

## N-Channel Enhancement Mode MOSFET

### 1. Product Information

#### 1.1 Features

- ☒ Advanced trench cell design
- ☒ Low Thermal Resistance

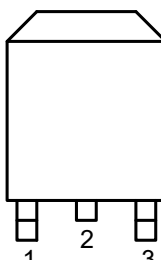
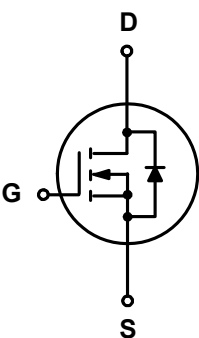
#### 1.2 Applications

- ☒ Motor drivers
- ☒ DC - DC Converter

#### 1.3 Quick reference

- ☒  $BV \geq 40\text{ V}$
- ☒  $P_{tot} \leq 35\text{ W}$
- ☒  $I_D \leq 60\text{ A}$
- ☒  $R_{DS(ON)} \leq 9\text{ m}\Omega @ V_{GS} = 10\text{ V}$
- ☒  $R_{DS(ON)} \leq 16\text{ m}\Omega @ V_{GS} = 4.5\text{ V}$

### 2. Pin Description

| Pin | Description | Simplified Outline                                                                                             | Symbol                                                                                |
|-----|-------------|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1   | Gate(G)     |  <p>Top View<br/>TO-252</p> |  |
| 2   | Drain(D)    |                                                                                                                |                                                                                       |
| 3   | Source(S)   |                                                                                                                |                                                                                       |

## 3. Limiting Values

| Symbol              | Parameter                               | Conditions                                                | Min  | Max      | Unit                          |
|---------------------|-----------------------------------------|-----------------------------------------------------------|------|----------|-------------------------------|
| $V_{DS}$            | Drain-Source Voltage                    | $T_C = 25\text{ }^{\circ}\text{C}$                        | 40   | -        | V                             |
| $V_{GS}$            | Gate-Source Voltage                     | $T_C = 25\text{ }^{\circ}\text{C}$                        | -    | $\pm 20$ | V                             |
| $I_{D^{*,***}}$     | Drain Current ( DC )                    | $T_C = 25\text{ }^{\circ}\text{C}, V_{GS} = 10\text{ V}$  | -    | 60       | A                             |
| $I_{D^*}$           |                                         | $T_C = 100\text{ }^{\circ}\text{C}, V_{GS} = 10\text{ V}$ | -    | 28       | A                             |
| $I_{DM^{*,**,***}}$ | Drain Current ( Pulsed )                | $T_C = 25\text{ }^{\circ}\text{C}, V_{GS} = 10\text{ V}$  | -    | 80       | A                             |
| $P_{tot^*}$         | Total Power Dissipation                 | $T_C = 25\text{ }^{\circ}\text{C}$                        | -    | 35       | W                             |
| $T_{stg}$           | Storage Temperature                     |                                                           | - 55 | 150      | $^{\circ}\text{C}$            |
| $T_J$               | Junction Temperature                    |                                                           | -    | 150      | $^{\circ}\text{C}$            |
| $I_S$               | Diode Forward Current                   | $T_C = 25\text{ }^{\circ}\text{C}$                        | -    | 60       | A                             |
| $E_{AS^*}$          | Single Pulsed Avalanche Energy          | $V_{DD} = 40\text{ V}, L = 1.0\text{ mH}$                 | -    | 84.5     | mJ                            |
| $R_{\theta JA^*}$   | Thermal Resistance- Junction to Ambient |                                                           | -    | 42       | $^{\circ}\text{C} / \text{W}$ |
| $R_{\theta JC^*}$   | Thermal Resistance- Junction to Case    |                                                           | -    | 1.3      |                               |

Notes :

- \* Surface Mounted on 1 in<sup>2</sup> pad area,  $t \leq 10\text{ sec}$
- \*\* Pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$
- \*\*\* limited by bonding wire

## 4. Marking Information

| Product Name | Marking                                                      |
|--------------|--------------------------------------------------------------|
| UP60N04K     | <div>60N04<br/>YWWXXX</div> <div>YWWXXX:<br/>Date Code</div> |

## 5. Ordering Code

| Product Name | Package | Reel Size | Tape width | Quantity | Note |
|--------------|---------|-----------|------------|----------|------|
| UP60N04K     | TO252   |           |            | 5000     |      |

Note: UOE defines " Green " as lead-free ( RoHS compliant ) and halogen free ( Br or Cl does not exceed 900 ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500 ppm by weight; Follow IEC 61249-2-21 and IPC / JEDEC J-STD-020C )

