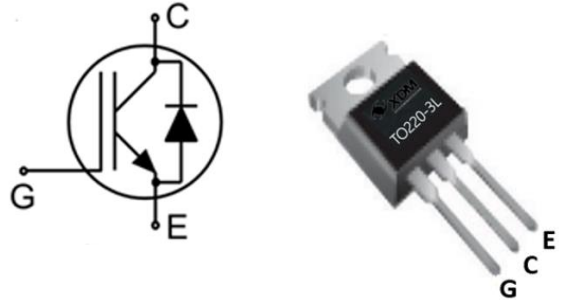


## Trench Field-Stop Technology IGBT

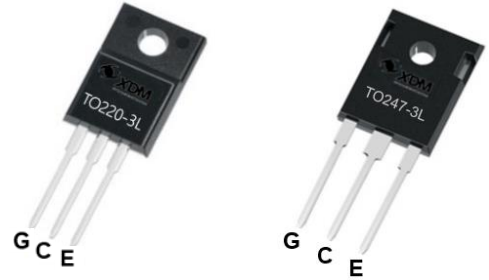
### Features

- 650V, 20A
- $V_{CE(sat)(typ.)} = 2.0V @ V_{GE} = 15V, I_C = 20A$
- Maximum Junction Temperature 175°C
- Pb-free Lead Plating; RoHS Compliant



### Applications

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



### Key Performance and Package Parameters

Order codes	$V_{CE}$	$I_C$	$V_{CEsat}, T_{vj}=25^{\circ}C$	$T_{vjmax}$	Marking	Package
XD020H065CX1L3	650V	20A	2.0V	175°C	D20H65CX1	TO220-3L
XD020H065CX1H3	650V	20A	2.0V	175°C	D20H65CX1	TO220F-3L
XD020H065CX1S3	650V	20A	2.0V	175°C	D20H65CX1	TO247-3L

### Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-Emitter Voltage	650	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
$I_C$	Continuous Collector Current ( $T_C=25^{\circ}C$ )	40	A
	Continuous Collector Current ( $T_C=100^{\circ}C$ )	20	A
$I_{CM}$	Pulsed Collector Current (Note 1)	60	A
$P_D$	Maximum Power Dissipation ( $T_C=25^{\circ}C$ ) (Note 2)	94	W
	Maximum Power Dissipation ( $T_C=100^{\circ}C$ ) (Note 2)	47	W
$T_J$	Operating Junction Temperature Range	-40 to 175	°C
$T_{STG}$	Storage Temperature Range	-55 to 150	°C

### Thermal Data

Symbol	Parameter	Conditions	Max.	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case for IGBT	TO220-3L	1.6	°C/W
		TO220F-3L	1.9	°C/W
		TO247-3L	1.2	°C/W
$R_{\theta JC}$	Thermal Resistance, Junction to Case for Diode	TO220-3L	2.7	°C/W
		TO220F-3L	2.9	°C/W
		TO247-3L	2.4	°C/W

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

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$BV_{CES}$	Collector-Emitter Breakdown Voltage	$V_{GE}=0V, I_C=200\mu A$	650	---	---	V
$I_{CES}$	Collector-Emitter Leakage Current	$V_{CE}=650V, V_{GE}=0V$	---	---	40	$\mu A$
$I_{GES}$	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	$V_{GE}=V_{CE}, I_C=150\mu A$	3.0	3.9	4.8	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$V_{GE}=15V, I_C=20A, T_j=25^\circ\text{C}$	---	2.0	2.40	V
		$V_{GE}=15V, I_C=20A, T_j=125^\circ\text{C}$	---	2.40	---	V
$Q_G$	Total Gate Charge	$V_{CC}=520V$	---	24.38	---	nC
$Q_{GE}$	Gate-Emitter Charge	$V_{GE}=15V$	---	5.82	---	nC
$Q_{GC}$	Gate-Collector Charge	$I_C=20A$	---	6.59	---	nC
$t_{d(on)}$	Turn-on Delay Time	$V_{CC}=400V$ $V_{GE}=\pm 15V$ $I_C=20A$ $R_G=39\Omega$ Inductive Load $T_C=25^\circ\text{C}$	---	5	---	ns
$t_r$	Turn-on Rise Time		---	28	---	ns
$t_{d(off)}$	Turn-off Delay Time		---	70	---	ns
$t_f$	Turn-off Fall Time		---	144	---	ns
$E_{on}$	Turn-on Switching Loss		---	0.2	---	mJ
$E_{off}$	Turn-off Switching Loss		---	0.45	---	mJ
$E_{ts}$	Total Switching Loss		---	0.65	---	mJ
$C_{ies}$	Input Capacitance	$V_{CE}=25V$	---	703	---	pF
$C_{oes}$	Output Capacitance	$V_{GE}=0V$	---	91	---	pF
$C_{res}$	Reverse Transfer Capacitance	$f=1\text{MHz}$	---	6	---	pF
SCSOA	Short Circuit Safe Operation Area	$V_{GE}=15V, V_{CC}\leq 400V,$ $T_{J,start}\leq 25^\circ\text{C}$	10	---	---	$\mu S$

