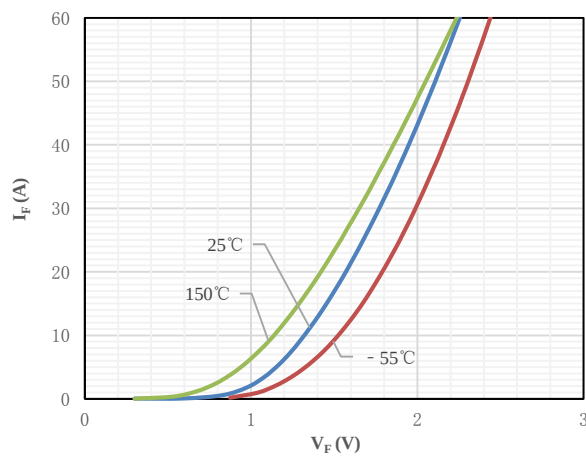


Fig 5 Diode forward current as a function of forward voltage V_F vs. I_F

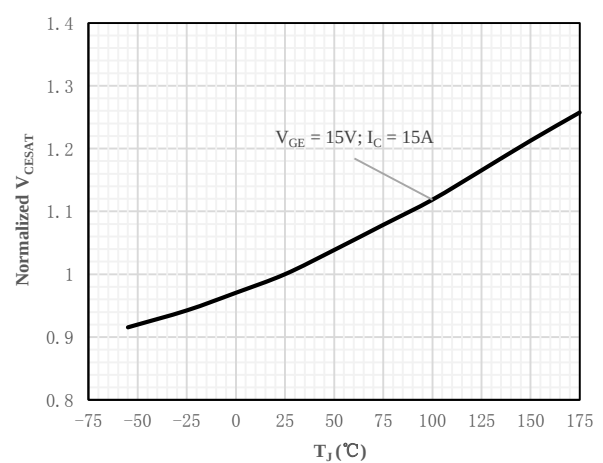
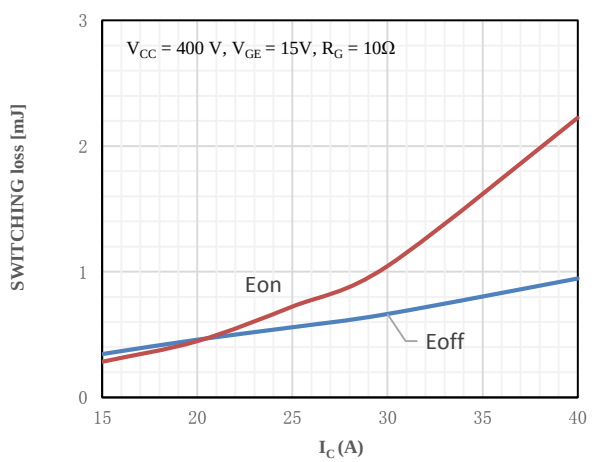
