# NCE20TD60D/NCE20TD60/NCE20TD60F/NCE20TD60T

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

### General Description:

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

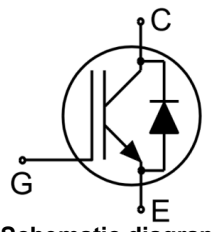
### Features

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

- Uninterruptible Power Supplies ( UPS )
- Welding Converters
- Inverters




Schematic diagram

TO-263

TO-220

TO-247

TO-220F

### Package Marking and Ordering Information

| Device | Device Package | Device Marking |
|---|---|---|
| NCE20TD60D | TO-263 | NCE20TD60D |
| NCE20TD60 | TO-220 | NCE20TD60 |

| Device | Device Package | Device Marking |
|---|---|---|
| NCE20TD60F | TO-220F | NCE20TD60F |
| NCE20TD60T | TO-247 | NCE20TD60T |

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

| Symbol | Parameter | NCE20TD60D NCE20TD60 NCE20TD60T | NCE20TD60F | Units |
|---|---|---|---|---|
| $V_{CES}$ | Collector-Emitter Voltage | 600 | | V |
| $V_{GES}$ | Gate- Emitter Voltage | ±30 | | V |
| $I_C$ | Collector Current | 40 | 40* | A |
| | Collector Current @$T_C$ = 100 °C | 20 | 20* | A |
| $I_{Cplus}$ | Pulsed Collector Current，$t_p$ limited by $T_{jmax}$ | 80 | 45 | A |
| - | turn off safe operating area，VCE=600V，Tj=150℃ | 80 | 45 | A |
| $I_F$ | Diode Continuous Forward Current @$T_C$ = 100 °C | 10 | 20* | A |
| $I_{FM}$ | Diode Maximum Forward Current | 80 | 80 | A |
| $P_D$ | Power Dissipation @ $T_C$ = 25°C | 166 | 86 | W |
| | Power Dissipation @$T_C$ = 100 °C | 67 | 35 | W |
| $T_J$,$T_{stg}$ | Operating Junction and Storage Temperature Range | -55 to +150 | | ℃ |
| $T_L$ | Maximum Temperature for Soldering | 260 | | ℃ |
| $t_{sc}$ | Short circuit withstand time $V_{GE}$=15.0V, $V_{CC}$≤400V, Allowed number of short circuits<1000Time between short circuits:≥1.0s,$T_j$≤150℃ | 10 | | us |

## Thermal Characteristic

| Symbol | Parameter | NCE20TD60D NCE20TD60 NCE20TD60T | NCE20TD60F | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to case for IGBT | 0.75 | 1.45 | ℃/W |
| $R_{\theta JC}$ | Thermal Resistance, Junction to case for Diode | 1.88 | 3.9 | ℃/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient | 62 | 78 | ℃/W |