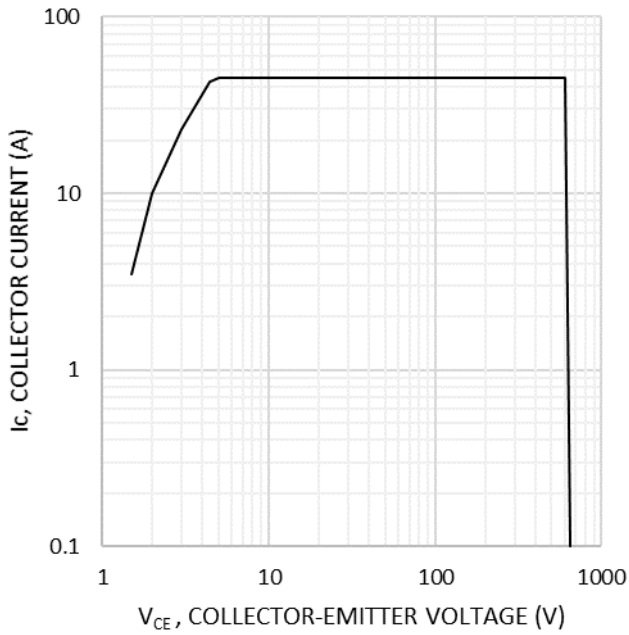
**Diode Characteristics** (  $T_C=25^{\circ}\text{C}$  unless otherwise noted)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_F$	Diode Forward Voltage	$I_F=20\text{A}, T_j=25^{\circ}\text{C}$	---	1.5	2.25	V
		$I_F=20\text{A}, T_j=150^{\circ}\text{C}$	---	1.3	2.00	V
$t_{rr}$	Diode Reverse Recovery Time	$V_R=400\text{V}$ $I_F=20\text{A}$ $dI_F/dt=300\text{A}/\mu\text{s}$ $T_C=25^{\circ}\text{C}$	---	105	---	ns
$I_{rr}$	Diode peak Reverse Recovery Current		---	5	---	A
$Q_{rr}$	Diode Reverse Recovery Charge		---	317	---	nC

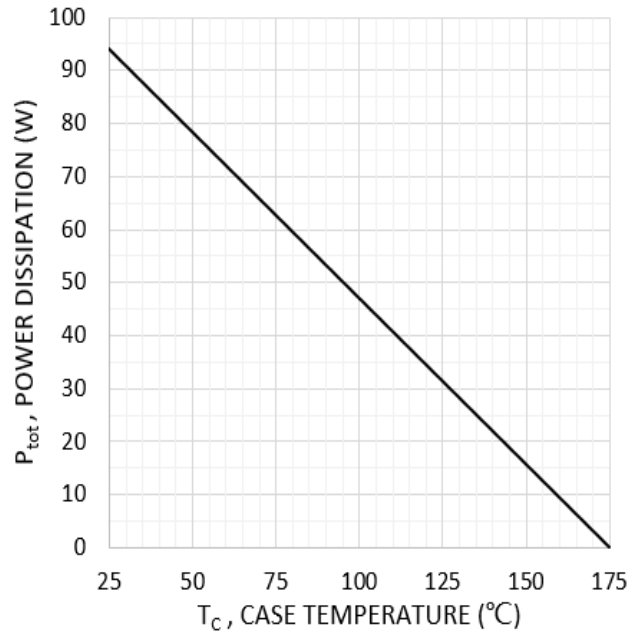
Note1: Repetitive rating, pulse width limited by maximum junction temperature

Note2: For TO-220

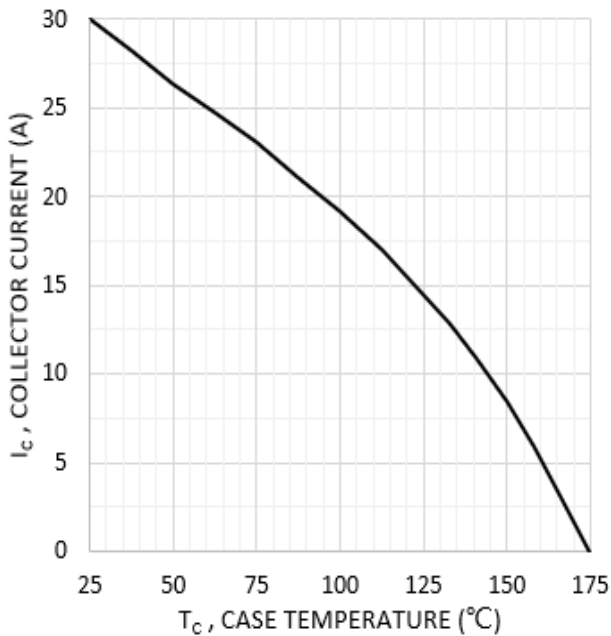
## Typical Characteristics



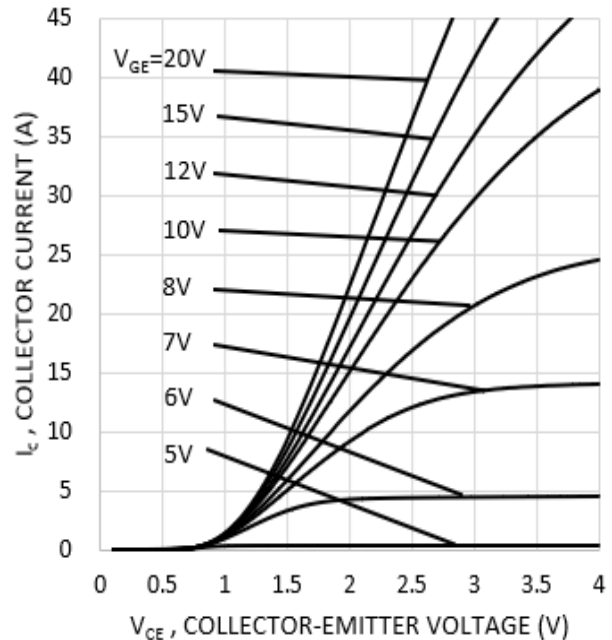
**Fig. 1 Forward bias safe operating area (D=0,  $T_c=25^\circ\text{C}$ ,  $T_{vj}\leq 175^\circ\text{C}$ ;  $V_{GE}=15\text{V}$ . Recommended use at  $V_{GE}\geq 7.5\text{V}$ )**



