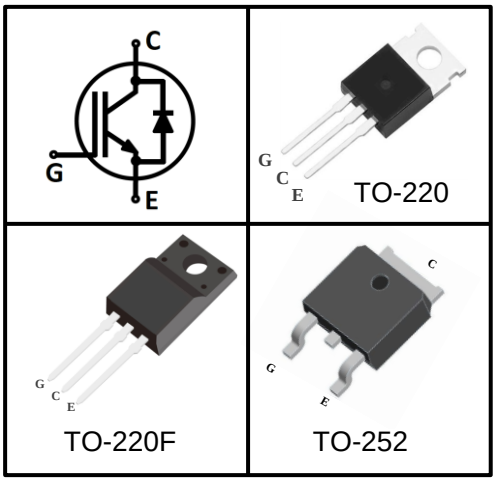
## Features

- Easy parallel switching capability due to positive temperature coefficient in $V_{CEsat}$
- Low $V_{CEsat}$, fast switching
- High ruggedness, good thermal stability
- Very tight parameter distribution

## Applications

- Motor Drives




| Type | Marking | Package Code |
|---|---|---|
| MPBP10N65EF | MP10N65EF | TO-220-3 |
| MPBA10N65EF | MP10N65EF | TO-220F-3 |
| MPBD10N65EF | MP10N65EF | TO-252 |

## Maximum Rated Values [1]

| Parameter | Symbol | Value | | | Unit |
|---|---|---|---|---|---|
| | | 220 | 220F | 252 | |
| Collector-emitter voltage | $V_{CE}$ | 650 | | | V |
| DC collector current[2] | | | | | A |
| $T_C$=25℃ | $I_C$ | 15 | | | |
| $T_C$=100℃ | | 10 | | | |
| Pulsed collector current[3] | $I_{Cpuls}$ | 20 | | | |
| Diode forward current[2] | | | | | |
| $T_C$=25℃ | $I_F$ | 20 | | | |
| $T_C$=100℃ | | 10 | | | |
| Diode pulsed current[3] | $I_{Fpuls}$ | 24 | | | |
| Short circuit withstanding time $V_{GE}$ = 15V, $V_{CC}$ ≤ 400V | $t_{SC}$ | 5 | | | us |
| Gate-emitter voltage | $V_{GE}$ | ±20 | | | V |
| Transient Gate-emitter voltage（$t_p$≤10us) | | ±30 | | | |
| Power dissipation | | | | | W |
| $T_C$=25℃ | $P_{tot}$ | 115 | 32 | 68 | |
| $T_C$=100℃ | | 58 | 16 | 34 | |
| Operating junction temperature | $T_j$ | -55~175 | | | ℃ |
| Storage temperature | $T_{stg}$ | -55~150 | | | |

1:Reference standard: JESD-022 2: limited by Tjmax 3: Tp limited by Tjmax ;

## Thermal Characteristics

| Parameter | Symbol | Max | | | Unit |
|---|---|---|---|---|---|
| | | 220 | 220F | 252 | |
| IGBT thermal resistance, junction-case | $R_{thJC}$ | 1.3 | 4.6 | 2.2 | K/W |
| Diode thermal resistance, junction-case | $R_{thJCD}$ | 2.4 | 5.6 | 2.9 | |
| Thermal Resistance, junction-ambient | $R_{thJA}$ | 62.5 | 65 | 62.5 | |

## Electrical Characteristics（at Tj=25℃, unless otherwise specified）

### Static Characteristics

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Collector-emitter breakdown voltage | $V_{(BR)CES}$ | $V_{GE}$=0V, $I_C$=0.25mA | 650 | - | - | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $V_{GE}$=15V, $I_C$=10A $T_j$=25℃ | - | 1.40 | 1.80 | |
| | | $T_j$=125℃ | - | 1.65 | - | |
| | | $T_j$=150℃ | - | 1.75 | - | |
| Diode forward voltage | $V_F$ | $V_{GE}$=0V， $I_F$=10A $T_j$=25℃ | - | 1.65 | 1.95 | |
| | | $T_j$=125℃ | - | 1.30 | - | |
| | | $T_j$=150℃ | - | 1.20 | - | |
| G-E threshold voltage | $V_{GE(th)}$ | $I_C$=150uA,$V_{CE}$=$V_{GE}$ | 4.5 | 5.8 | 6.5 | |
| C-E leakage current | $I_{CES}$ | $V_{CE}$=650V, $V_{GE}$=0V $T_j$=25℃ | - | - | 0.01 | mA |
| | | $T_j$=150℃ | - | - | 1.0 | |
| G-E leakage current | $I_{GES}$ | $V_{CE}$=0V, $V_{GE}$=20V | - | - | 250 | nA |
| Transconductance | $g_{FS}$ | $V_{CE}$=20V, $I_C$=10A | - | 5 | - | S |