## Electrical Characteristics ($T_C$=25℃unless otherwise noted)

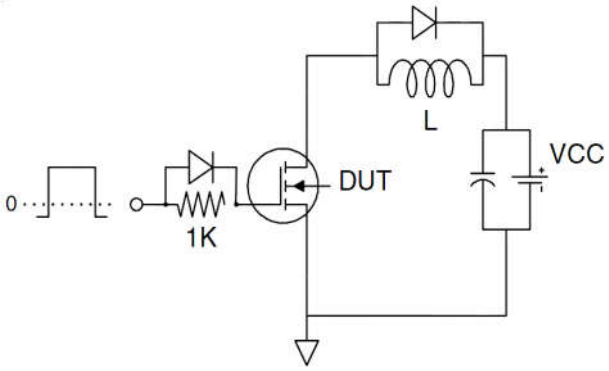
| Symbol | Parameter | Test Conditions | Rating | | | Units |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| **OFF Characteristics** | | | | | | |
| $V_{(BR)CES}$ | Collector-EmitterBreakdown Voltage | $V_{GE}$=0V,$I_{CE}$=1mA | 600 | -- | -- | V |
| $I_{CES}$ | Collector-Emitter Leakage Current | $V_{GE}$ =0V,$V_{CE}$=600V | -- | -- | 4 | uA |
| $I_{GES(F)}$ | Gate to Emitter Forward Leakage | $V_{GE}$=+30V,$V_{CE}$=0V | -- | -- | 100 | nA |
| $I_{GES(R)}$ | Gate to Source Reverse Leakage | $V_{GE}$=-30V,$V_{CE}$ =0V | -- | -- | 100 | nA |
| **ON Characteristics** | | | | | | |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $I_C$=20A,$V_{GE}$=15V | -- | 1.7 | 1.9 | V |
| $V_{GE(th)}$ | Gate Threshold Voltage | $I_C$=1mA,$V_{CE}$=$V_{GE}$ | 4.0 | 5.0 | 6.0 | V |
| **Dynamic Characteristics** | | | | | | |
| $C_{ies}$ | Input Capacitance | $V_{CE}$=25V,$V_{GE}$=0V, f=1MHz | -- | 950 | -- | pF |
| $C_{oes}$ | Output Capacitance | | -- | 75 | -- | |
| $C_{res}$ | Reverse Transfer Capacitance | | -- | 52 | -- | |
| $Q_{Gate}$ | Gate charge | $V_{CC}$=480V, $I_C$=20A $V_{GE}$=15V | -- | 100 | -- | nC |
| $I_{C(SC)}$ | Short circuit collector current Max.1000 short circuits Time between short circuits: ≥1.0s | $V_{GE}$=15V,$V_{CC}$≤400V, $t_{SC}$≤10us,Tj≤150℃ | -- | 100 | -- | A |
| **Switching Characteristics** | | | | | | |
| $t_{d(ON)}$ | Turn-on Delay Time | $V_{CE}$=400V,$I_C$=20A $V_{GE}$=0/15V, $R_g$=15Ω Inductive Load | -- | 30 | -- | ns |
| $t_r$ | Rise Time | | -- | 18 | -- | |
| $t_{d(OFF)}$ | Turn-Off Delay Time | | -- | 176 | -- | |
| $t_f$ | Fall Time | | -- | 40 | -- | |
| $E_{on}$ | Turn-On Switching Loss | | -- | 1.0 | -- | mJ |
| $E_{off}$ | Turn-Off Switching Loss | | -- | 0.4 | -- | |
| $E_{ts}$ | Total Switching Loss | | -- | 1.4 | -- | |

## Electrical Characteristics of the Diode（$T_C$= 25℃ unless otherwise specified）

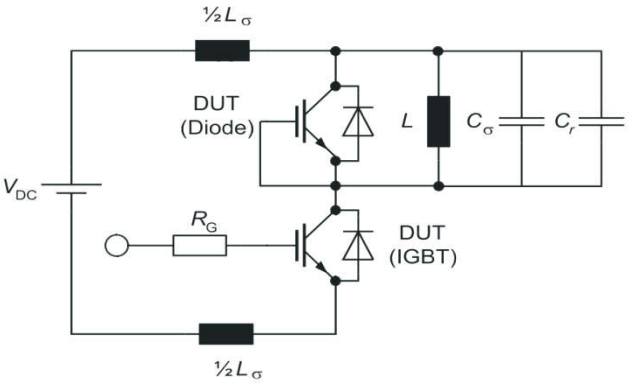
| Symbol | Parameter | Test Conditions | Rating | | | Units |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $V_{FM}$ | Diode Forward Voltage | $I_F$=10A | -- | 1.27 | 1.7 | V |
| $T_{rr}$ | Reverse Recovery Time | Vcc=400V, $I_F$=10A, di/dt=600A/uS | -- | 130 | -- | ns |
| $I_{RRM}$ | Diode Peak Reverse Recovery Current | | -- | 15 | -- | A |
| $Q_{rr}$ | Reverse Recovery Charge | | -- | 0.97 | -- | uC |

