

## 600V, 15A, Trench FS II IGBT

### General Description:

Using PBT (Proprietary trench design and advanced FS (field stop) second generation technology, the 600V Trench FS II IGBT offers superior conduction and switching performances, and easy parallel operation;

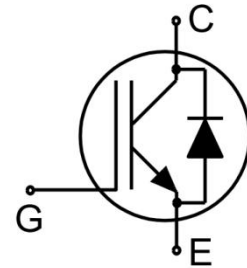
### Features

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
PT 0F1 B1 D	TO-263	PT 0F1 B1 D
PT 0F1 B1 E	TO-220	PT 0F1 B1 E
PT 0F1 B1 F	TO-220F	PT 0F1 B1 F



TO-263



TO-220



TO-220F

### Absolute Maximum Ratings (TC=25°C unless otherwise noted)

Symbol	Parameter	HMG15N60D HMG15N60	HMG15N60F	Units
$V_{CES}$	Collector-Emitter Voltage	600		V
$V_{GES}$	Gate- Emitter Voltage	±30		V
$I_C$	Collector Current	30	30*	A
	Collector Current @ $T_C = 100^\circ\text{C}$	15	15*	A
$I_{Cplus}$	Pulsed Collector Current, $t_p$ limited by $T_{jmax}$	45	45	A
-	turn off safe operating area, $V_{CE}=600\text{V}$ , $T_j=150^\circ\text{C}$	45	45	A
$I_F$	Diode Continuous Forward Current @ $T_C = 100^\circ\text{C}$	15	15*	A
$I_{FM}$	Diode Maximum Forward Current	45	45	A
$P_D$	Power Dissipation @ $T_C = 25^\circ\text{C}$	105	35	W
	Power Dissipation @ $T_C = 100^\circ\text{C}$	42	12.8	W
$T_J, T_{stg}$	Operating Junction and Storage Temperature Range	-55 to +150		$^\circ\text{C}$
$T_L$	Maximum Temperature for Soldering	260		$^\circ\text{C}$
$t_{sc}$	Short circuit withstand time $V_{GE}=15.0\text{V}$ , $V_{CC} \leq 400\text{V}$ , Allowed number of short circuits<1000Time between short circuits: $\geq 1.0\text{s}, T_j \leq 150^\circ\text{C}$	10		us

**Thermal Characteristic**

Symbol	Parameter	HMG15N60D HMG15N60	HMG15N60F	Units
R <sub>θJC</sub>	Thermal Resistance, Junction to case for IGBT	1.19	3.6	°C/W
R <sub>θJC</sub>	Thermal Resistance, Junction to case for Diode	1.92	3.9	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	62	78	°C/W