### Dynamic Characteristics

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Input capacitance | $C_{iss}$ | $V_{CE}$=25V, $V_{GE}$=0V, f=1MHz | - | 1000 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 45 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 16 | - | |
| Gate charge | $Q_G$ | $V_{CC}$=300V, $I_C$=10A, $V_{GE}$=15V | - | 58 | - | nC |

## IGBT Switching Characteristics

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Turn-on delay time | $t_{d(on)}$ | $T_j$=25℃, $V_{CC}$=400V, $I_C$=10A, $V_{GE}$=0/15V, $R_G$=10Ω, Inductive load | - | 47 | - | ns |
| Rise time | $t_r$ | | - | 28 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 103 | - | |
| Fall time | $t_f$ | | - | 80 | - | |
| Turn-on energy | $E_{on}$ | | - | 0.17 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.20 | - | |
| Total switching energy | $E_{ts}$ | | - | 0.37 | - | |
| Turn-on delay time | $t_{d(on)}$ | $T_j$=150℃, $V_{CC}$=400V, $I_C$=10A, $V_{GE}$=0/15V, $R_G$=10Ω, Inductive load | - | 63.2 | - | ns |
| Rise time | $t_r$ | | - | 30.4 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 149.2 | - | |
| Fall time | $t_f$ | | - | 111 | - | |
| Turn-on energy | $E_{on}$ | | - | 0.287 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.280 | - | |
| Total switching energy | $E_{ts}$ | | - | 0.567 | - | |

## Diode Characteristics

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Diode reverse recovery time | $t_{rr}$ | $T_j$=25℃, $V_R$=400V, $I_F$=10A, $di_F/dt$=350A/μs | - | 66 | - | ns |
| Diode reverse recovery charge | $Q_{rr}$ | | - | 0.23 | - | μC |
| Diode peak reverse recovery current | $I_{rrm}$ | | - | 5.55 | - | A |
| Diode reverse recovery time | $t_{rr}$ | $T_j$=150℃, $V_R$=400V, $I_F$=10A, $di_F/dt$=357A/μs | - | 95 | - | ns |
| Diode reverse recovery charge | $Q_{rr}$ | | - | 0.59 | - | μC |
| Diode peak reverse recovery current | $I_{rrm}$ | | - | 10.20 | - | A |