## Test Circuit

### 1) Gate Charge Test Circuit

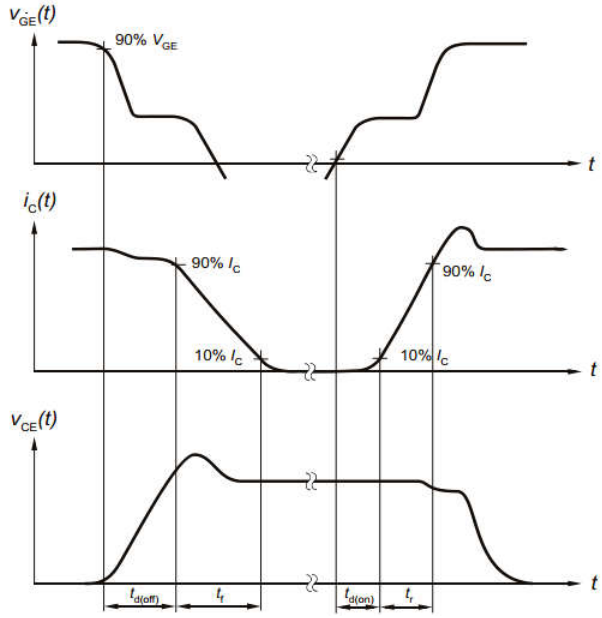



### 2) Switch Time Test Circuit

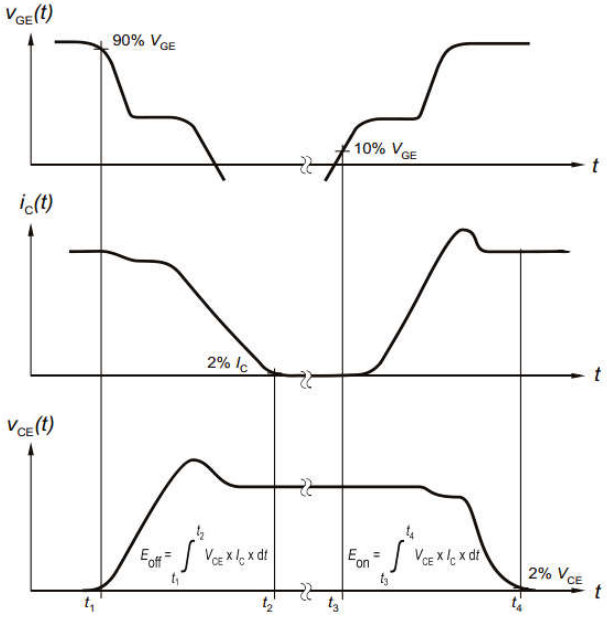



## Switching characteristics

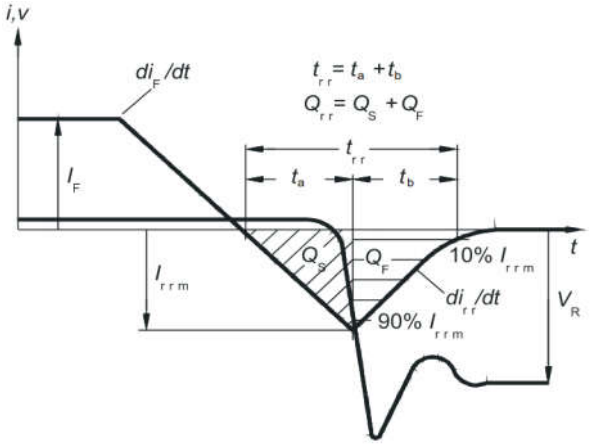
### 1) definition of switching times




### 2) definition of switching losses

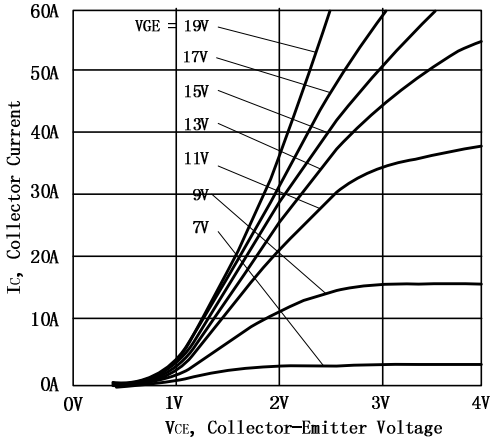



### 3) Definition of diode switching characteristics

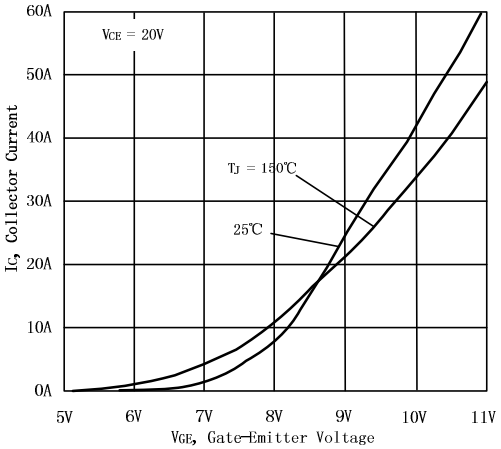