**Fig. 2 Power dissipation as a function of case temperature ( $T_{vj}\leq 175^\circ\text{C}$ )**



**Fig. 3 Collector current as a function of case temperature ( $V_{GE}\geq 15\text{V}$ ,  $T_{vj}\leq 175^\circ\text{C}$ )**



**Fig. 4 Typical output characteristic ( $T_{vj}=25^\circ\text{C}$ )**

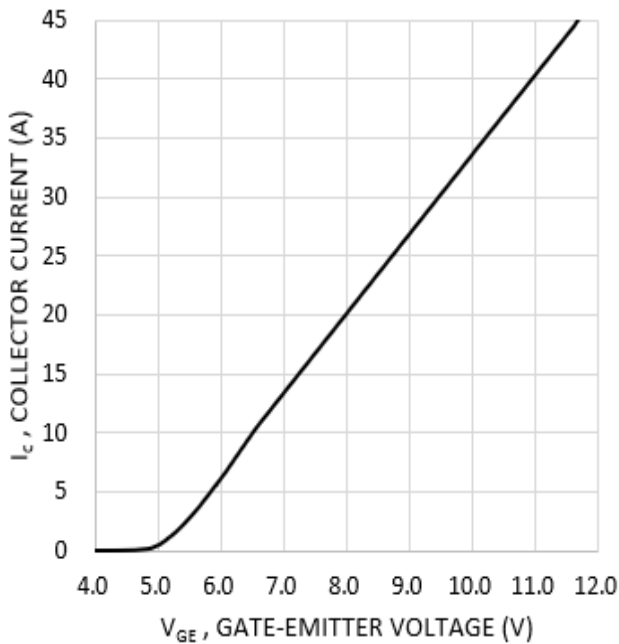


Fig. 5 Typical transfer characteristics ( $V_{CE}=20V$ )

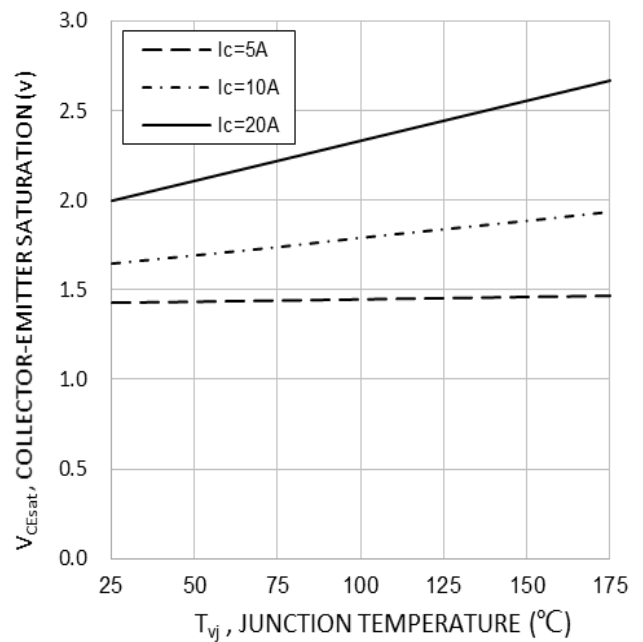


Fig. 6 Typical collector-emitter saturation voltage as a function of junction temperature ( $V_{GE}=15V$ )

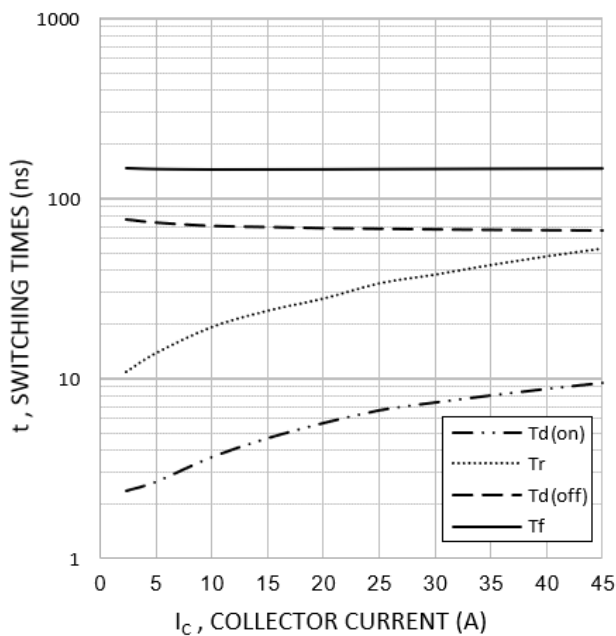


Fig. 7 Typical switching times as a function of collector current (inductive load,  $T_{yj}=25^{\circ}C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $r_G=39\Omega$ )