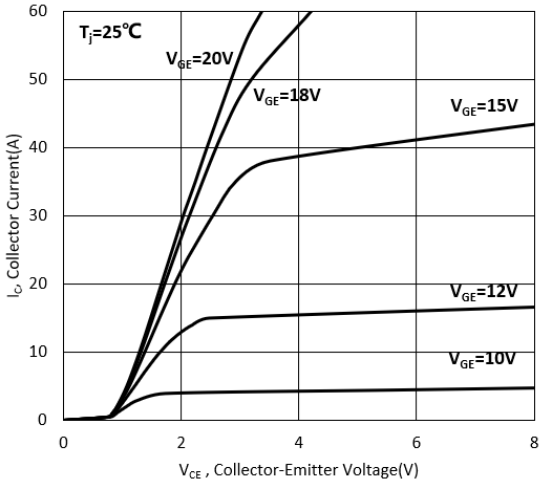



**Figure 1. Typical output characteristic** ($T_j$ =25℃)

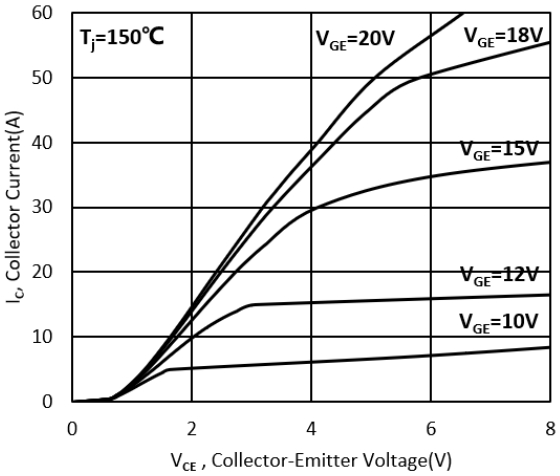



**Figure 2. Typical output characteristic** ($T_j$ =150℃)

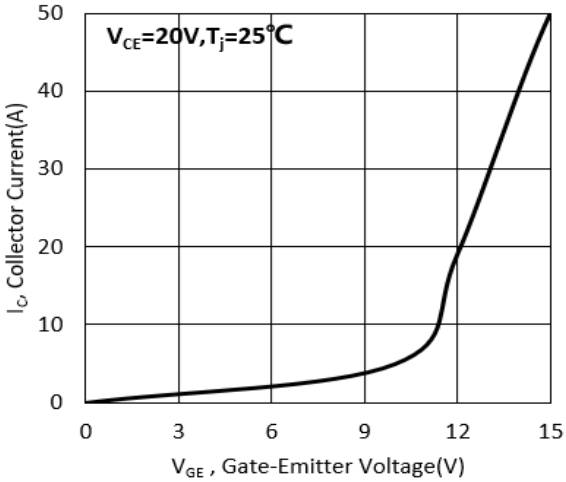



**Figure 3. Typical transfer characteristic** ($T_j$ =25℃)

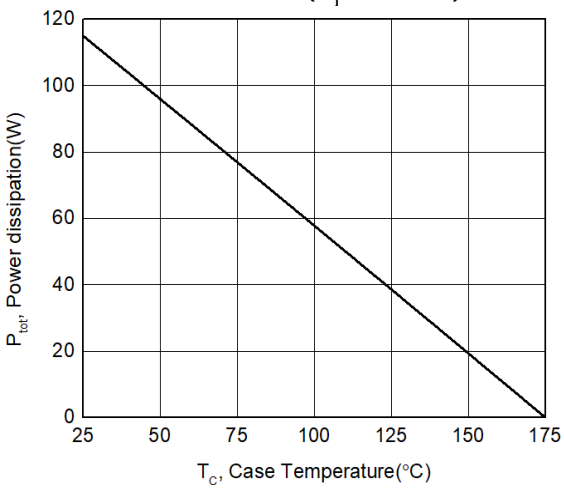



**Figure 4. Power dissipation as a function of case temperature** (TO-220)

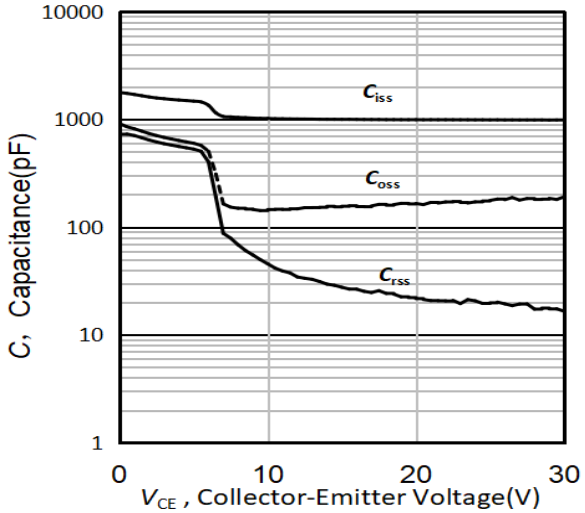