## Typical Electrical and Thermal Characteristics

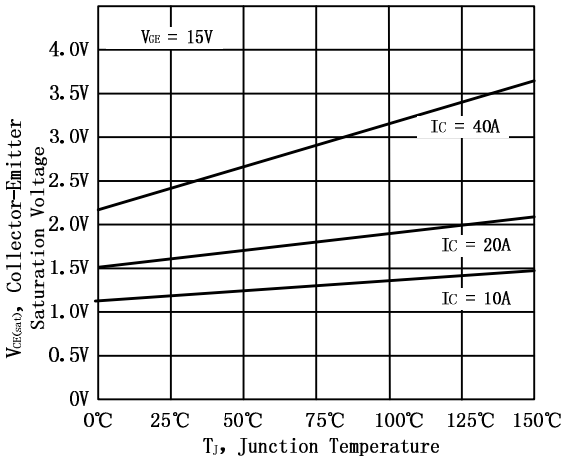
### Figure 1 Output Characteristics



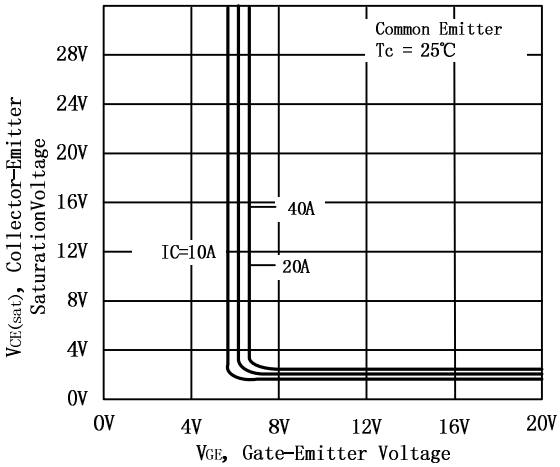

### Figure 2. Transfer Characteristics



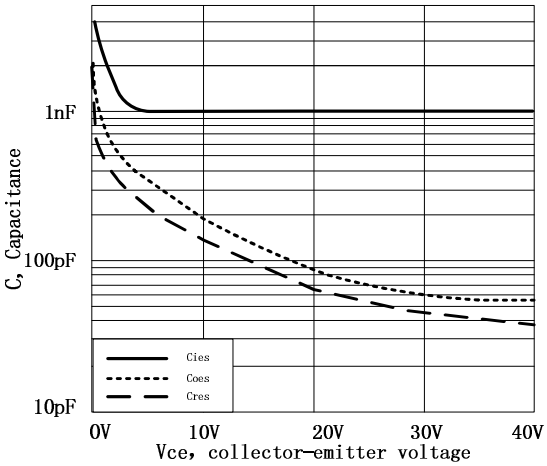

### Figure 3 $V_{CEsat}$ vs. Case Temperature



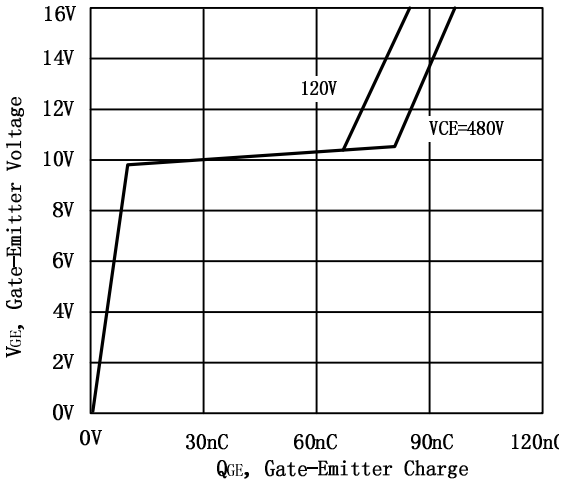

### Figure 4 Saturation Voltage vs. VGE




### Figure 5 Capacitance Characteristics

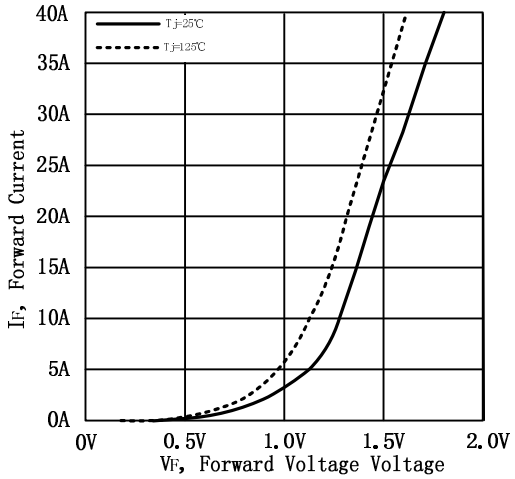