**Electrical Characteristics (T<sub>c</sub>=25°C unless otherwise noted)**

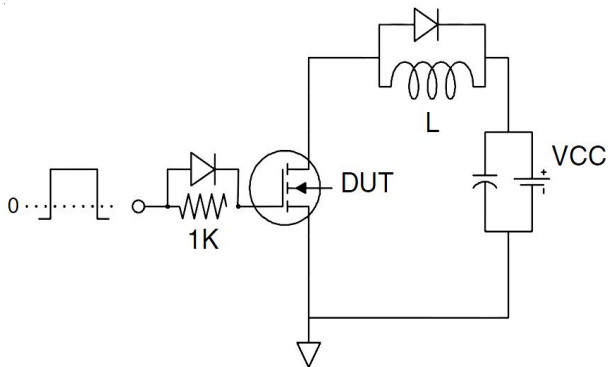
Symbol	Parameter	Test Conditions	Rating			Units
			Min.	Typ.	Max.	
<b>OFF Characteristics</b>						
V <sub>(BR)CES</sub>	Collector-Emitter Breakdown Voltage	V <sub>GE</sub> =0V, I <sub>CE</sub> =1mA	600	--	--	V
I <sub>CES</sub>	Collector-Emitter Leakage Current	V <sub>GE</sub> =0V, V <sub>CE</sub> =600V	--	--	4	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 Source Reverse Leakage	V <sub>GE</sub> =-30V, V <sub>CE</sub> =0V	--	--	100	nA
<b>ON Characteristics</b>						
V <sub>CE(sat)</sub>	Collector-Emitter Saturation Voltage	I <sub>C</sub> =15A, V <sub>GE</sub> =15V	--	1.8	2.0	V
V <sub>GE(th)</sub>	Gate Threshold Voltage	I <sub>C</sub> =1mA, V <sub>CE</sub> =V <sub>GE</sub>	4.0	5.0	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	--	649	--	pF
C <sub>oes</sub>	Output Capacitance		--	61	--	
C <sub>res</sub>	Reverse Transfer Capacitance		--	27	--	
Q <sub>Gate</sub>	Gate charge	V <sub>CC</sub> =480V, I <sub>C</sub> =15A V <sub>GE</sub> =15V	--	75	--	nC
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> ≤10us, T <sub>j</sub> ≤150°C	--	70	--	A
<b>Switching Characteristics</b>						
t <sub>d(ON)</sub>	Turn-on Delay Time	V <sub>CE</sub> =400V, I <sub>C</sub> =15A V <sub>GE</sub> =0/15V, R <sub>G</sub> =15Ω Inductive Load	--	17	--	ns
t <sub>r</sub>	Rise Time		--	18	--	
t <sub>d(OFF)</sub>	Turn-Off Delay Time		--	114	--	
t <sub>f</sub>	Fall Time		--	41	--	
E <sub>on</sub>	Turn-On Switching Loss		--	0.60	--	mJ
E <sub>off</sub>	Turn-Off Switching Loss		--	0.38	--	
E <sub>ts</sub>	Total Switching Loss		--	0.98	--	

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

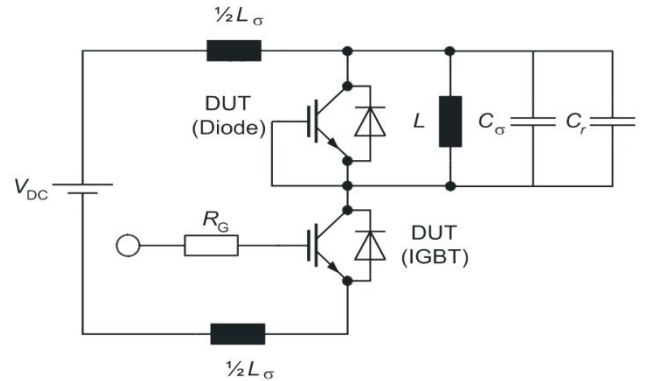
Symbol	Parameter	Test Conditions	Rating			Units
			Min.	Typ.	Max.	
V <sub>FM</sub>	Diode Forward Voltage	I <sub>F</sub> =15A	--	1.45	1.7	V
T <sub>rr</sub>	Reverse Recovery Time	V <sub>CC</sub> =400V, I <sub>F</sub> =15A, di/dt=800A/uS	--	122	--	ns
I <sub>RRM</sub>	Diode Peak Reverse Recovery Current		--	13	--	A
Q <sub>rr</sub>	Reverse Recovery Charge		--	1.04	--	uC
Pulse width t <sub>tp</sub> ≤380μs, δ≤2%						

