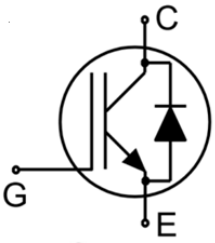
Trench Field-Stop Technology IGBT



TO220F

Features

- 650V, 6A
- $V_{CE(sat)(typ.)}$ =1.75V@V_{GE}=15V, I_C=6A
- Maximum Junction Temperature 175℃
- Pb-free Lead Plating; RoHS Compliant

Applications

- Solar Converters
- Uninterrupted Power Supply
- Welding Converters
- Mid to High Range Switching Frequency Converters

TO263

TO252

Key Performance and Package Parameters

Order codes	V_{CE}	I_C	V_{CEsat}, T_{vj}=25℃	T_{vjmax}	Marking	Package
XD006H065CX2H3	650V	6A	1.75V	175℃	D6H65CX2	TO220F-3L
XD006H065CX2R3	650V	6A	1.75V	175℃	D6H65CX2	TO263-2L
XD006H065CX2G3	650V	6A	1.75V	175℃	D6H65CX2	TO252-2L

Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-Emitter Voltage	650	V
V_{GES}	Gate-Emitter Voltage	±20	V
I_C	Continuous Collector Current (T_C=25℃)	12	A
	Continuous Collector Current (T_C=100℃)	6	A
I_{CM}	Pulsed Collector Current (Note 1)	18	A
I_F	Diode Continuous Forward Current (TC=25℃)	12	A
	Diode Continuous Forward Current (TC=100℃)	6	A
I_{FM}	Diode Maximum Forward Current	18	A
P_D	Maximum Power Dissipation (T_C=25℃) (Note 2)	89	W
	Maximum Power Dissipation (T_C=100℃) (Note 2)	44	W
T_J	Operating Junction Temperature Range	-40 to 175	℃
T_{STG}	Storage Temperature Range	-55 to 150	℃

Thermal Data

Symbol	Parameter	Conditoins	Max.	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case for IGBT	TO220F-3L	3.6	℃/W
		TO263-2L	1.6	℃/W
		TO252-2L	1.6	℃/W
$R_{\theta JC}$	Thermal Resistance, Junction to Case for Diode	TO220F-3L	3.7	℃/W
		TO263-2L	2.6	℃/W
		TO252-2L	2.2	℃/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	TO220F-3L	66	℃/W
		TO263-2L	60	℃/W
		TO252-2L	78	℃/W

Electrical Characteristics (T_C=25℃ unless otherwise noted.)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
BV_{CES}	Collector-Emitter Breakdown Voltage	V_{GE}=0V, I_C=200uA	650	---	---	V
I_{CES}	Collector-Emitter Leakage Current	V_{CE}=650V, V_{GE}=0V	---	---	40	uA
I_{GES}	Gate Leakage Current, Forward	V_{GE}=20V, V_{CE}=0V	---	---	100	nA
	Gate Leakage Current, Reverse	V_{GE}=-20V, V_{CE}=0V	---	---	100	nA
$V_{GE(th)}$	Gate Threshold Voltage	V_{GE}=V_{CE}, I_C=200uA	4.8	5.8	6.8	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	V_{GE}=15V, I_C=6A, T_j=25℃	---	1.75	2.10	V
		V_{GE}=15V, I_C=6A, T_j=150℃	---	2.05	---	V
Q_G	Total Gate Charge	V_{CC}=400V V_{GE}=15V I_C=6A	---	11.5	---	nC
Q_{GE}	Gate-Emitter Charge		---	3.5	---	nC
Q_{GC}	Gate-Collector Charge		---	3.5	---	nC
$t_{d(on)}$	Turn-on Delay Time	V_{CC}=400V V_{GE}=±15V I_C=6A R_G=10Ω Inductive Load T_C=25℃	---	12.5	---	ns
t_r	Turn-on Rise Time		---	6.4	---	ns
$t_{d(off)}$	Turn-off Delay Time		---	14.5	---	ns
t_f	Turn-off Fall Time		---	158	---	ns
E_{on}	Turn-on Switching Loss		---	95	---	uJ
E_{off}	Turn-off Switching Loss		---	98	---	uJ
E_{ts}	Total Switching Loss		---	193	---	uJ

C_{ies}	Input Capacitance	V_{CE}=25V V_{GE}=0V f =1MHz	---	313	---	pF
C_{oes}	Output Capacitance		---	34	---	pF
C_{res}	Reverse Transfer Capacitance		---	5	---	pF
SCSOA	Short Circuit Safe Operation Area	V_{GE}=15V, V_{CC}≤400V, $T_{J,start}$≤25℃	7	---	---	us

Diode Characteristics (T_C=25℃ unless otherwise noted)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_F	Diode Forward Voltage	I_F=6A, T_j=25℃	---	1.65	2.10	V
		I_F=6A, T_j=150℃	---	1.48		V
t_{rr}	Diode Reverse Recovery Time	VR=400V I_F=6A dI_F/dt=20A/us T_C=25℃	---	46.5	---	ns
I_{rr}	Diode peak Reverse Recovery Current		---	0.35	---	A
Q_{rr}	Diode Reverse Recovery Charge		---	8.5	---	nC