### Figure 6 Gate charge waveform

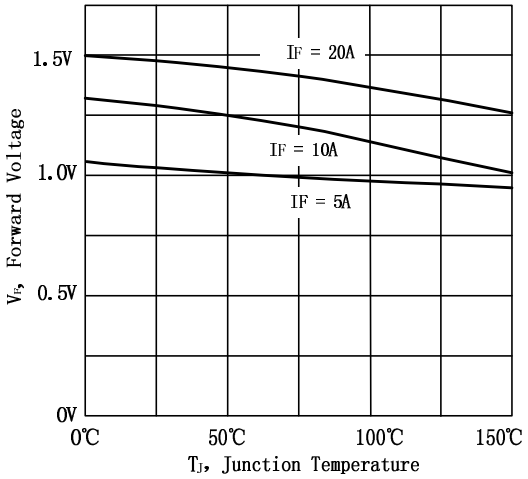


## Typical Electrical and Thermal Characteristics（continued）

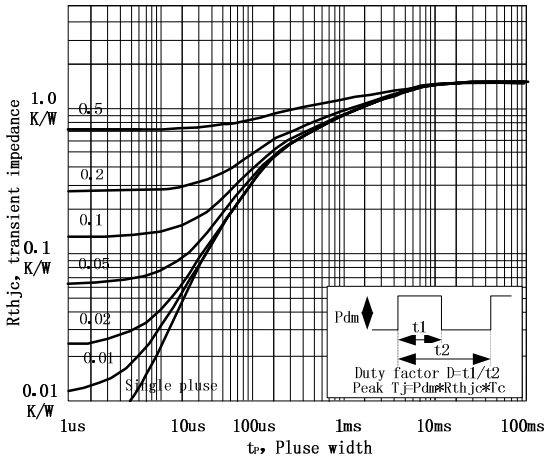
### Figure 7. Forward Characteristics



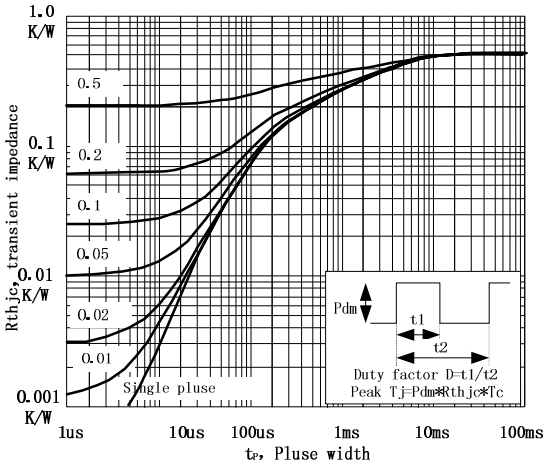

### Figure 8 $V_F$ vs. Temperature



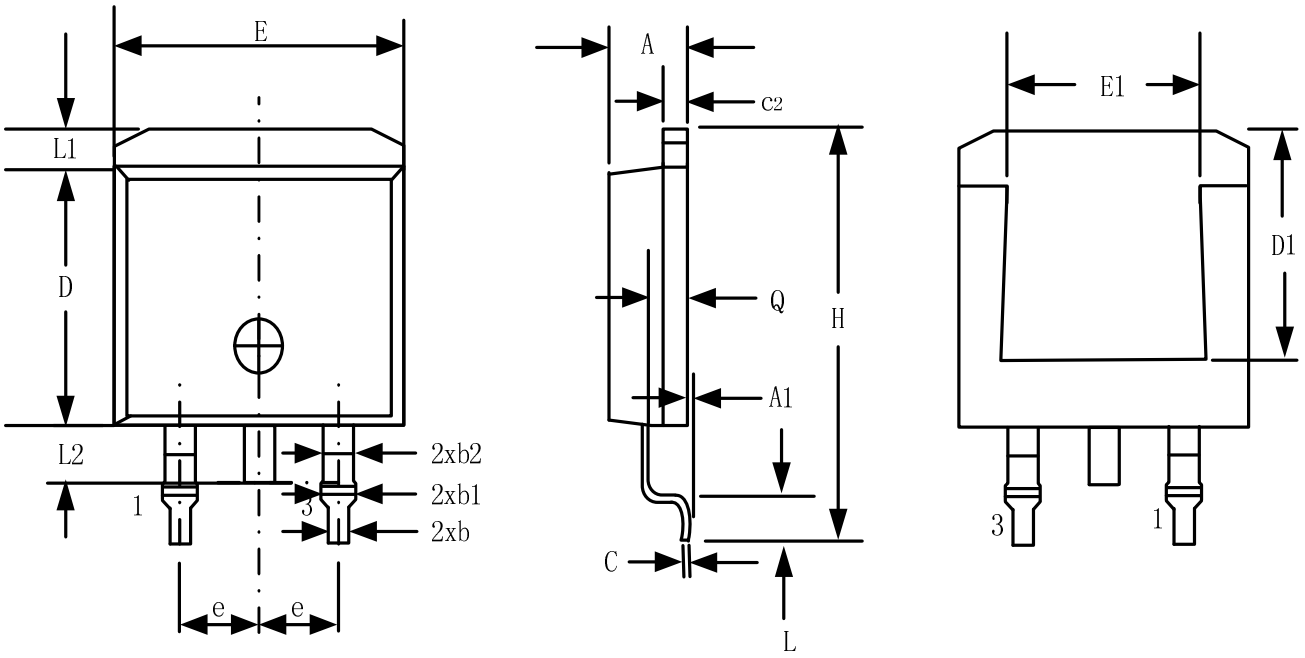