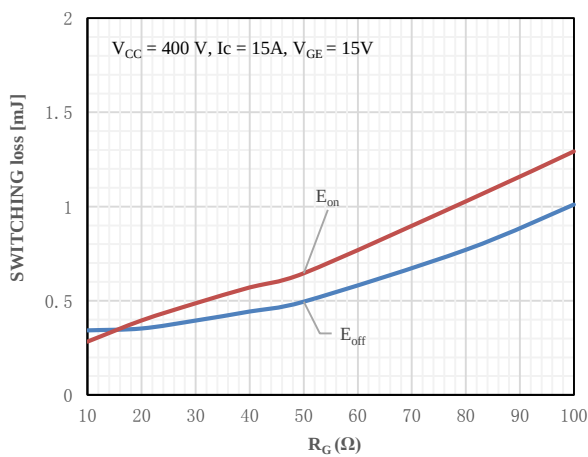
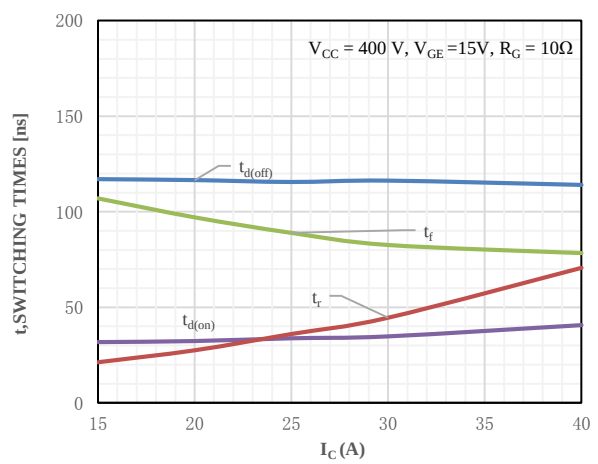
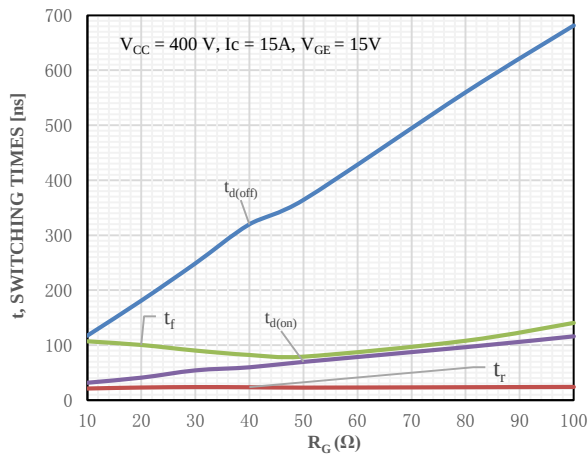
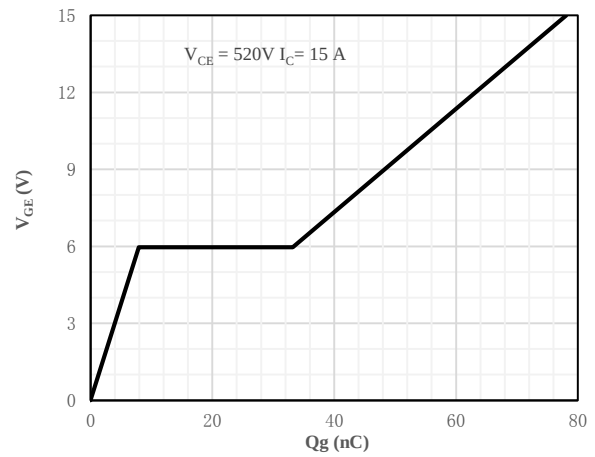
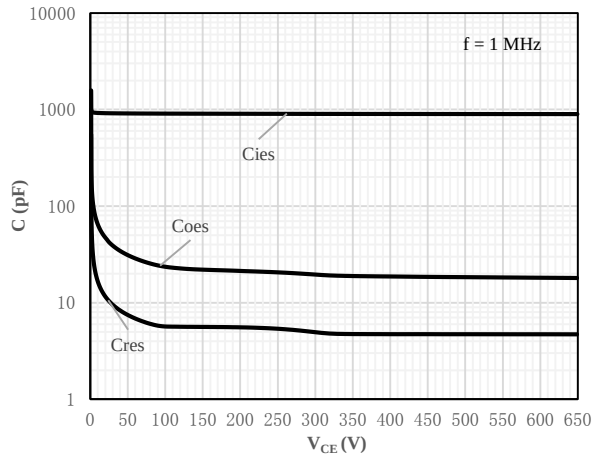