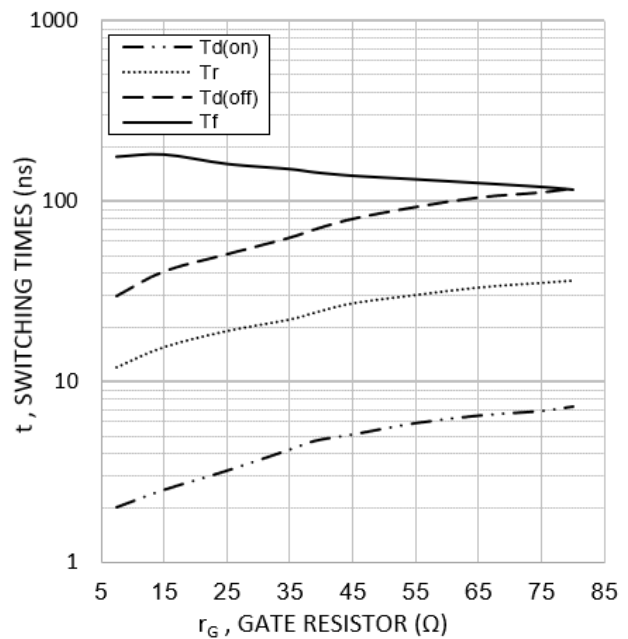
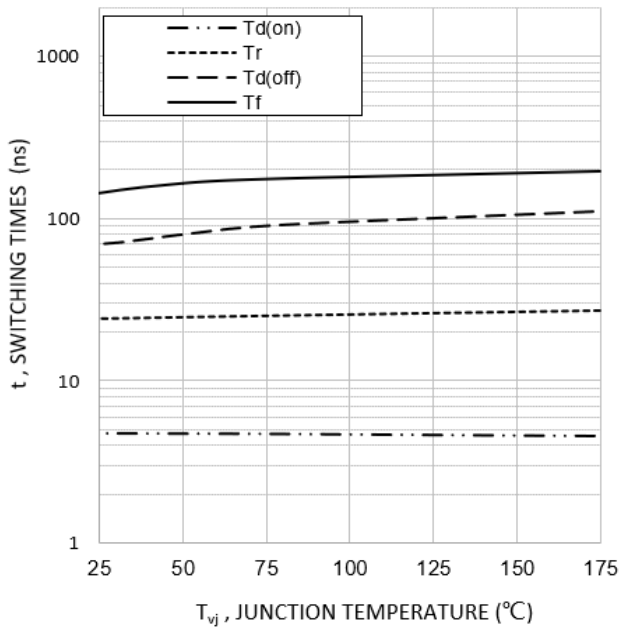
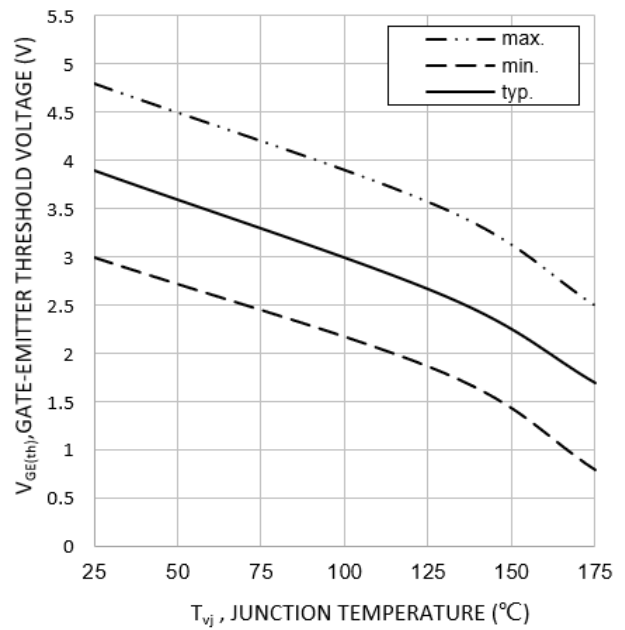


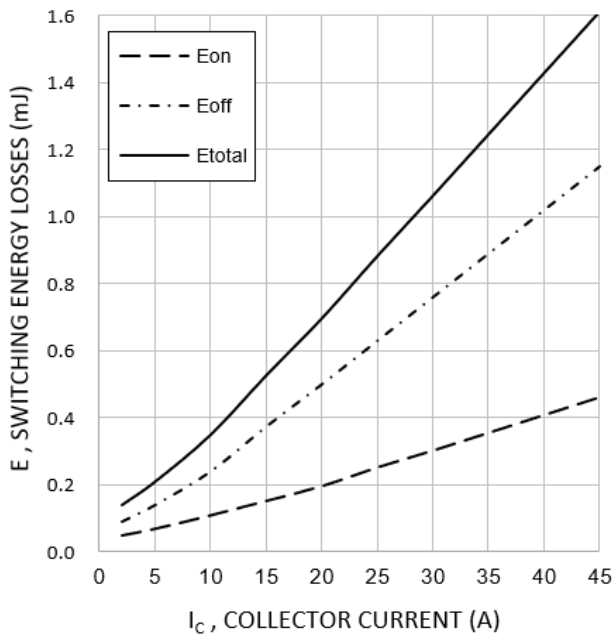
Fig. 8 Typical switching times as a function of gate resistor (inductive load,  $T_{yj}=25^{\circ}C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_c=20A$ )



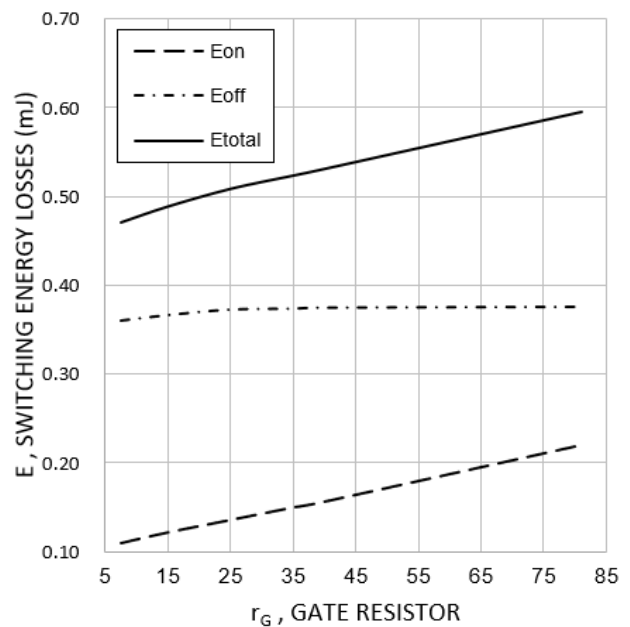
**Fig. 9 Typical switching times as a function of junction temperature (inductive load,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ ,  $r_G=39\Omega$ )**