Note1：Repetitive rating, pulse width limited by maximum junction temperature

Note2：For TO-263

Typical Characteristics

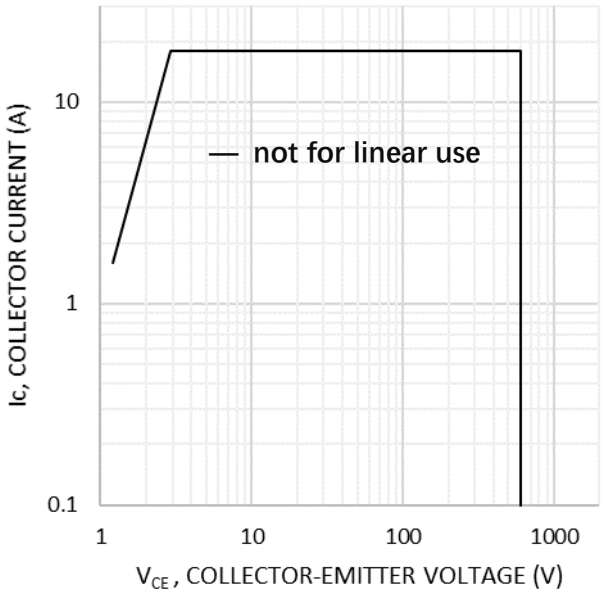


Fig. 1 Forward bias safe operating area (D=0, T_c=25℃, T_{vj}≤175℃; V_{GE}=15V)

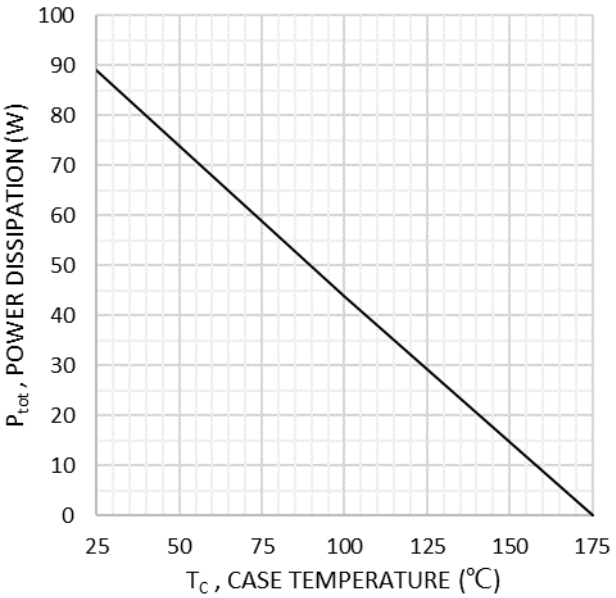


Fig. 2 Power dissipation as a function of case temperature (T_{vj}≤175℃)

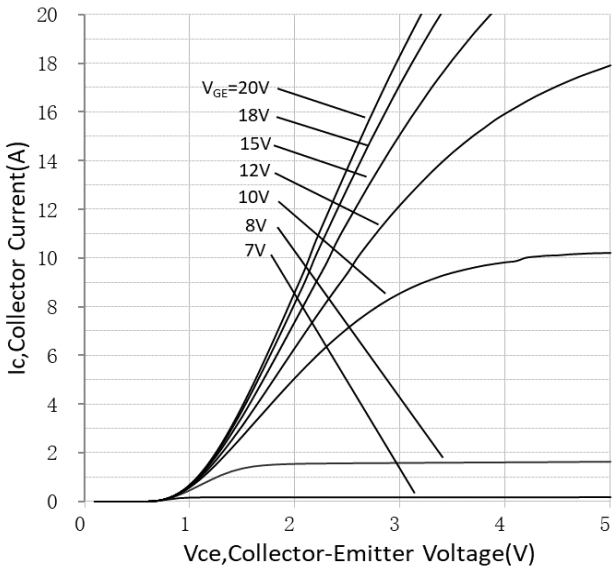


Fig. 3 Typical output characteristic (T_{vj}=25℃)

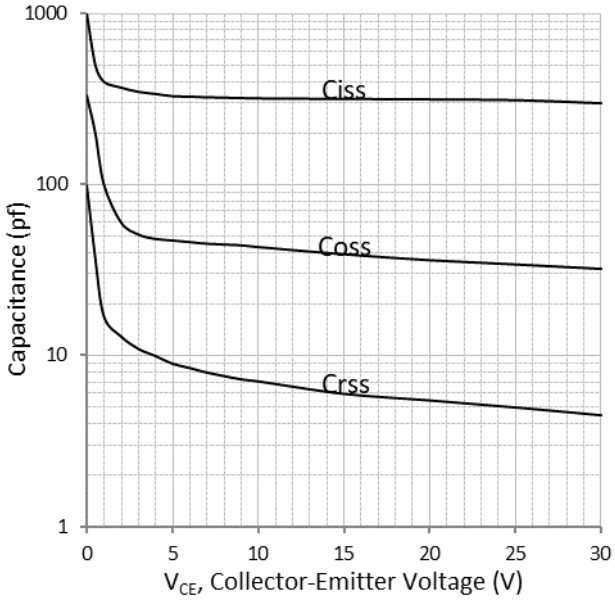


Fig. 4 Typical capacitance as a function of collector-emitter voltage (V_{GE}=0V, f=1MHz)