Fig 6 Normalized Collector-Emitter Saturation Voltage vs. Junction Temperature



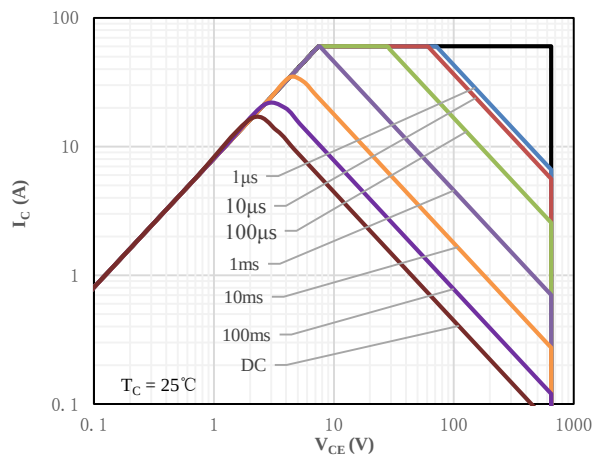


Fig 13 SOA characteristics (ITO-220AB)

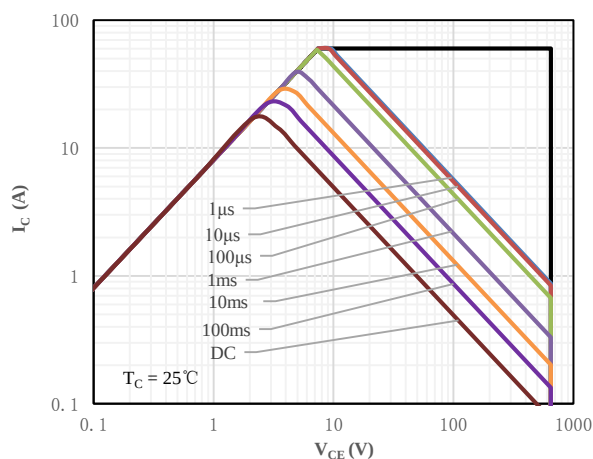


Fig 14 SOA characteristics (TO-263)

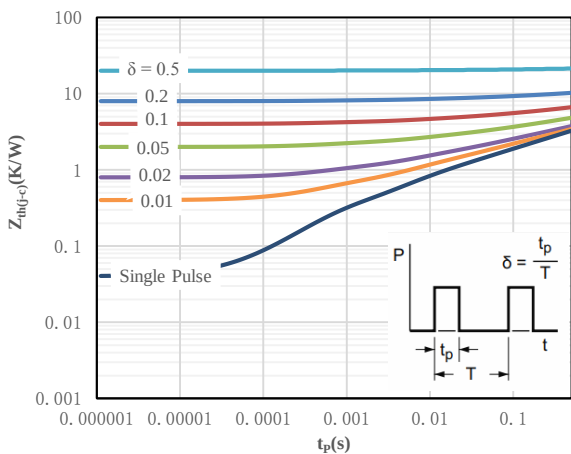


Fig 15 Maximum transient thermal impedance
(ITO-220AB)

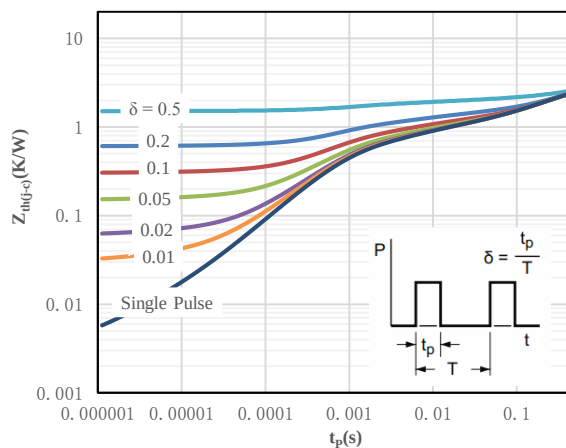


Fig 16 Maximum transient thermal impedance
(TO-263)