**Test Circuit**

**1) Gate Charge Test Circuit**

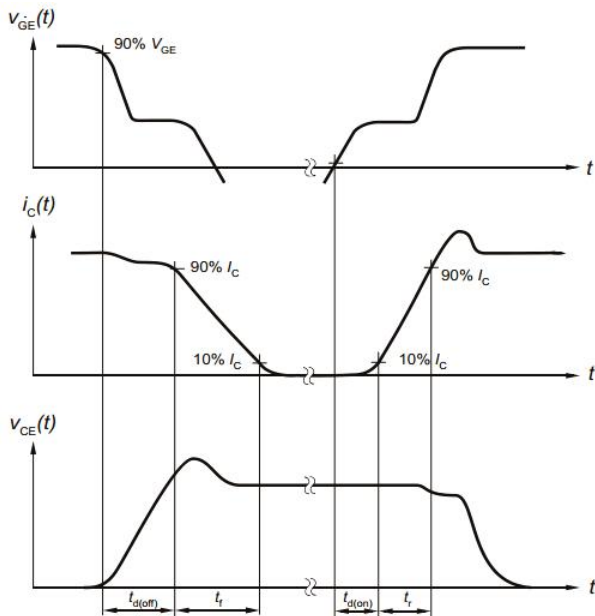


**2) Switch Time Test Circuit**

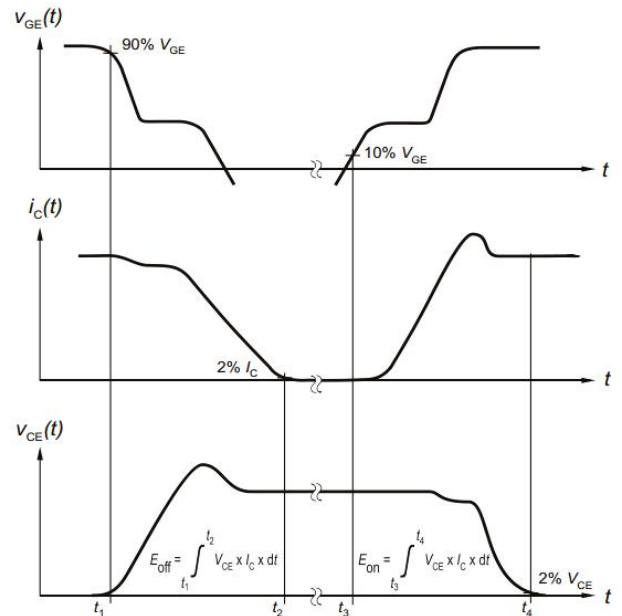


**Switching characteristics**

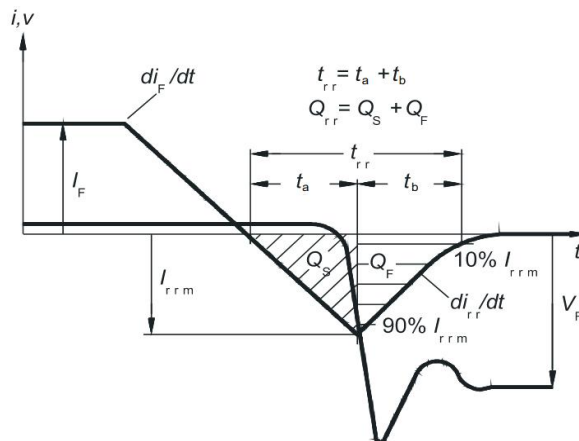
**1) definition of switching times**



**2) definition of switching losses**



**3) Definition of diode switching characteristics**



Typical Electrical and Thermal Characteristics