**Figure 5. Capacitance characteristic** ($V_{GE}$=0V, $f$=1MHz)

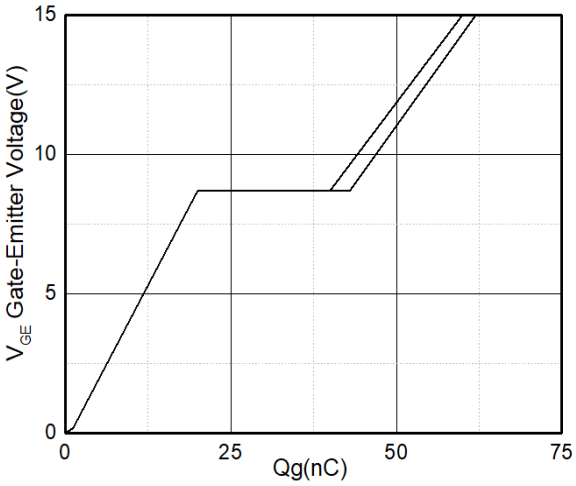



**Figure 6. Typical gate charge ($I_C$=10A)**

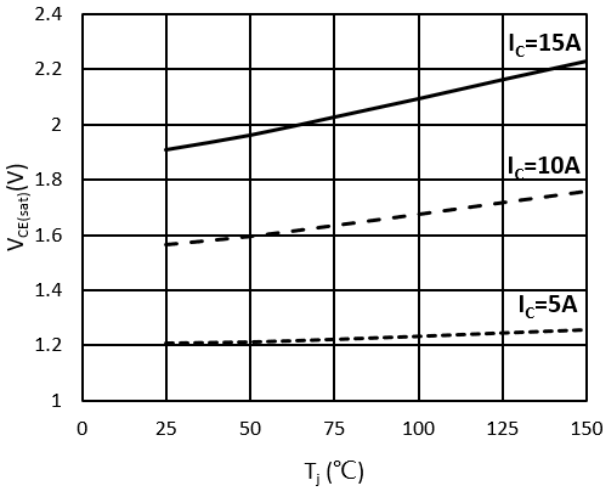



**Figure 7. $V_{CESAT}$ as a function of junction temperature ($V_{GE}$=15V)**

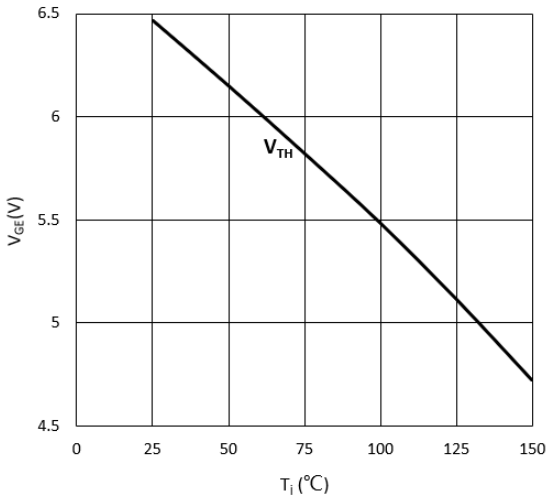



**Figure 8. $V_{TH}$ as a function of junction temperature ($I_{CE}$=250uA)**

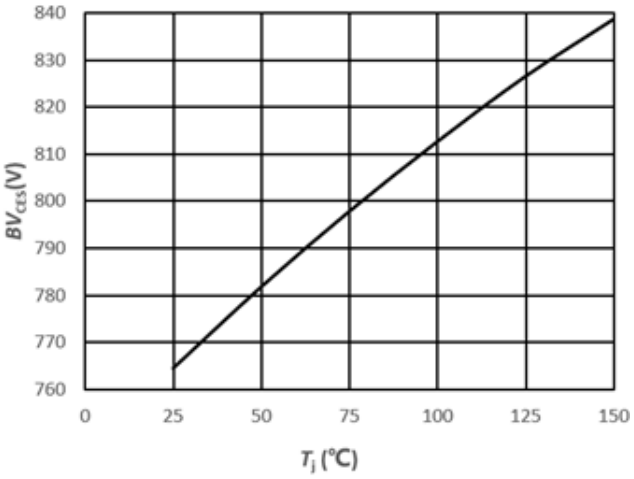