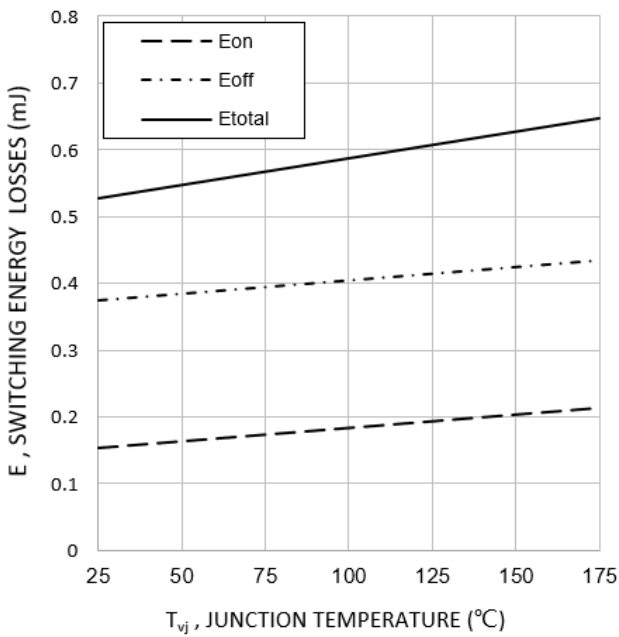
**Fig. 10 Gate-emitter threshold voltage as a function of junction temperature ( $I_C=0.15mA$ )**



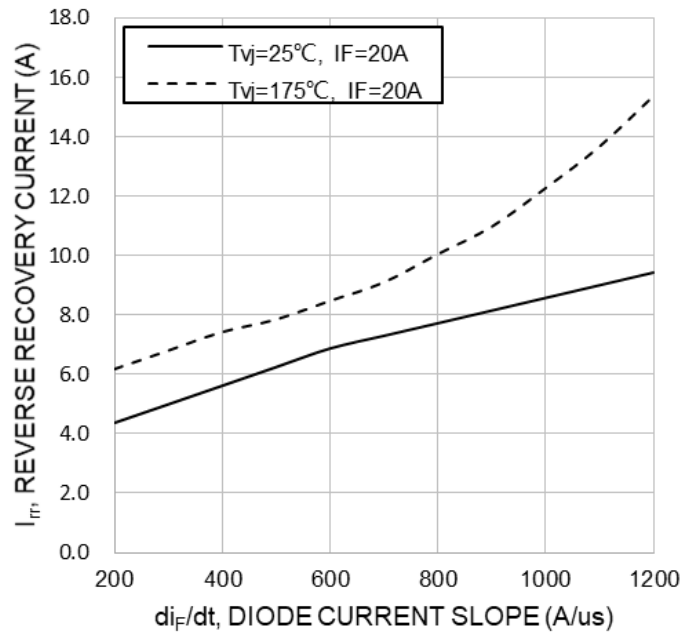
**Fig. 11 Typical switching energy losses as a function of collector current (inductive load,  $T_{j}=25^{\circ}C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $r_G=39\Omega$ )**



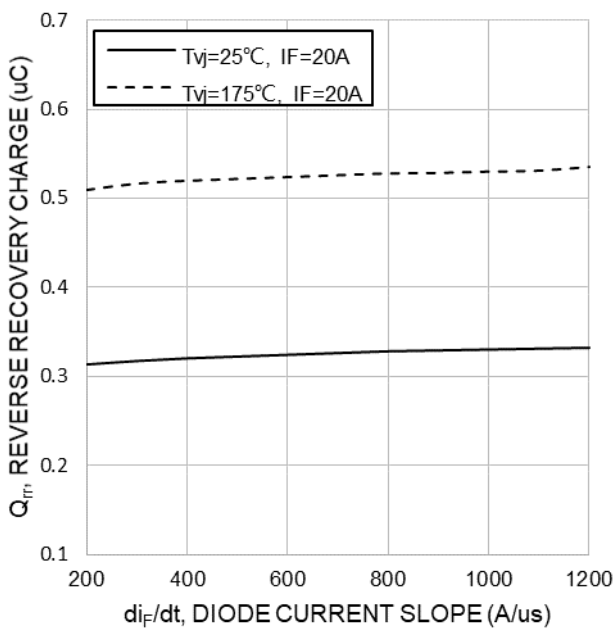
**Fig. 12 Typical switching energy losses as a function of gate resistor (inductive load,  $T_{j}=25^{\circ}C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ )**