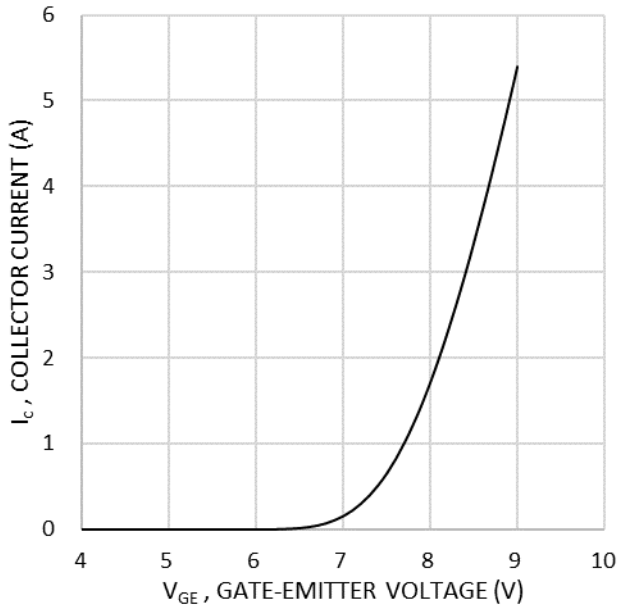


Fig. 5 Typical transfer characteristics (V_{CE}=10V)

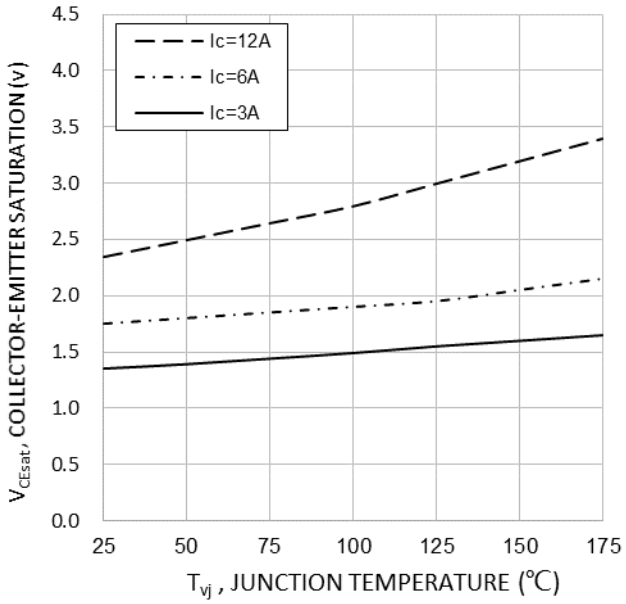


Fig. 6 Typical collector-emitter saturation voltage as a function of junction temperature (V_{GE}=15V)

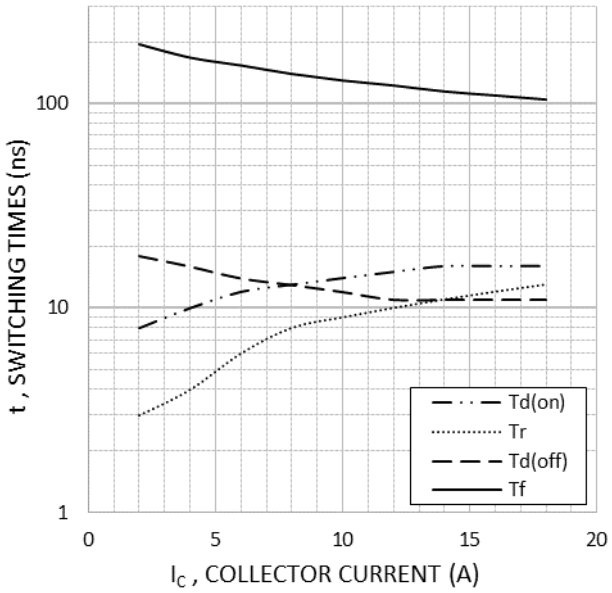


Fig. 7 Typical switching times as a function of collector current (inductive load, T_{yj}=25℃, V_{CE}=400V, V_{GE}=15/0V, r_G=10Ω)

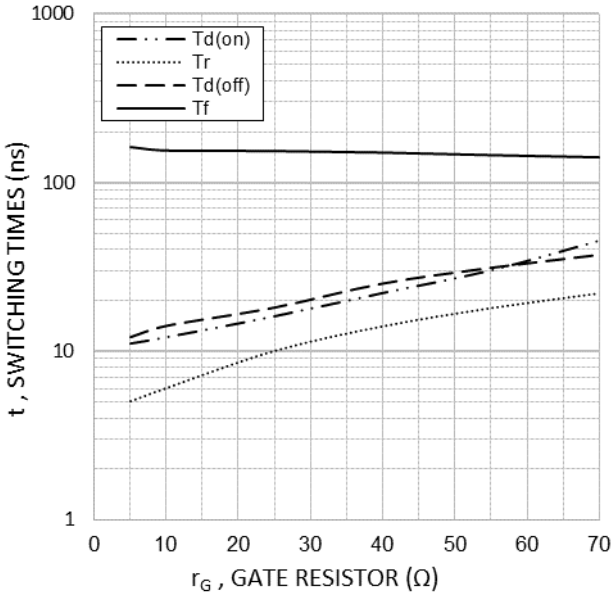


Fig. 8 Typical switching times as a function of gate resistor (inductive load, T_{yj}=25℃, V_{CE}=400V, V_{GE}=15/0V, I_C=6A)