**Figure 9. BV as a function of junction temperature ($I_{CE}$=250uA)**

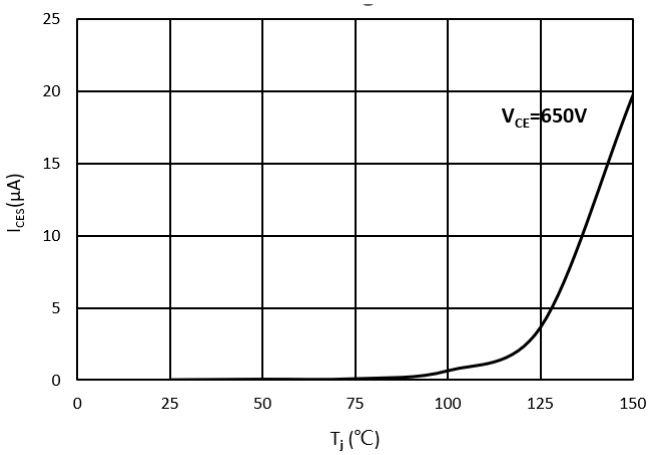



**Figure 10. $I_{CES}$ leakage current as a function of junction temperature**

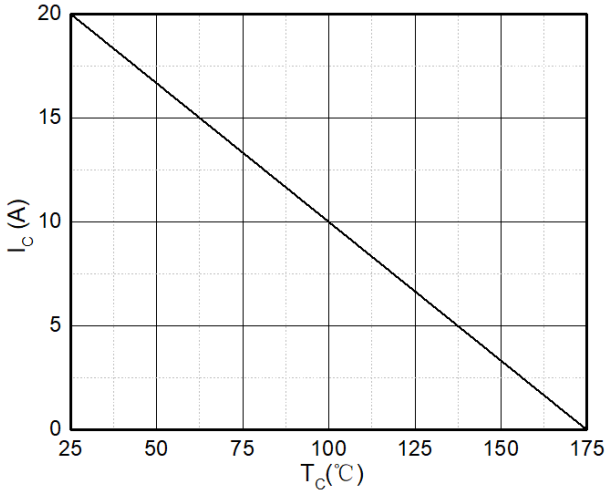



**Figure 11. Collector current as a function of case temperature($V_{GE}$≥15V, $T_j$≤175 ℃)**

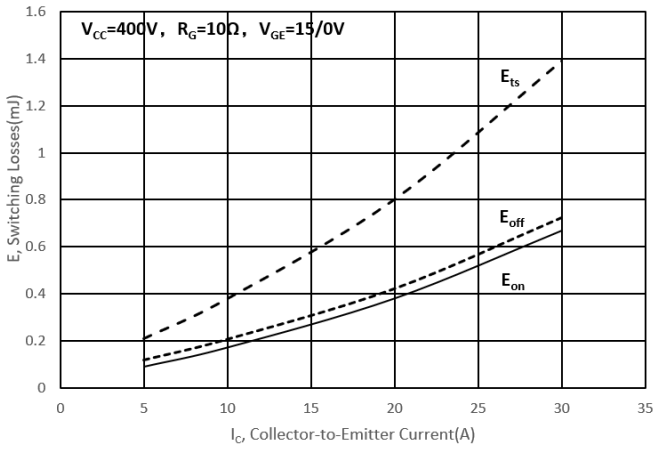



**Figure 12. $E_{on}$, $E_{off}$ as a function of $I_C$ ($T_j$=25 ℃)**

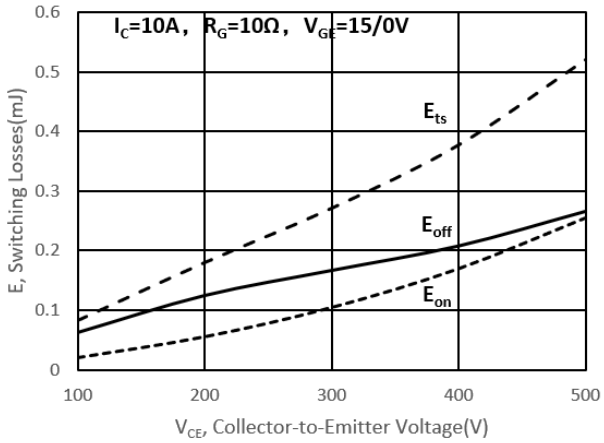