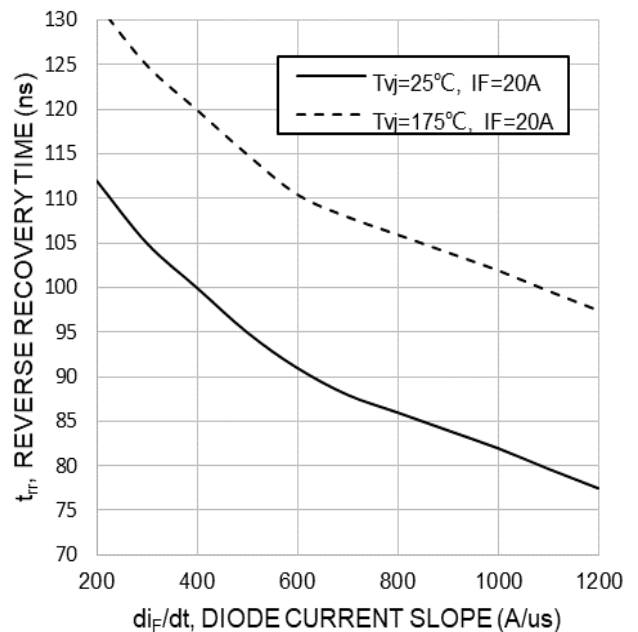
**Fig. 13** Typical switching energy losses as a function of junction temperature (inductive load,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ ,  $r_G=39\Omega$ )



**Fig. 14** Typical reverse recovery time as a function of diode current slope ( $V_R=400V$ )



**Fig. 15** Typical reverse recovery charge as a function of diode current slope ( $V_R=400V$ )



**Fig. 16** Typical reverse recovery current as a function of diode current slope ( $V_R=400V$ )

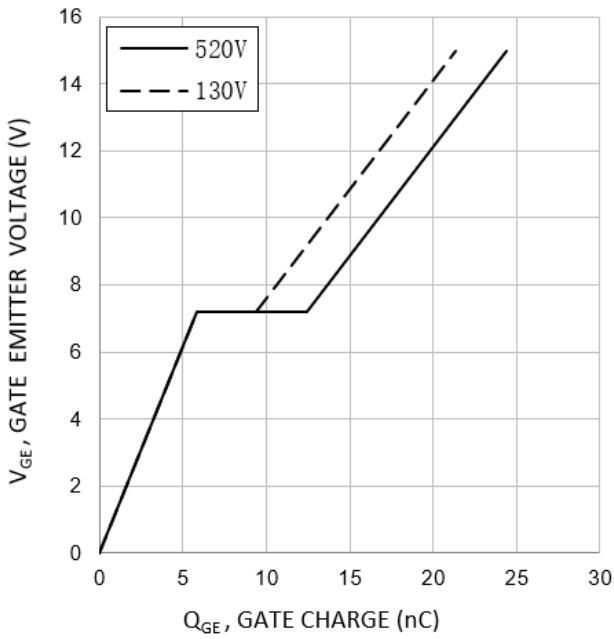


Fig. 17 Typical gate charge ( $I_C=20A$ )

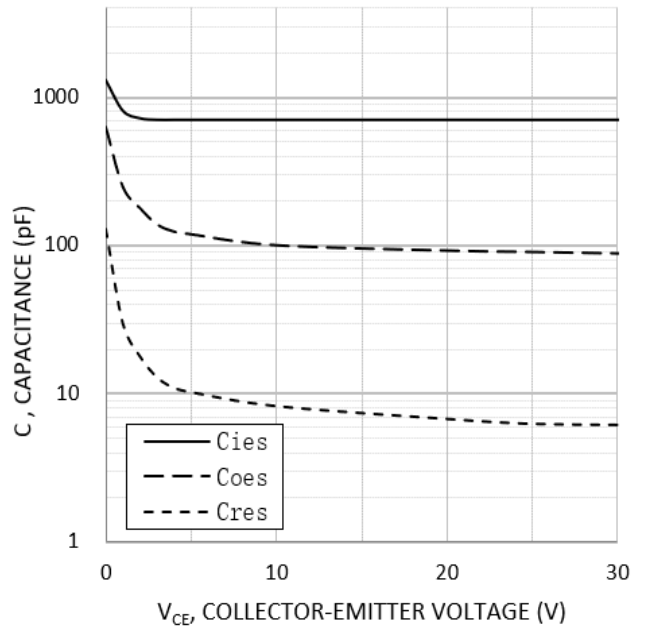


Fig. 18 Typical capacitance as a function of collector-emitter voltage ( $V_{GE}=0V, f=1MHz$ )

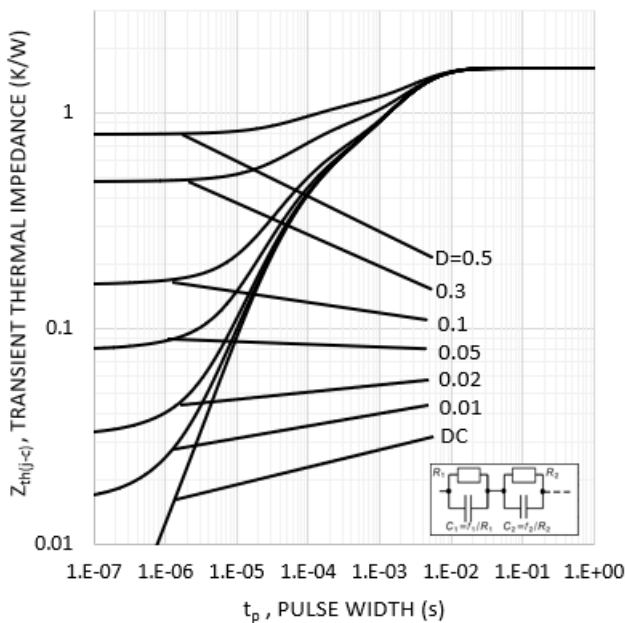


Fig. 19 IGBT transient thermal impedance ( $D=t_p/T$ ) (TO-220)