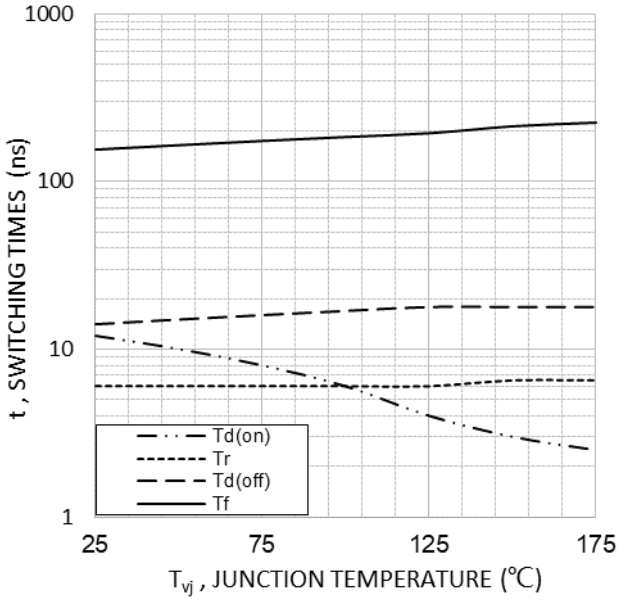


Fig. 9 Typical switching times as a function of junction temperature (inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=6A, r_G=10Ω)

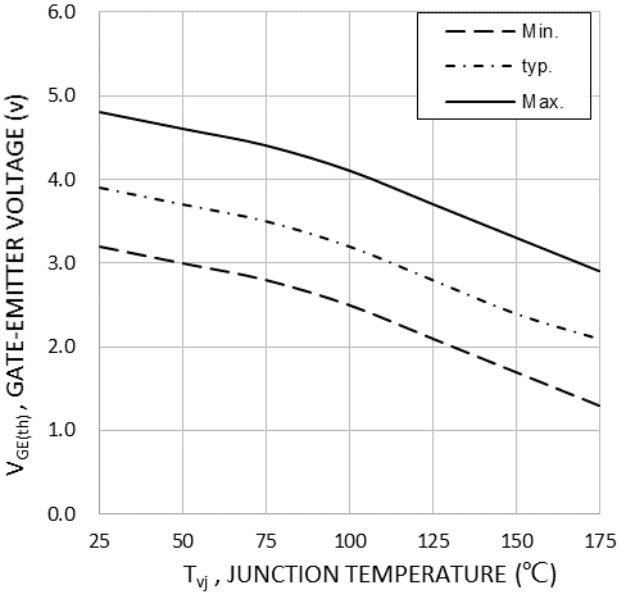


Fig. 10 Gate-emitter threshold voltage as a function of junction temperature (I_C=0.2mA)

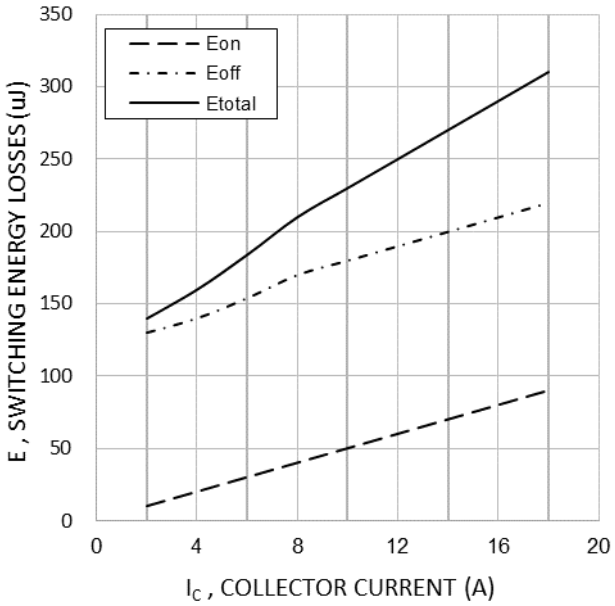


Fig. 11 Typical switching energy losses as a function of collector current (inductive load, T_{yj}=25℃, V_{CE}=400V, V_{GE}=15/0V, r_G=10Ω)