**Figure 13. $E_{on}$, $E_{off}$ as a function of $V_{CE}$** ($T_j$=25 ℃)

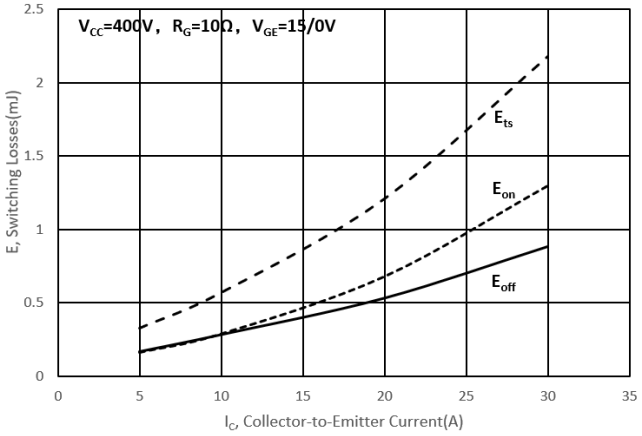



**Figure 14. $E_{on}$, $E_{off}$ as a function of $I_C$** ($T_j$=150 ℃)

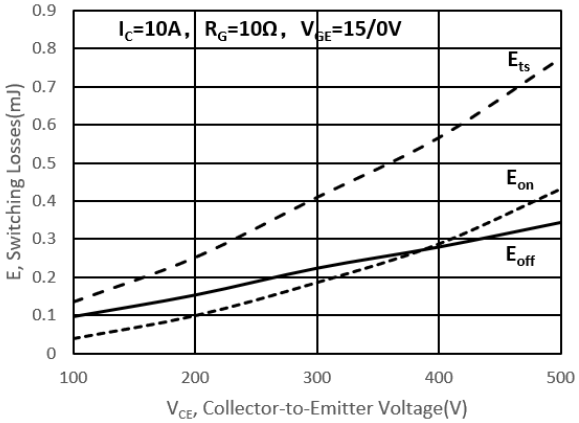



**Figure 15. $E_{on}$, $E_{off}$ as a function of $V_{CE}$** ($T_j$=150 ℃)

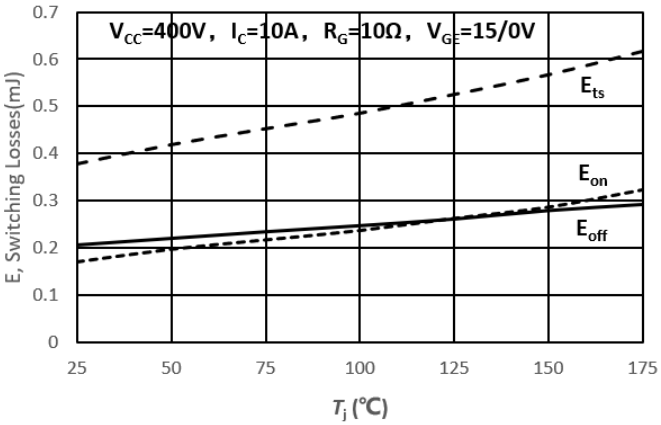
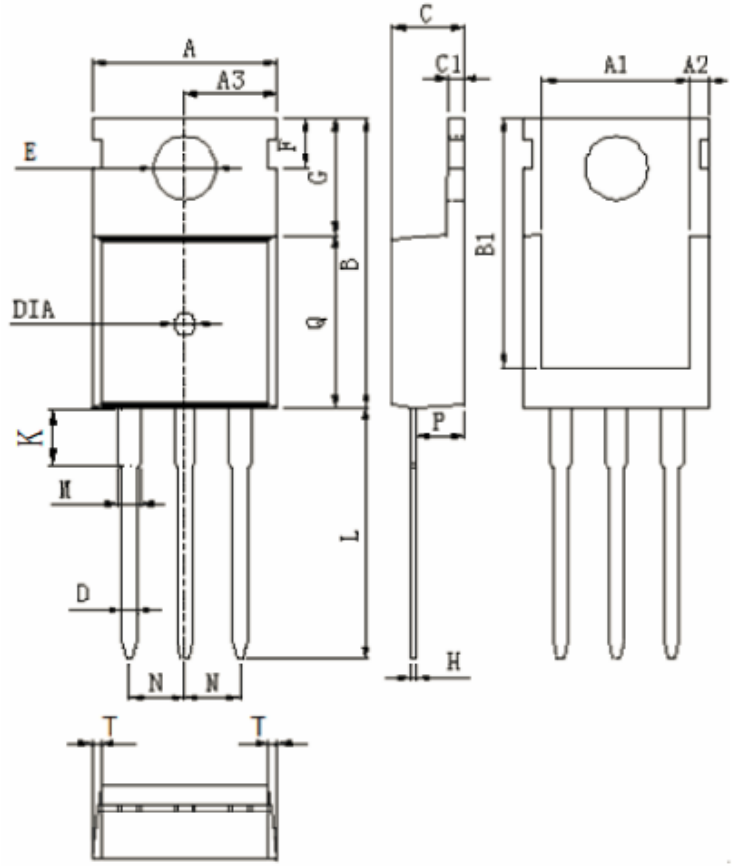