Figure 1 Output Characteristics

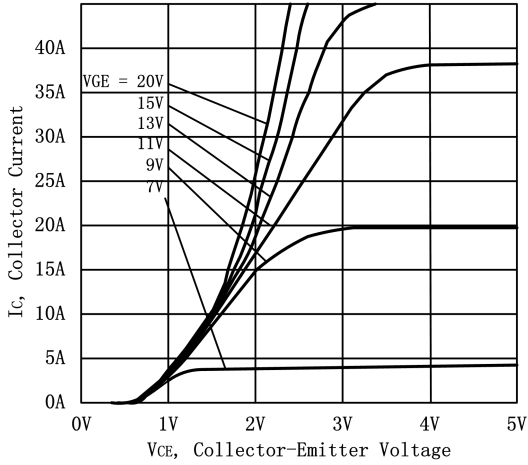


Figure 2. Transfer Characteristics

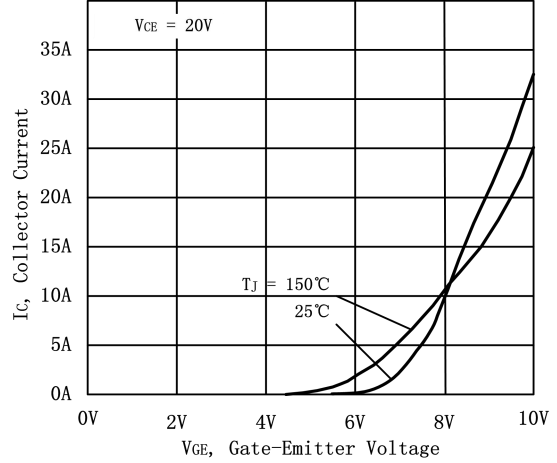


Figure 3  $V_{CEsat}$  vs. Case Temperature

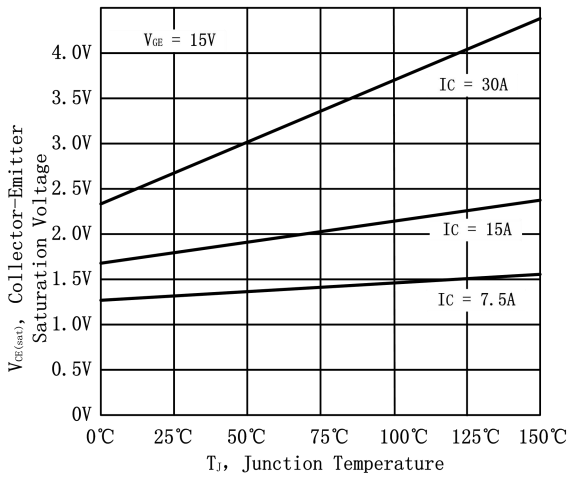


Figure 4 Saturation Voltage vs. VGE

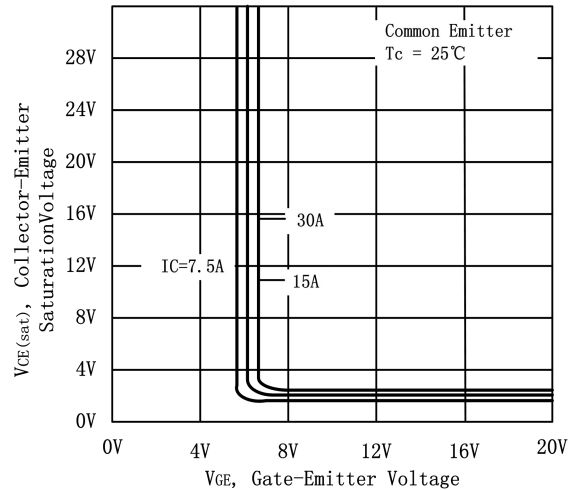


Figure 5 Capacitance Characteristics

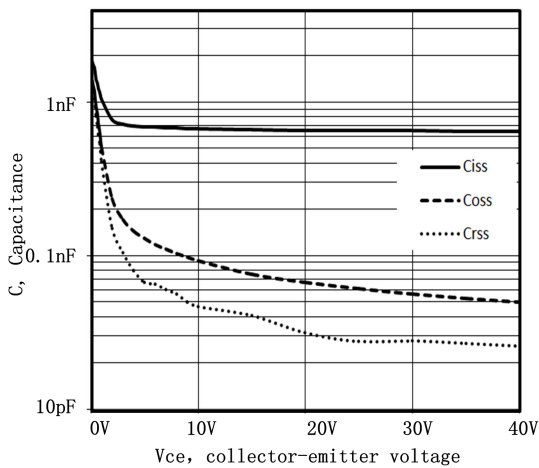
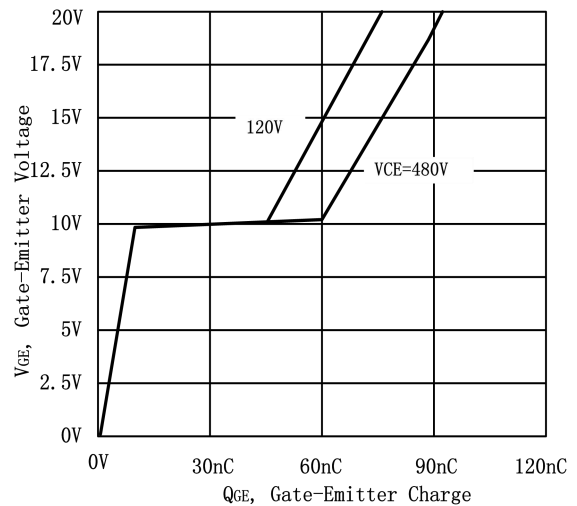