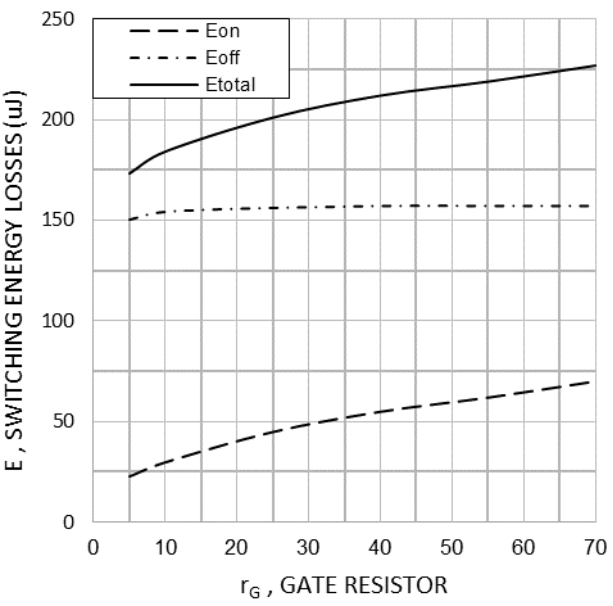


Fig. 12 Typical switching energy losses as a function of gate resistor (inductive load, T_{yj}=25℃, V_{CE}=400V, V_{GE}=15/0V, I_C=6A)

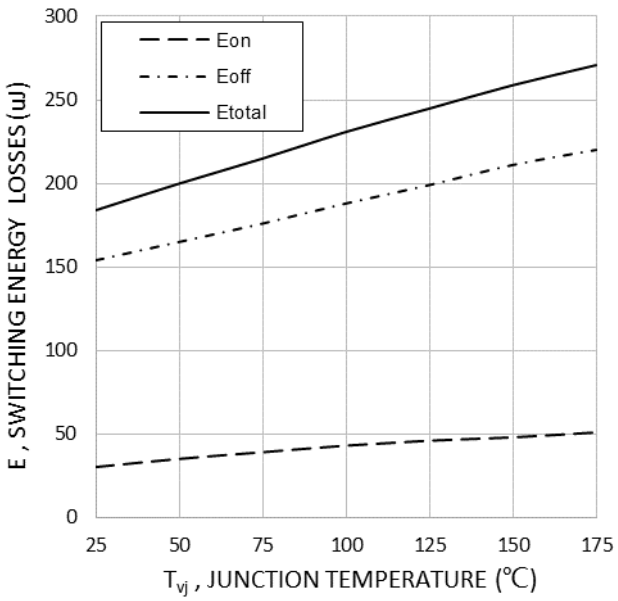


Fig. 13 Typical switching energy losses as a function of junction temperature (inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=50A, r_G=10Ω)