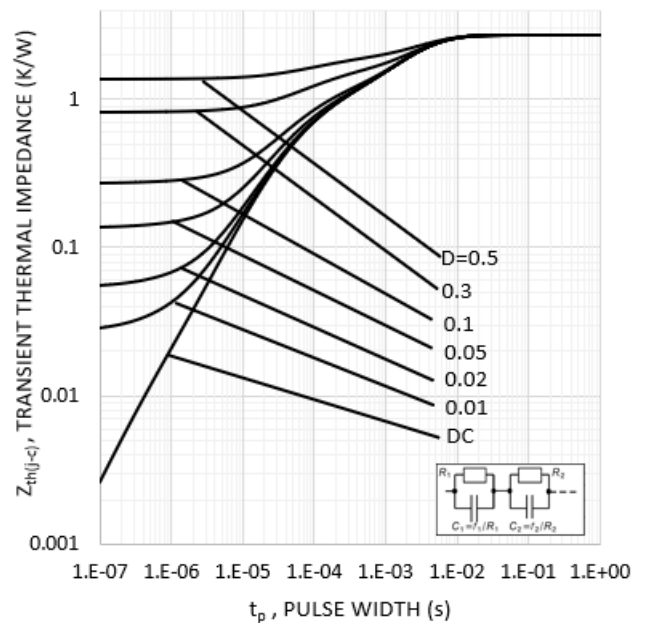
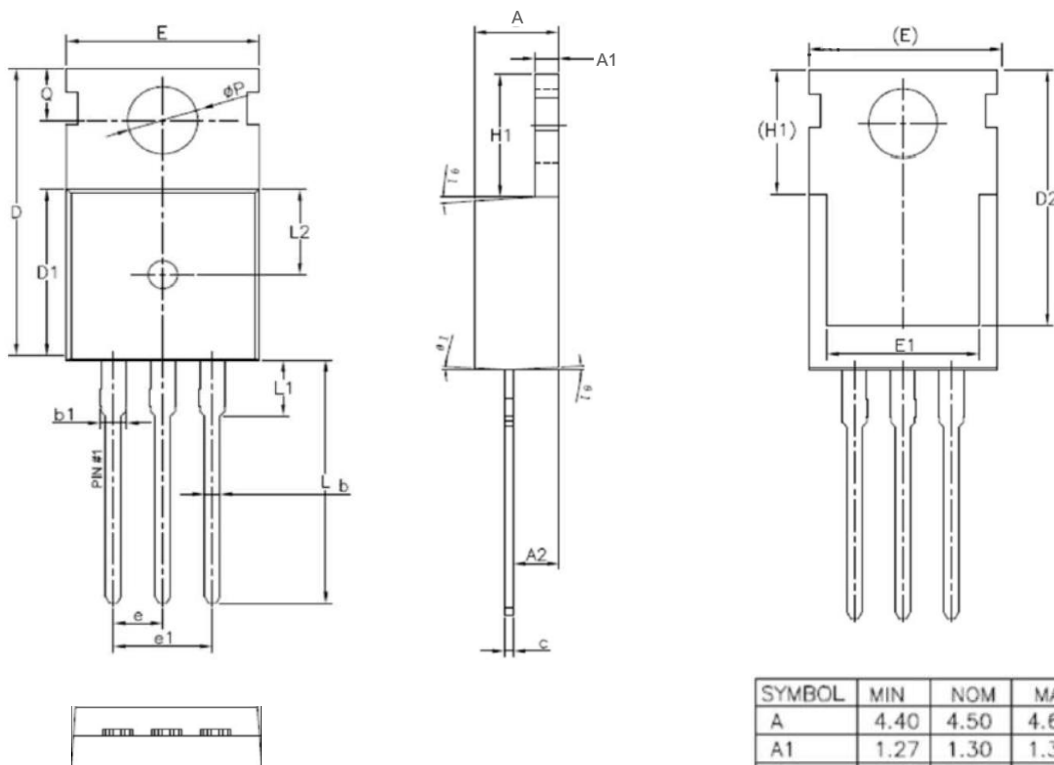


Fig. 20 Diode transient thermal impedance as a function of pulse width ( $D=t_p/T$ ) (TO-220)