### Figure 9. Transient Thermal Impedance of IGBT for TO-220F




### Figure 10. Transient Thermal Impedance of IGBT for TO-220,TO-263,TO-247

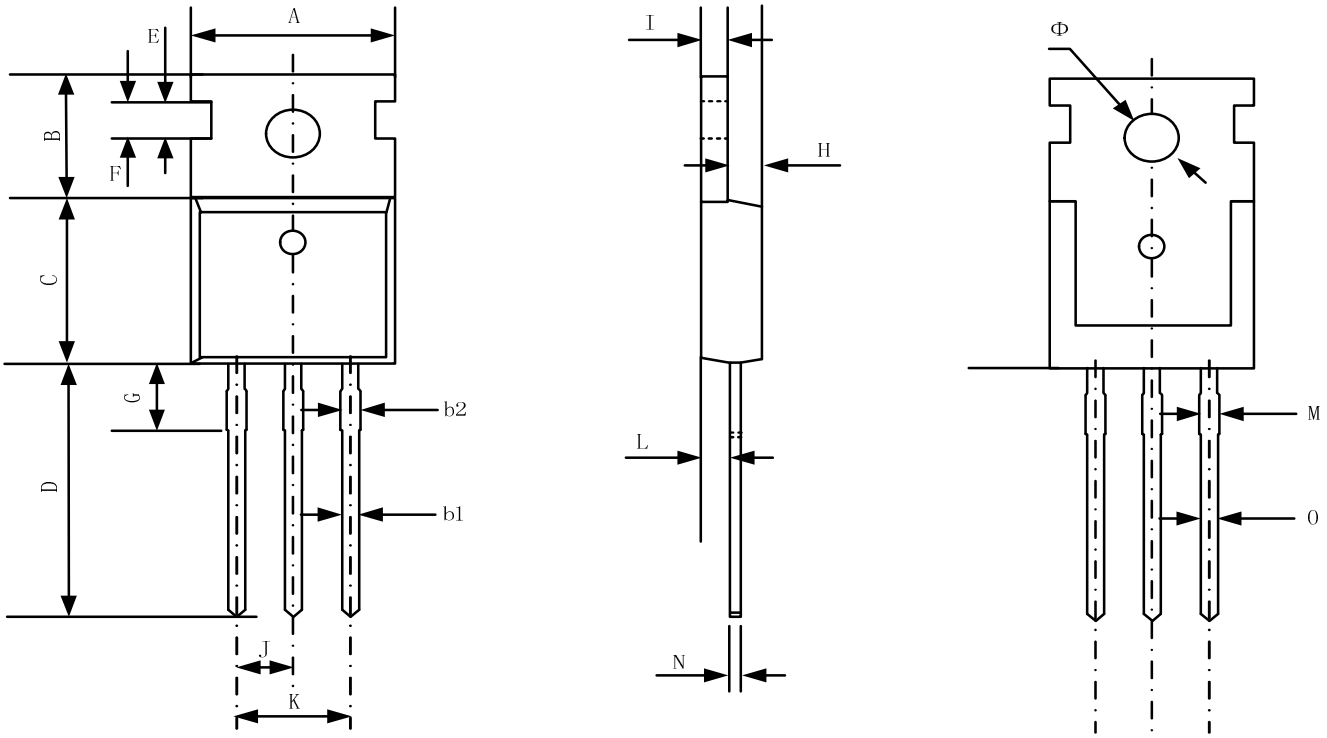


## TO-263-3L Package Information



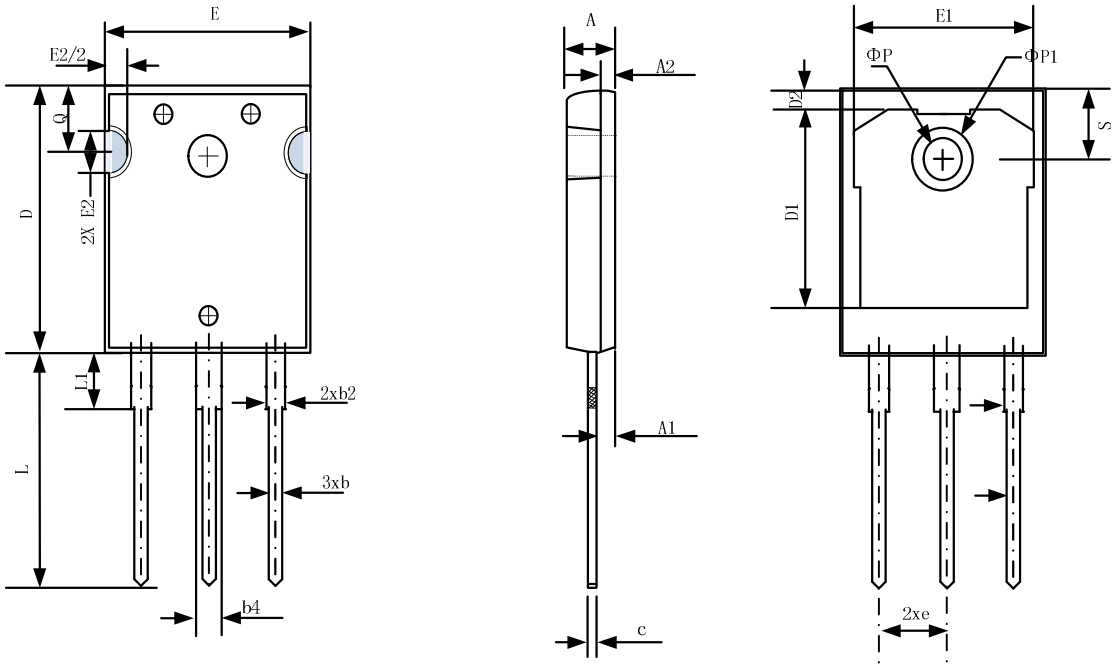

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 4.24 | 4.64 | 0.167 | 0.183 |
| A1 | 0.00 | 0.25 | 0.000 | 0.010 |
| b | 0.70 | 0.90 | 0.028 | 0.035 |
| b1 | 1.20 | 1.75 | 0.047 | 0.069 |
| b2 | 1.20 | 1.70 | 0.047 | 0.067 |
| C | 0.40 | 0.60 | 0.016 | 0.024 |
| c2 | 1.15 | 1.40 | 0.045 | 0.055 |
| D | 8.82 | 9.02 | 0.347 | 0.355 |
| D1 | 6.86 | -- | 0.270 | -- |
| E | 9.96 | 10.36 | 0.392 | 0.408 |
| E1 | 6.89 | 7.89 | 0.271 | 0.311 |
| e | 2.54 BSC | | 0.10 BSC | |
| H | 14.61 | 15.88 | 0.575 | 0.625 |
| L | 1.78 | 2.79 | 0.070 | 0.110 |
| L1 | 1.36 REF | | 0.054 REF | |
| L2 | 1.50 REF | | 0.059 REF | |
| L3 | 0.25 REF | | 0.010 REF | |
| Q | 2.30 | 2.70 | 0.091 | 0.106 |