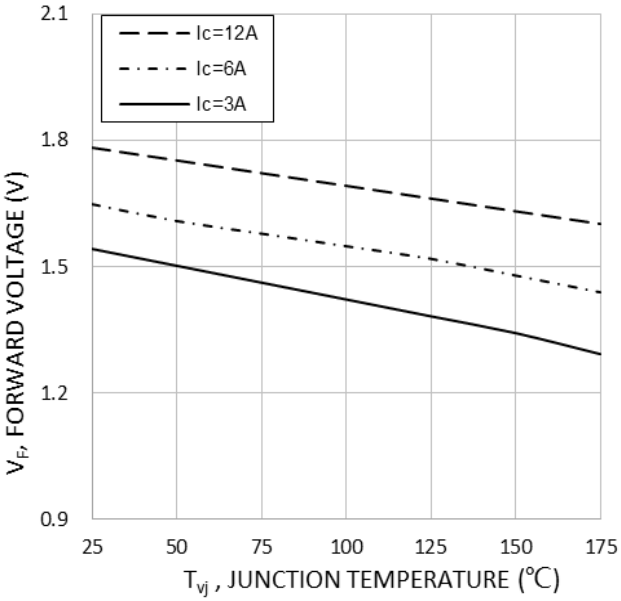


Fig. 14 Typical diode forward voltage as a function of junction temperature

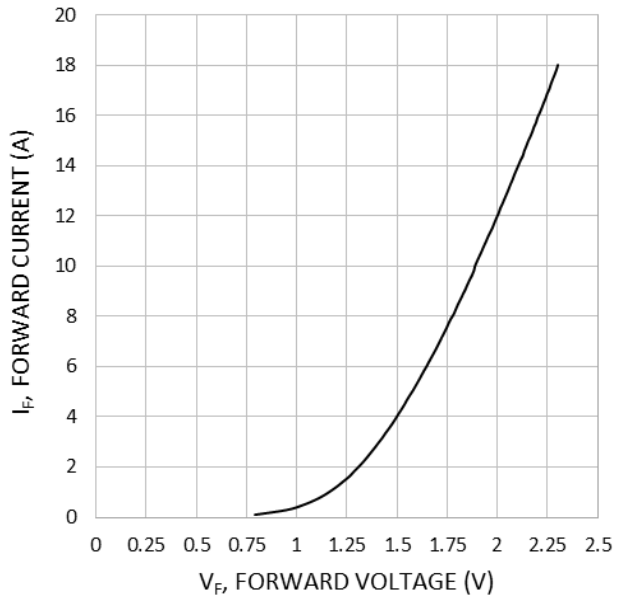


Fig. 15 Typical diode forward current as a function of forward voltage

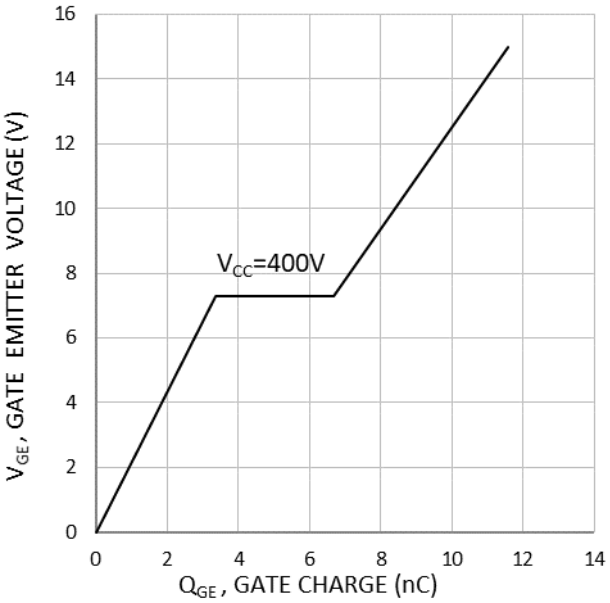


Fig. 16 Typical gate charge (I_C=6A)

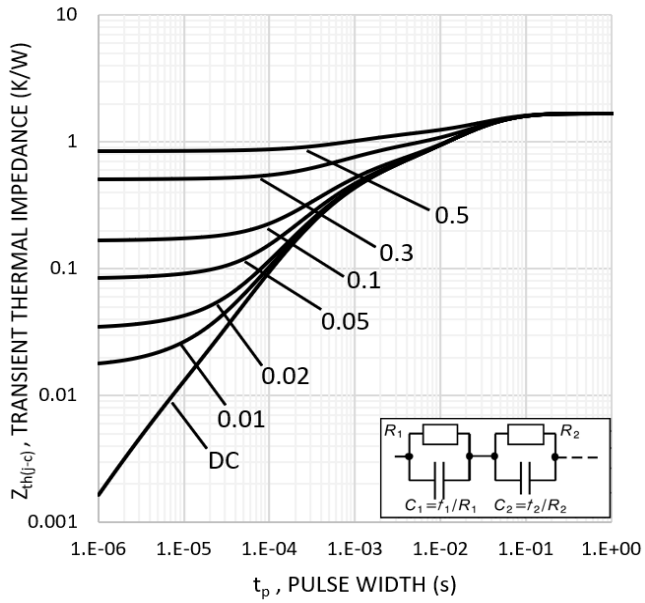


Fig. 17 IGBT transient thermal impedance (D=t_p/T)（TO-263）

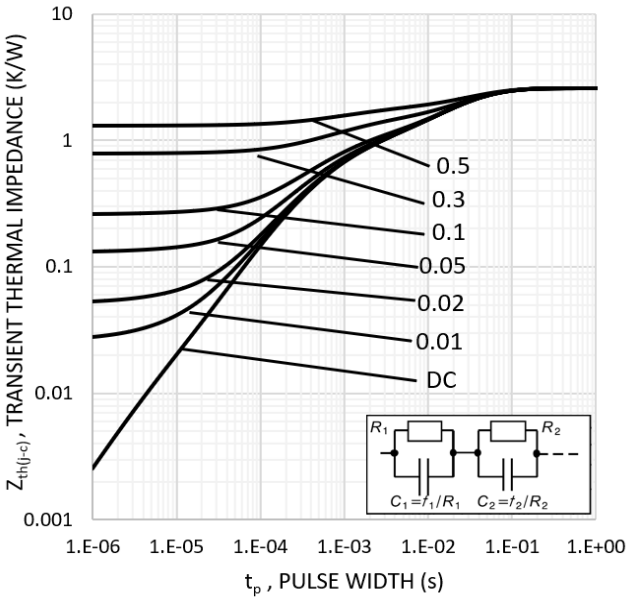
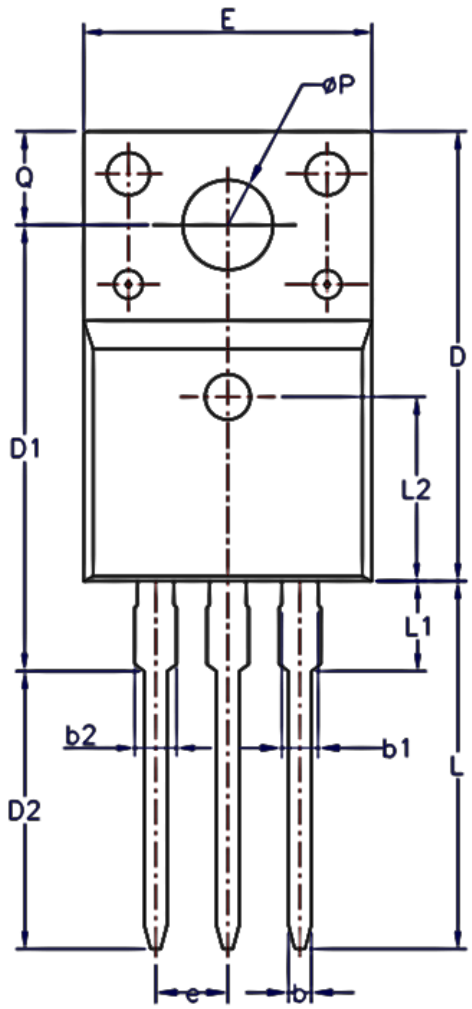
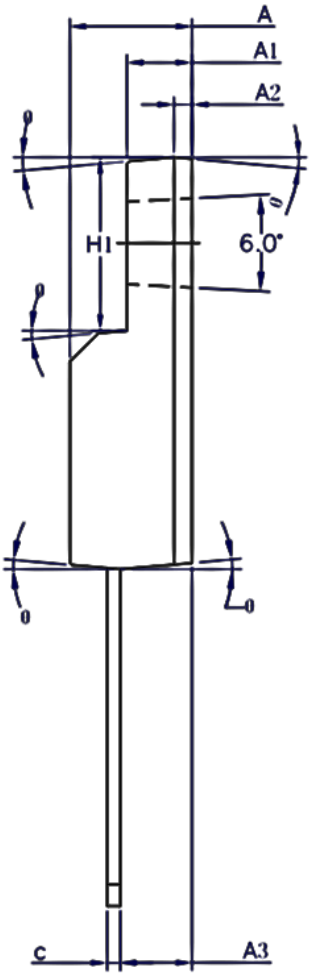