Figure 6 Gate charge waveform



Typical Electrical and Thermal Characteristics (continued)

Figure 7. Forward Characteristics

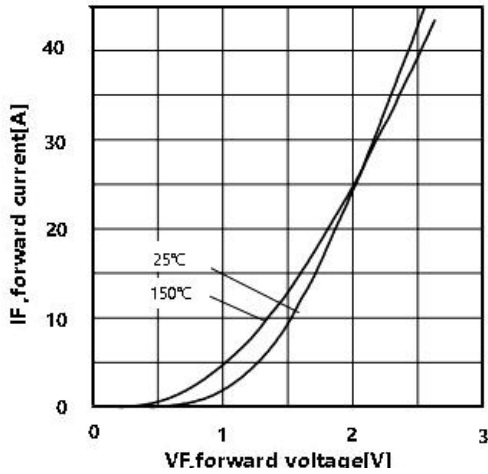


Figure 8  $V_F$  vs. temperature

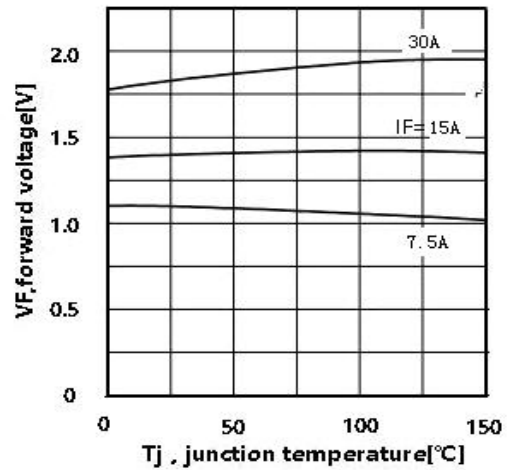


Figure 9. Transient Thermal Impedance of IGBT for TO-220F

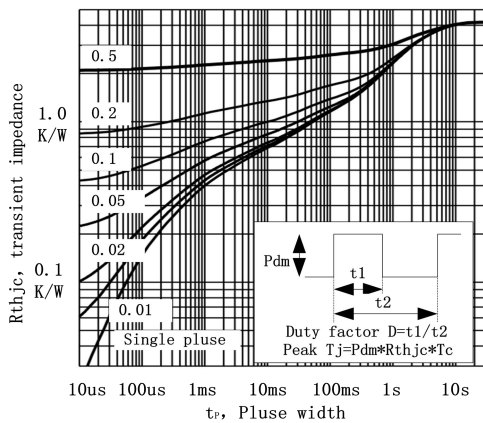
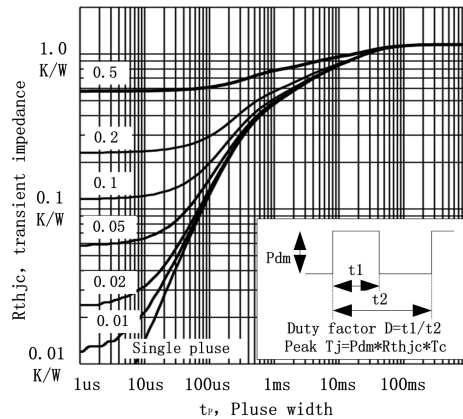
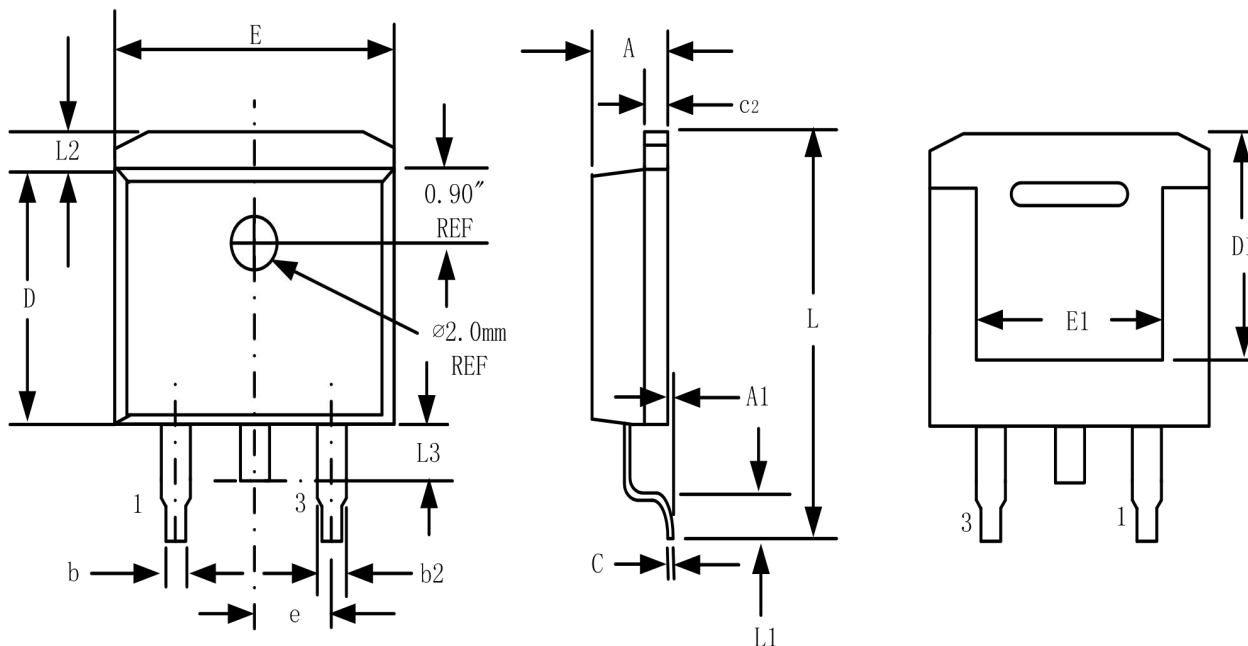