Waveform definitions

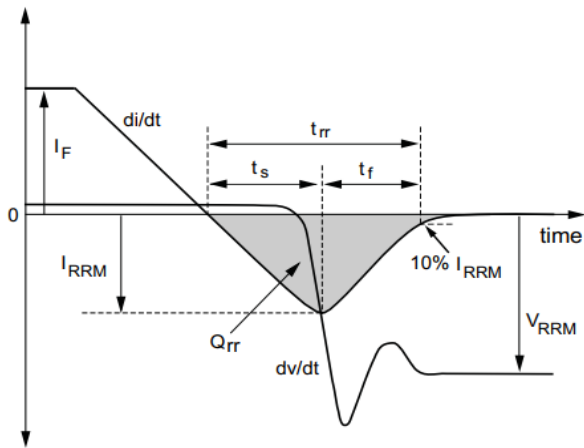


Fig 1 Diode Reverse Recovery Waveform Definitions

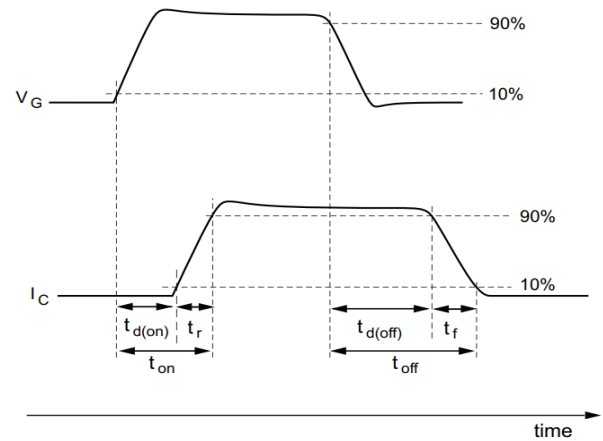
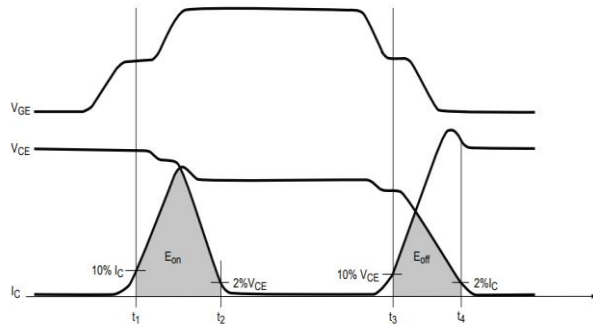