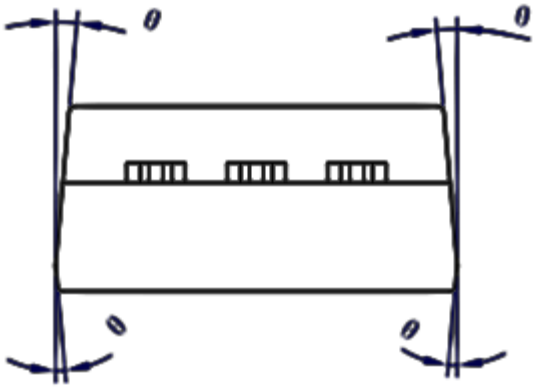
Fig. 18 FRD transient thermal impedance (D=t_p/T) （TO-263）

Package Information

TO-220F-3L

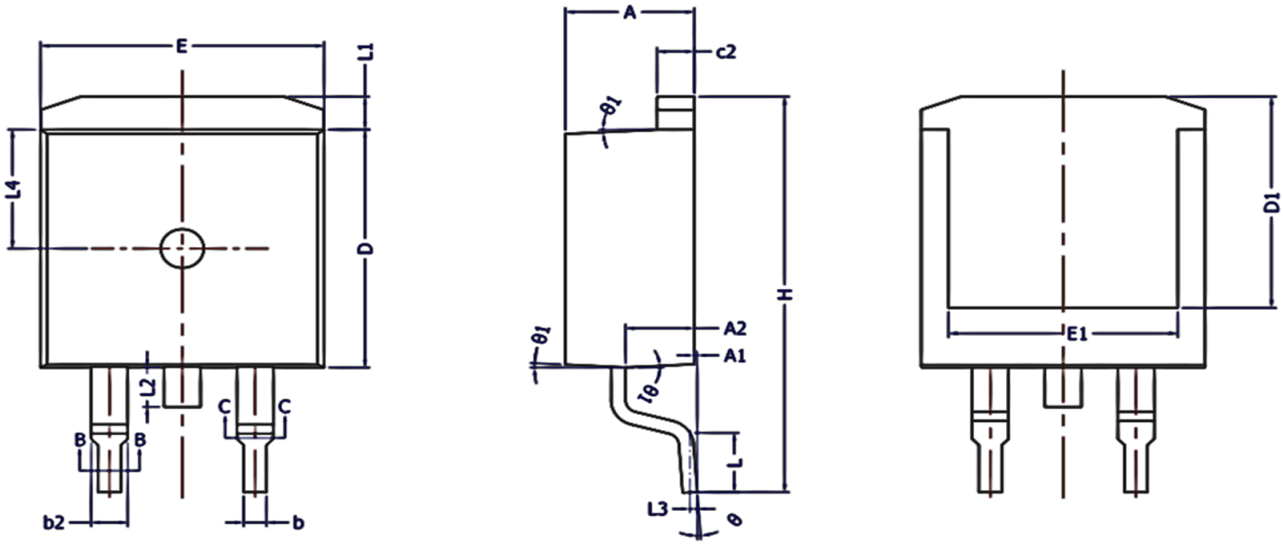


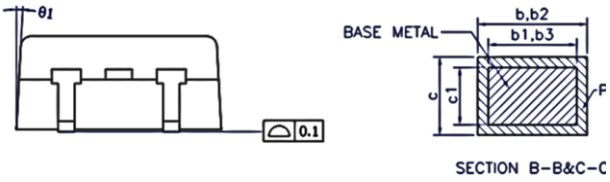




SYMBOL	MIN	NOM	MAX
A	4.50	4.70	4.83
A1	2.34	2.54	2.74
A2		0.70 REF	
A3	2.56	2.76	2.93
b	0.70	–	0.90
b1	1.18	–	1.38
b2	–	–	1.47
c	0.45	0.50	0.60
D	15.67	15.87	16.07
D1	15.55	15.75	15.95
D2	9.60	9.80	10.0
E	9.96	10.16	10.36
e		2.54BSC	
H1	6.48	6.68	6.88
L	12.68	12.98	13.28
L1	–	–	3.50
L2		6.50REF	
øP	3.08	3.18	3.28
Q	3.20	–	3.40
θ1	1°	3°	5°