Figure 10. Transient Thermal Impedance of IGBT for TO-220, TO-263

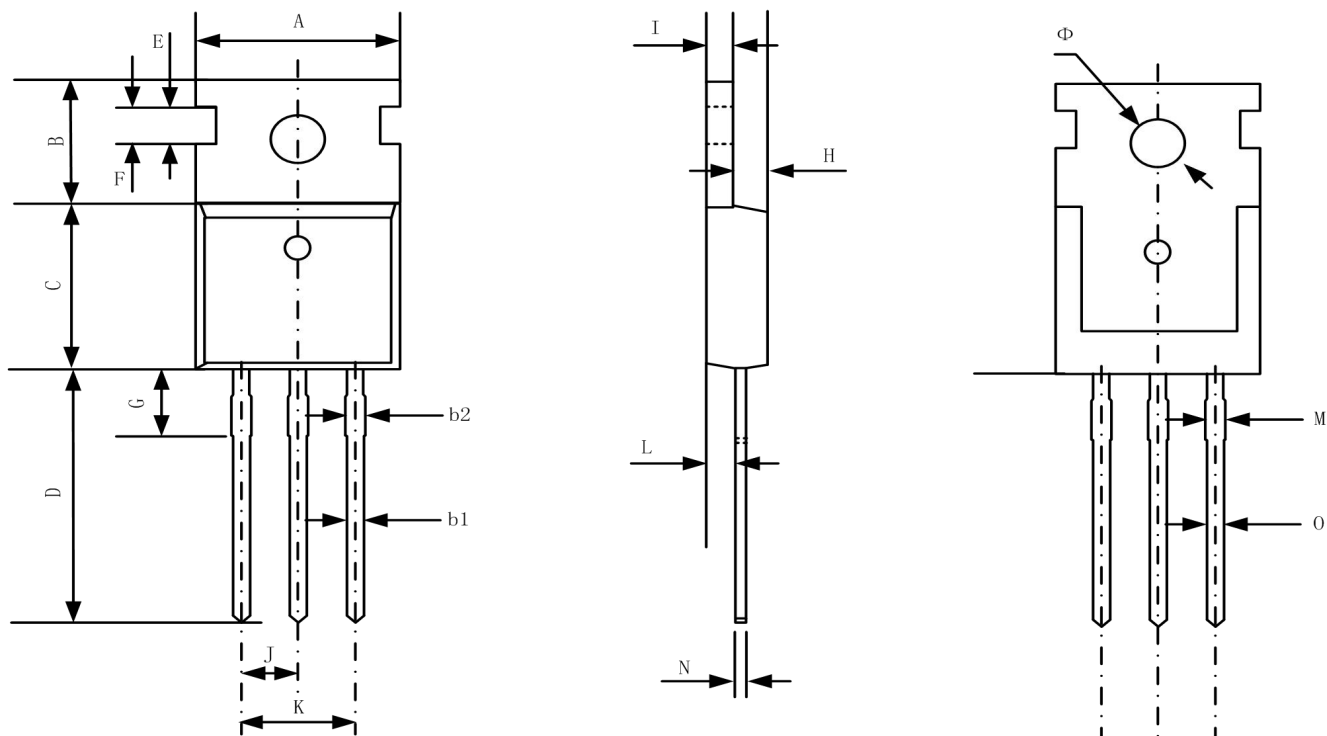


**TO-263-3L Package Information**



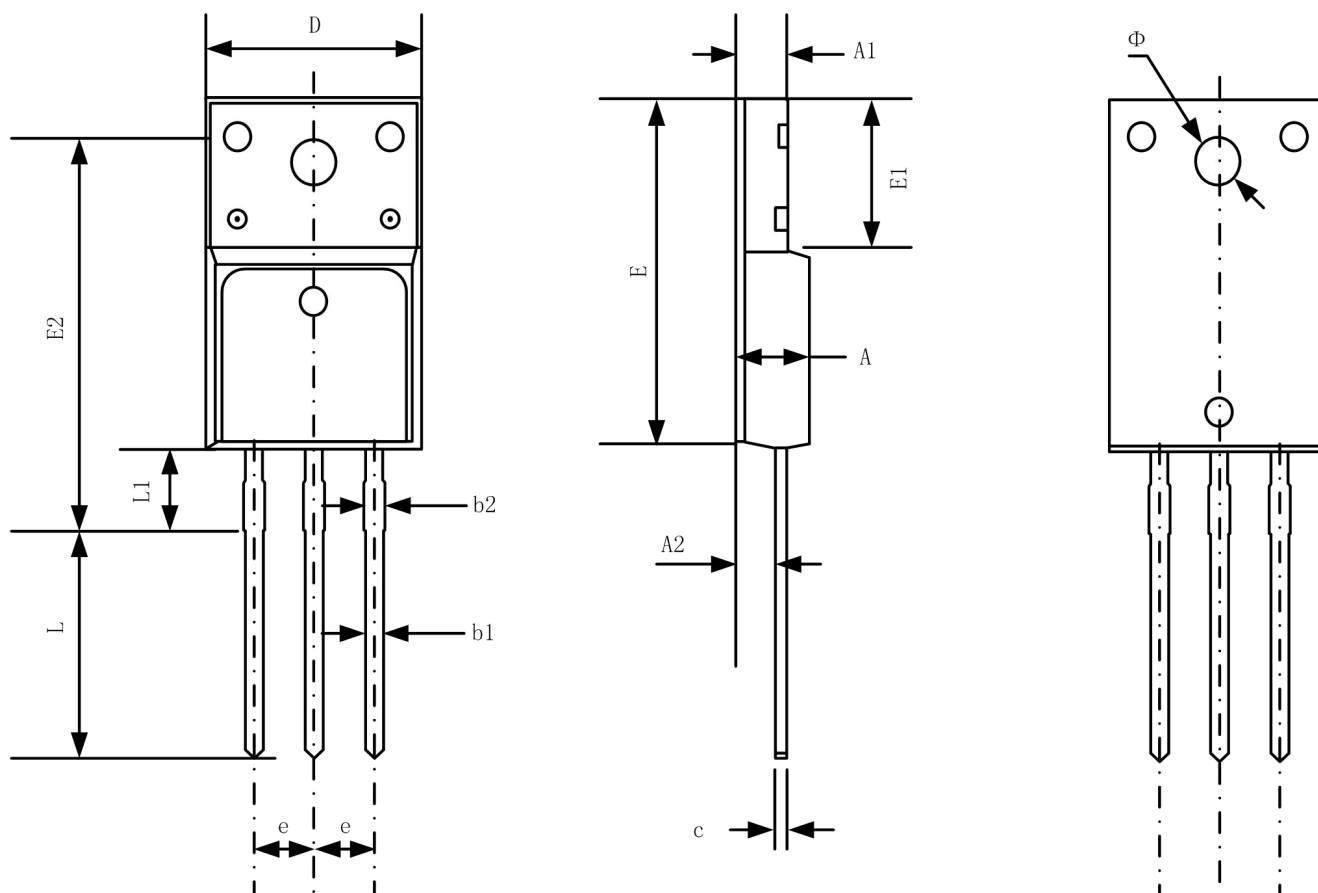
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.32	4.57	0.170	0.180
A1	-	0.25		0.010
b	0.71	0.94	0.028	0.037
b2	1.15	1.40	0.045	0.055
c	0.46	0.61	0.018	0.024
c2	1.22	1.40	0.048	0.055
D	8.89	9.40	0.350	0.370
D1	8.01	8.23	0.315	0.324
E	10.04	10.28	0.395	0.405
E1	7.88	8.08	0.310	0.318
e	2.54 BSC		0.100 BSC	
L	14.73	15.75	0.580	0.620
L1	2.29	2.79	0.090	0.110
L2	1.15	1.39	0.045	0.055
L3	1.27	1.77	0.050	0.070

TO-220-3L-C Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	9.70	10.10	0.38	0.40
B	6.30	6.70	0.25	0.26
C	9.00	9.47	0.35	0.37
D	12.80	13.30	0.50	0.52
E	1.20	1.40	0.05	0.06
F	1.70 REF		0.067 REF	
G	2.65 REF		0.104 REF	
H	3.00	3.40	0.12	0.13
I	1.25	1.40	0.05	0.06
J	2.40	2.70	0.09	0.11
K	5.00	5.15	0.20	0.20
L	2.20	2.60	0.09	0.10
M	1.25	1.45	0.05	0.06
N	0.45	0.60	0.02	0.02
O	0.70	0.90	0.03	0.04
Φ	3.6 REF		0.142 REF	

TO-220F Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.500	4.900	0.177	0.193
A1	2.340	2.740	0.092	0.108
A2	2.560	2.960	0.101	0.117
b1	0.700	0.900	0.028	0.035
b2	1.180	1.580	0.046	0.062
c	0.400	0.600	0.016	0.024
D	9.960	10.360	0.392	0.408
E	15.670	15.970	0.617	0.629
E1	6.500	6.900	0.256	0.272
E2	15.500	16.100	0.610	0.634
e	2.540 TYP		0.100 TYP	
Φ	3.080	3.280	0.121	0.129
L	12.640	13.240	0.498	0.521
L1	3.030	3.430	0.119	0.135