Fig 2 IGBT Switching Times Definitions



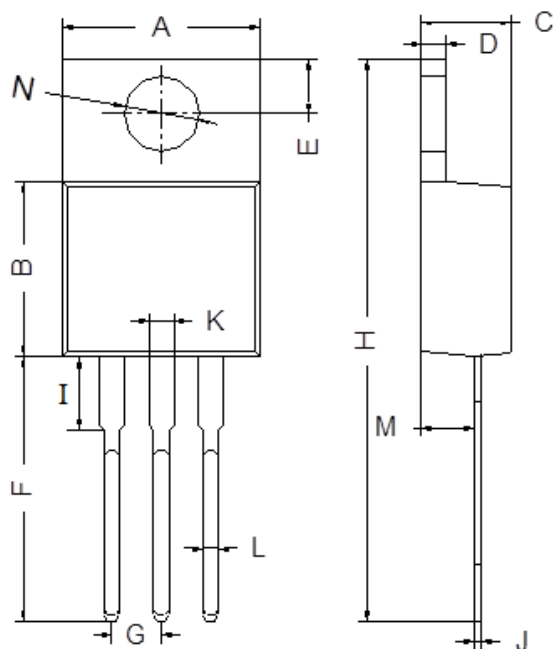
Where

$$E_{on} = \int_{t_1}^{t_2} V_{CE} I_C dt$$

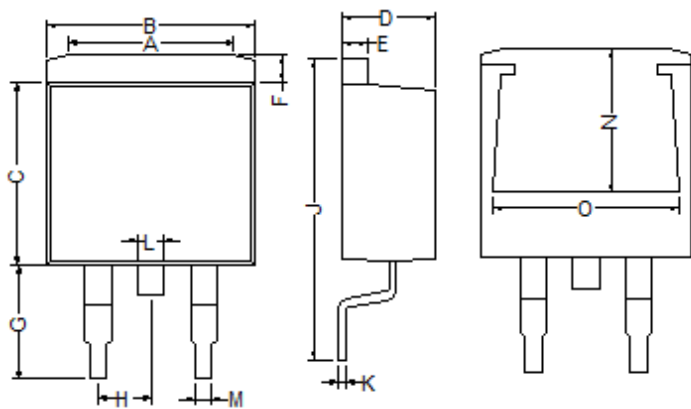
$$E_{off} = \int_{t_3}^{t_4} V_{CE} I_C dt$$

Fig 3 IGBT Switching Energy Loss Definitions

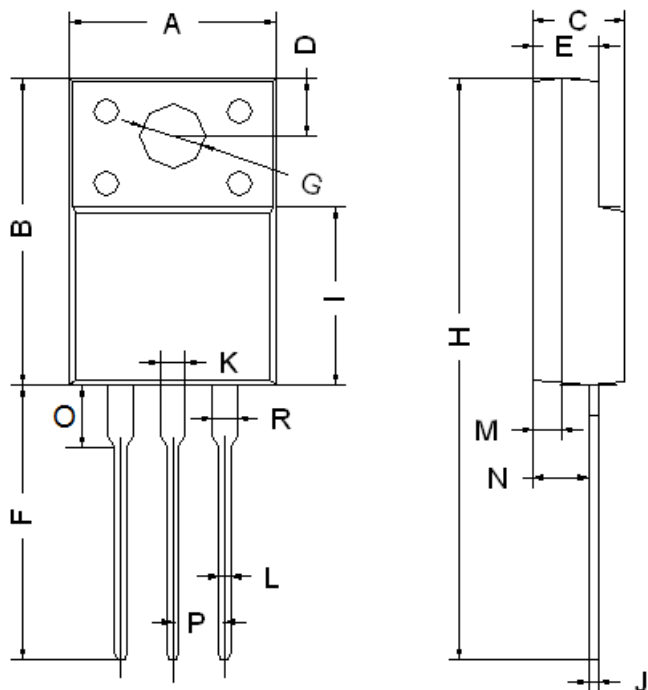
Package Outline Dimensions (Unit: mm)



TO-220AB		
Dimension	Min.	Max.
A	9.80	10.30
B	8.70	9.10
C	4.37	4.77
D	1.07	1.47
E	2.64	2.84
F	13.14	13.74
G	2.44	2.64
H	28.03	28.83
I	3.50	4.00
J	0.28	0.48
K	1.22	1.32
L	0.71	0.91
M	2.40	2.60
N	3.76	3.96



TO-263		
Dimension	Min.	Max.
A	6.00	8.00
B	9.90	10.30
C	8.50	9.10
D	4.37	4.77
E	1.07	1.47
F	1.07	1.47
G	5.05	5.74
H	2.44	2.66
J	15.15	15.80
K	0.28	0.48
L	1.17	1.37
M	0.71	0.91
N	6.55	7.68
O	7.70	8.10



ITO-220AB		
Dimension	Min.	Max.
A	9.90	10.30
B	14.80	15.20
C	4.30	4.70
D	2.50	2.90
E	2.80	3.30
F	13.00	13.60
G	3.10	3.30
H	28.00	28.60
I	7.90	8.90
J	0.40	0.60
L	0.70	0.90
M	1.30	1.50
N	2.60	2.80
O	2.60	3.10
P	2.45	2.65
K/R	1.10	1.30