TO-263-2L



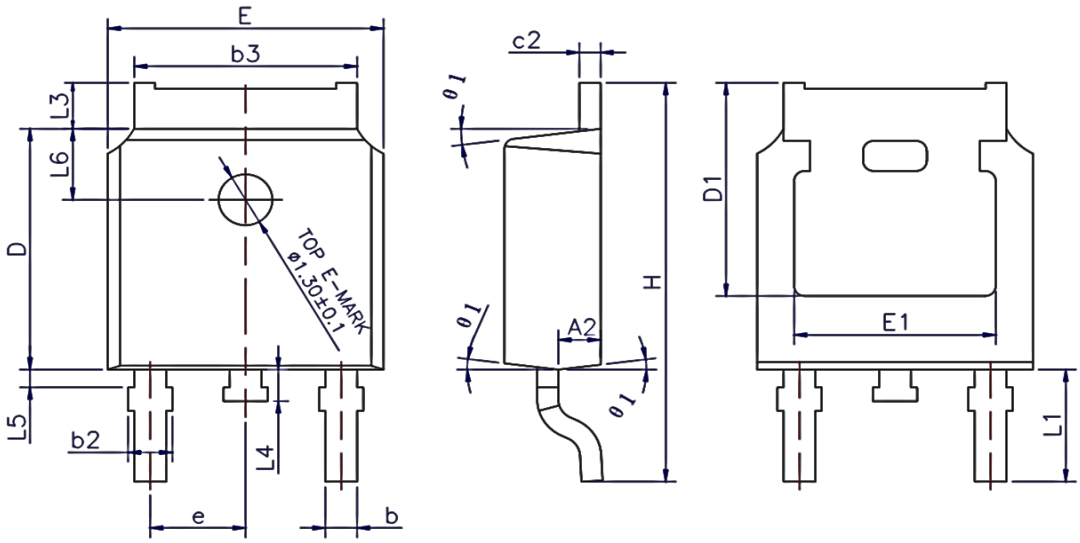


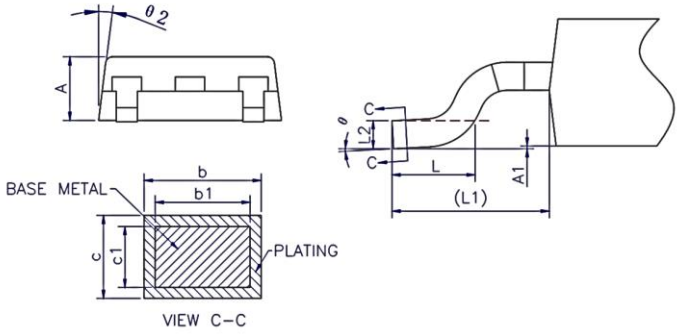
COMMON DIMENSIONS
(UNITS OF MEASURE =MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	4.40	4.50	4.60
A1	0	0.10	0.25
A2	2.20	2.40	2.60
b	0.76	---	0.89
b1	0.75	0.80	0.85
b2	1.23	---	1.37
b3	1.22	1.27	1.32
c	0.47	---	0.60
c1	0.46	0.51	0.56
c2	1.25	1.30	1.35
D	9.10	9.20	9.30
D1	8.00	---	---
E	9.80	9.90	10.00
E1	7.80	---	---
e	2.54 BSC		
H	14.90	15.30	15.70
L	2.00	2.30	2.60
L1	1.17	1.27	1.40
L2	---	---	1.75
L3	0.25BSC		
L4	4.60 REF		
θ	0°	---	8°
θ1	1°	3°	5°

NOTES:
ALL DIMENSIONS REFER TO JEDEC STANDARD TO-263 AB
DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

TO-252-2L





NOTES:
ALL DIMENSIONS REFER TO JEDEC STANDARED TO-252 AA DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS

COMMON DIMENSIONS
(UNITS OF MEASURE =MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	2.20	2.30	2.38
A1	0	---	0.10
A2	0.90	1.01	1.10
b	0.72	---	0.85
b1	0.71	0.76	0.81
b2	0.72	---	0.90
b3	5.13	5.33	5.46
c	0.47	---	0.60
c1	0.46	0.51	0.56
c2	0.47	---	0.60
D	6.00	6.10	6.20
D1	5.25	---	---
E	6.50	6.60	6.70
E1	4.70	---	---
e	2.186	2.286	2.386
H	9.80	10.10	10.40
L	1.40	1.50	1.70
L1	2.90 REF		
L2	0.508 BSC		
L3	0.90	---	1.25
L4	0.60	0.80	1.00
L5	0.15	---	0.75
L6	1.80 REF		
θ	0°	---	8°
θ1	5°	7°	9°
θ2	5°	7°	9°