## TO-220-3L-C Package Information



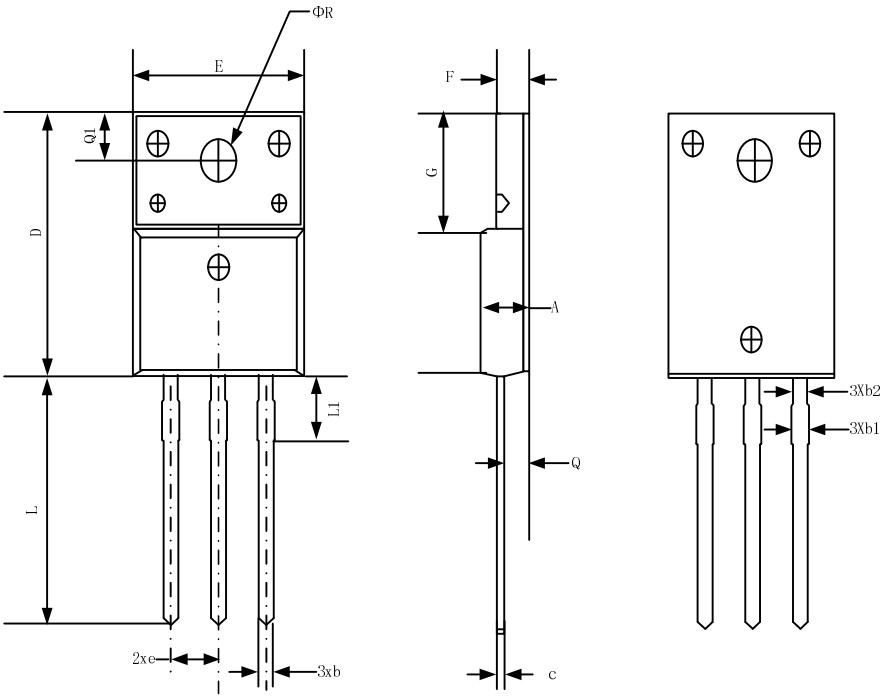

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 9.70 | 10.10 | 0.38 | 0.40 |
| B | 6.30 | 6.70 | 0.25 | 0.26 |
| C | 9.00 | 9.47 | 0.35 | 0.37 |
| D | 12.80 | 13.30 | 0.50 | 0.52 |
| E | 1.20 | 1.40 | 0.05 | 0.06 |
| F | 1.70 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-247-3L Package Information




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 4.83 | 5.21 | 0.190 | 0.205 |
| A1 | 2.29 | 2.55 | 0.090 | 0.100 |
| A2 | 1.50 | 2.49 | 0.059 | 0.098 |
| b | 1.12 | 1.33 | 0.044 | 0.052 |
| b2 | 1.91 | 2.39 | 0.075 | 0.094 |
| b4 | 2.87 | 3.22 | 0.113 | 0.127 |
| c | 0.55 | 0.69 | 0.022 | 0.027 |
| D | 20.80 | 21.10 | 0.819 | 0.831 |
| D1 | 16.25 | 17.65 | 0.640 | 0.695 |
| D2 | 0.51 | 1.35 | 0.020 | 0.053 |
| E | 15.75 | 16.13 | 0.620 | 0.635 |
| E1 | 13.46 | 14.16 | 0.530 | 0.557 |
| E2 | 4.32 | 5.49 | 0.170 | 0.216 |
| e | 5.44 BSC | | 0.214 BSC | |
| L | 19.81 | 20.32 | 0.780 | 0.800 |
| L1 | 4.10 | 4.40 | 0.161 | 0.173 |
| ΦP | 3.56 | 3.65 | 0.140 | 0.144 |
| ΦP1 | 7.19 REF | | 0.283 REF | |
| Q | 5.39 | 6.20 | 0.212 | 0.244 |
| S | 6.04 | 6.30 | 0.238 | 0.248 |

# TO-220F Package Information




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 4.50 | 4.83 | 0.18 | 0.19 |
| b | 0.70 | 0.91 | 0.03 | 0.04 |
| b1 | 1.20 | 1.47 | 0.05 | 0.06 |
| b2 | 1.10 | 1.38 | 0.04 | 0.05 |
| c | 0.45 | 0.63 | 0.02 | 0.02 |
| D | 15.67 | 16.07 | 0.62 | 0.63 |
| e | 2.54 BSC | | 0.10 BSC | |
| E | 9.96 | 10.36 | 0.39 | 0.41 |
| F | 2.34 | 2.74 | 0.09 | 0.11 |
| G | 6.48 | 6.90 | 0.26 | 0.27 |
| L | 12.68 | 13.30 | 0.50 | 0.52 |
| L1 | 3.13 | 3.50 | 0.12 | 0.14 |
| Q | 2.56 | 2.93 | 0.10 | 0.12 |
| Q1 | 3.20 | 3.40 | 0.13 | 0.13 |
| ΦR | 3.08 | 3.28 | 0.12 | 0.13 |

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