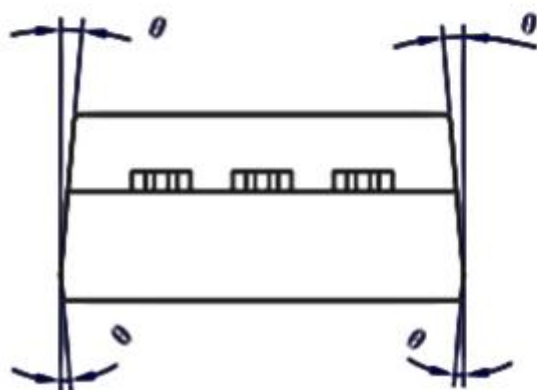
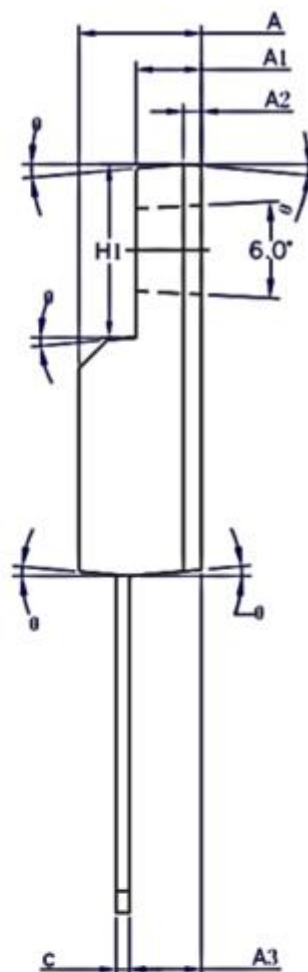
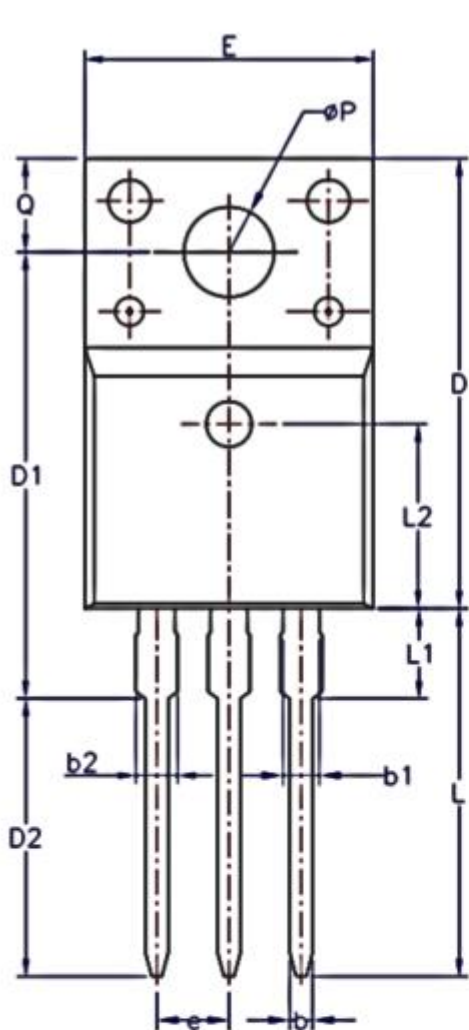
## Package Information

TO-220-3L



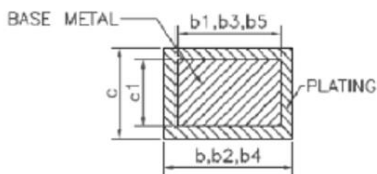
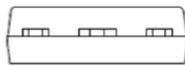
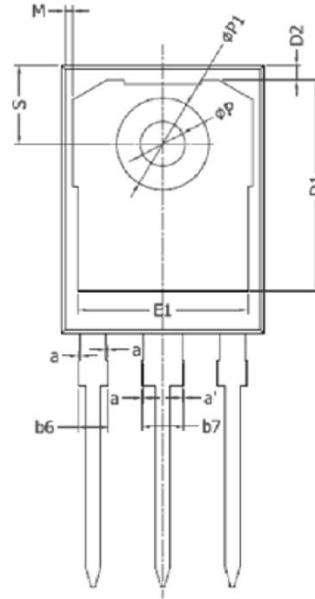
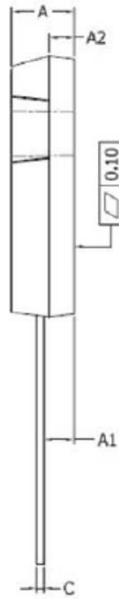
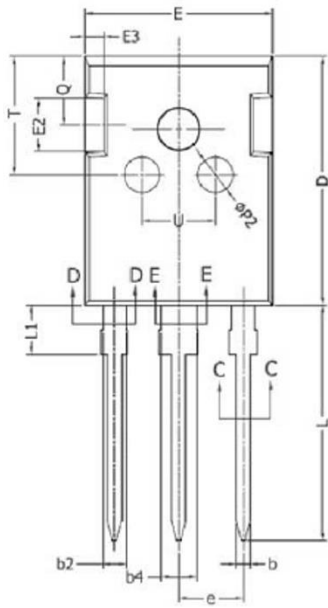
SYMBOL	MIN	NOM	MAX
A	4.40	4.50	4.60
A1	1.27	1.30	1.33
A2	2.30	2.40	2.50
b	0.70	—	0.90
b1	1.27	—	1.40
c	0.45	0.50	0.60
D	15.30	15.70	16.10
D1	9.10	9.20	9.30
D2	13.10	—	13.70
E	9.70	9.90	10.20
E1	7.80	8.00	8.20
e	2.54BSC		
e1	5.08BSC		
H1	6.30	6.50	6.70
L	12.78	13.08	13.38
L1	—	—	3.50
L2	4.60REF		
øP	3.55	3.60	3.65
Q	2.73	—	2.87
#1	1°	3°	5°

TO220F-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		
phi P	3.08	3.18	3.28
Q	3.20	-	3.40
theta	1°	3°	5°

TO-247-3L



SECTION C-C, D-D & E-E

SYMBOL	MIN	NOM	MAX
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
a	0	---	0.15
a'	0	---	0.15
b	1.16	---	1.26
b1	1.15	1.2	1.22
b2	1.96	---	2.06
b3	1.95	2.00	2.02
b4	2.96	---	3.06
b5	2.96	3.00	3.02
b6	---	---	2.25
b7	---	---	3.25
c	0.59	---	0.66
c1	0.58	0.60	0.62
D	20.90	21.00	21.10
D1	16.25	16.55	16.85
D2	1.05	1.17	1.35
E	15.70	15.80	15.90
E1	13.10	13.30	13.50
E2	4.40	4.50	4.60
E3	1.50	1.60	1.70
e	5.436 BSC		
L	19.80	19.92	20.10
L1	---	---	4.30
M	0.35	---	0.95
P	3.40	3.50	3.60
P1	7.00	---	7.40
P2	2.40	2.50	2.60
Q	5.60	---	6.00
S	6.05	6.15	6.25
T	9.80	---	10.20
U	6.00	---	6.40