**Figure 16. $E_{on}$, $E_{off}$ as a function of junction temperature**

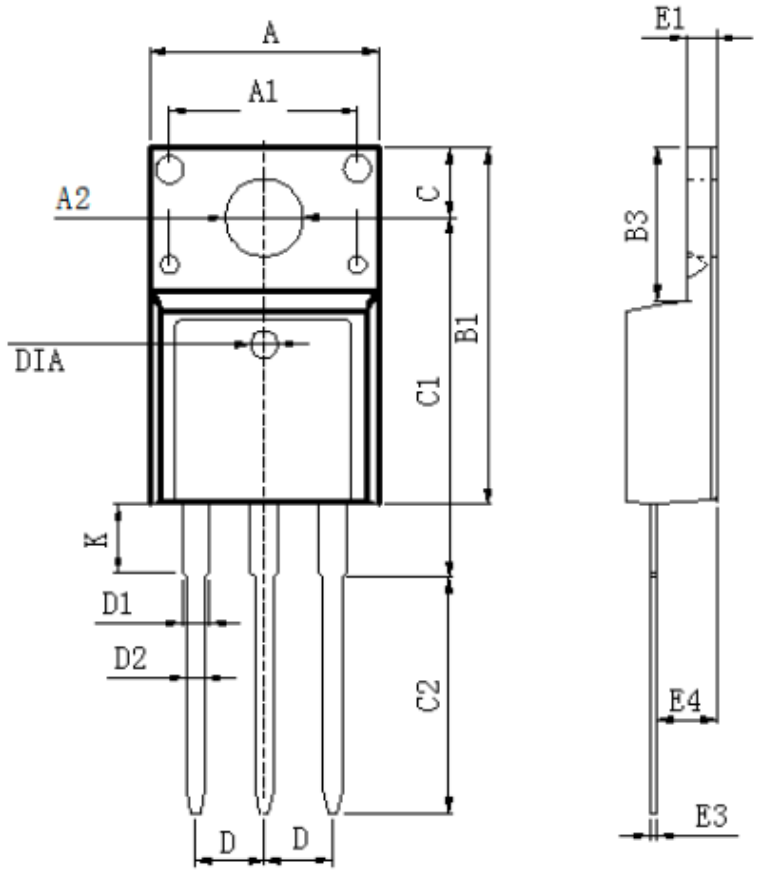
## TO-220-3L

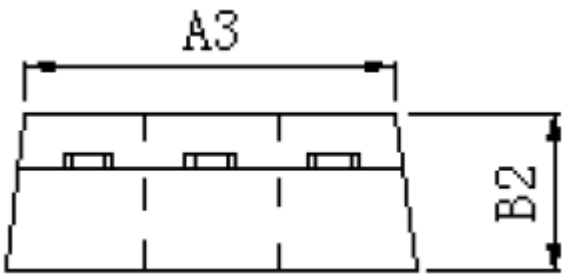



| DIM | MILLIMETERS |
|---|---|
| A | 10.0±0.3 |
| A1 | 8.64±0.2 |
| A2 | 1.15±0.1 |
| A3 | 5.0±0.2 |
| B | 15.8±0.4 |
| B1 | 13.2±0.3 |
| C | 4.56±0.1 |
| C1 | 1.3±0.2 |
| D | 0.8±0.2 |
| E | 3.6±0.2 |
| F | 2.95±0.3 |
| G | 6.5±0.3 |
| H | 0.5±0.1 |
| K | 3.1±0.2 |
| L | 13.2±0.4 |
| M | 1.25±0.1 |
| N | 2.54±0.1 |
| P | 2.4±0.3 |
| Q | 9.0±0.3 |
| T | W:0.35 |
| DIA | ⊙1.5(deep 0.2) |

Unit :mm

# TO-220F-3L

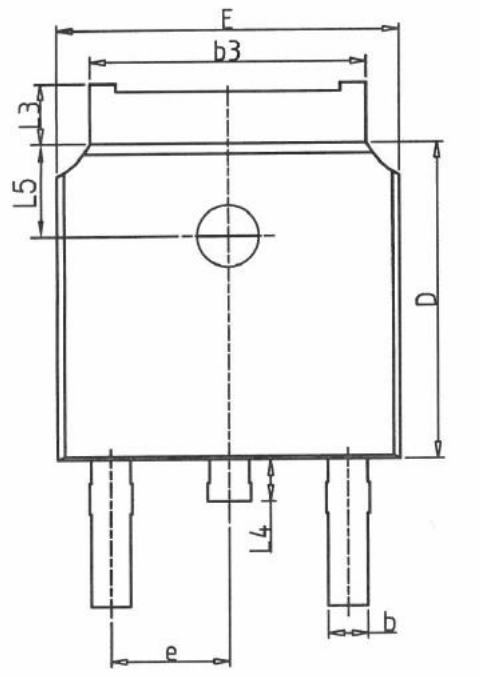


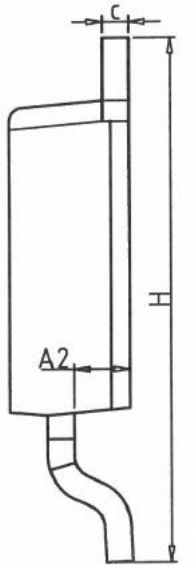




| DIM | MILLIMETERS |
|---|---|
| A | 10.16±0.3 |
| A1 | 7.00±0.1 |
| A2 | 3.3±0.2 |
| A3 | 9.5±0.2 |
| B1 | 15.87±0.3 |
| B2 | 4.7±0.2 |
| B3 | 6.68±0.4 |
| C | 3.3±0.2 |
| C1 | 12.57±0.3 |
| C2 | 10.02±0.5 |
| D | 2.54±0.05 |
| D1 | 1.28±0.2 |
| D2 | 0.8±0.1 |
| K | 3.1±0.3 |
| E1 | 2.54±0.1 |
| E3 | 0.5±0.1 |
| E4 | 2.76±0.2 |
| DIA | ⊙1.5(deep 0.2) |

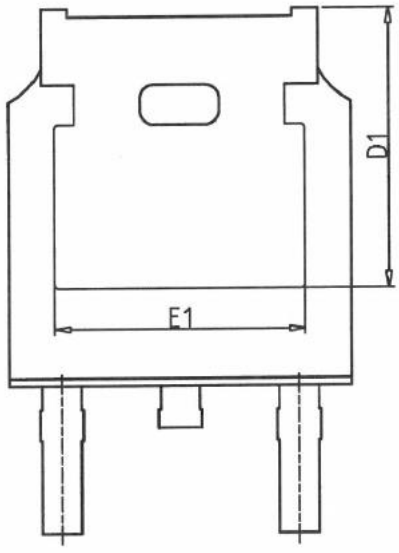
Unit :mm

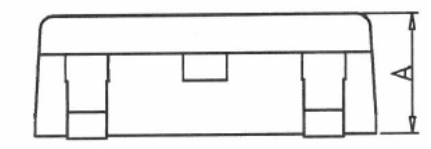
# TO-252

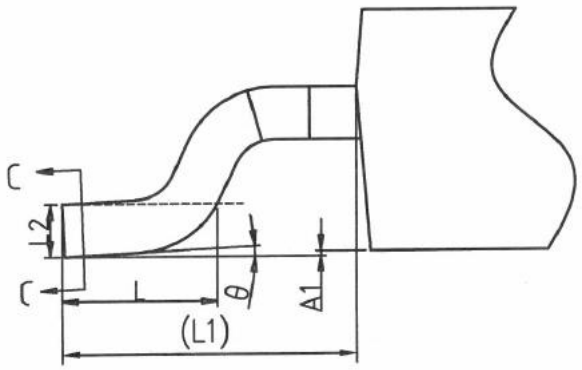



| SYMBOL | mm | | |
|---|---|---|---|
| | Min | Nom | Max |
| A | 2.20 | 2.30 | 2.38 |
| A1 | 0.00 | - | 0.20 |
| A2 | 0.97 | 1.07 | 1.17 |
| b | 0.68 | 0.78 | 0.90 |
| b3 | 5.20 | 5.33 | 5.46 |
| c | 0.43 | 0.53 | 0.61 |
| D | 5.98 | 6.10 | 6.22 |
| D1 | 5.30REF | | |
| E | 6.40 | 6.60 | 6.73 |
| E1 | 4.63 | - | - |
| e | 2.286BSC | | |
| H | 9.40 | 10.10 | 10.50 |
| L | 1.38 | 1.50 | 1.75 |
| L1 | 2.90REF | | |
| L2 | 0.51BSC | | |
| L3 | 0.88 | - | 1.28 |
| L4 | 0.50 | - | 1.00 |
| L5 | 1.65 | 1.80 | 1.95 |
| θ | 0° | - | 8° |



## Revision History:

| Revision | Date | Subjects (major changes since last revision) |
|---|---|---|
| 1.0 | 2021-12 | Initial version |
| 1.1 | 2023-03 | Add the graphs |

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