## 6. Electrical Characteristics (T<sub>A</sub> = 25 °C Unless Otherwise Noted)

| Symbol                                   | Parameter                        | Conditions                                                                                                                  | Min | Typ  | Max   | Unit |
|------------------------------------------|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-----|------|-------|------|
| Static Characteristics                   |                                  |                                                                                                                             |     |      |       |      |
| BV <sub>DSS</sub>                        | Drain-Source Breakdown Voltage   | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                              | 40  | -    | -     | V    |
| V <sub>GS(th)</sub>                      | Gate Threshold Voltage           | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>DS</sub> = 250 μA                                                                | 1   | -    | 2     | V    |
| I <sub>DSS</sub>                         | Zero Gate Voltage Source Current | V <sub>DS</sub> = 32 V, V <sub>GS</sub> = 0 V                                                                               | -   | -    | 1     | μA   |
| I <sub>GSS</sub>                         | Gate Leakage Current             | V <sub>GS</sub> = ± 20 V, V <sub>DS</sub> = 0 V                                                                             | -   | -    | ± 100 | nA   |
| R <sub>DS(ON)</sub> <sup>a</sup>         | Drain-Source On-State Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 20 A                                                                               | -   | 8    | 9     | m Ω  |
|                                          |                                  | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 10 A                                                                              | -   | 14   | 16    |      |
| Diode Characteristics                    |                                  |                                                                                                                             |     |      |       |      |
| V <sub>SD</sub> <sup>a</sup>             | Diode Forward Voltage            | I <sub>SD</sub> = 20 A, V <sub>GS</sub> = 0 V                                                                               | -   | -    | 1.3   | V    |
| t <sub>rr</sub>                          | Reverse Recovery Time            | I <sub>SD</sub> = 20 A, dI <sub>SD</sub> /dt = 100 A/μs                                                                     | -   | 11   | -     | nS   |
| Q <sub>rr</sub>                          | Reverse Recovery Charge          |                                                                                                                             | -   | 6.4  | -     | nC   |
| Dynamic Characteristics <sup>b</sup>     |                                  |                                                                                                                             |     |      |       |      |
| C <sub>iss</sub>                         | Input Capacitance                | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 20 V<br>Frequency = 1 MHz                                                          | -   | 1582 | -     | pF   |
| C <sub>oss</sub>                         | Output Capacitance               |                                                                                                                             | -   | 112  | -     |      |
| C <sub>rss</sub>                         | Reverse Transfer Capacitance     |                                                                                                                             | -   | 90   | -     |      |
| t <sub>d(on)</sub>                       | Turn-on Delay Time               | V <sub>DS</sub> = 20 V, V <sub>GEN</sub> = 10 V,<br>R <sub>G</sub> = 3.9 Ω, R <sub>L</sub> = 1 Ω,<br>I <sub>DS</sub> = 20 A | -   | 8.1  | -     | nS   |
| t <sub>r</sub>                           | Turn-on Rise Time                |                                                                                                                             | -   | 46   | -     |      |
| t <sub>d(off)</sub>                      | Turn-off Delay Time              |                                                                                                                             | -   | 30   | -     |      |
| t <sub>f</sub>                           | Turn-off Fall Time               |                                                                                                                             | -   | 28   | -     |      |
| Gate Charge Characteristics <sup>b</sup> |                                  |                                                                                                                             |     |      |       |      |
| Q <sub>g</sub>                           | Total Gate Charge                | V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 10 V,<br>I <sub>DS</sub> = 20 A                                                   | -   | 29   | -     | nC   |
| Q <sub>gs</sub>                          | Gate-Source Charge               |                                                                                                                             | -   | 7.1  | -     |      |
| Q <sub>gd</sub>                          | Gate-Drain Charge                |                                                                                                                             | -   | 5    | -     |      |

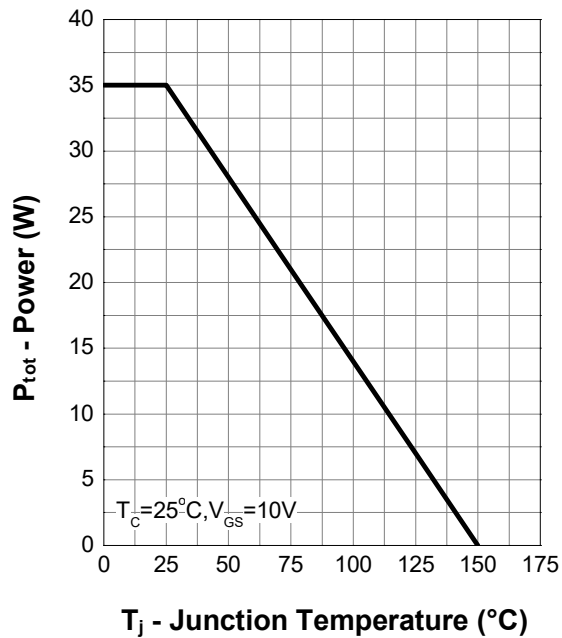
Notes :

a : Pulse test ; pulse width ≤ 300 μs, duty cycle ≤ 2 %

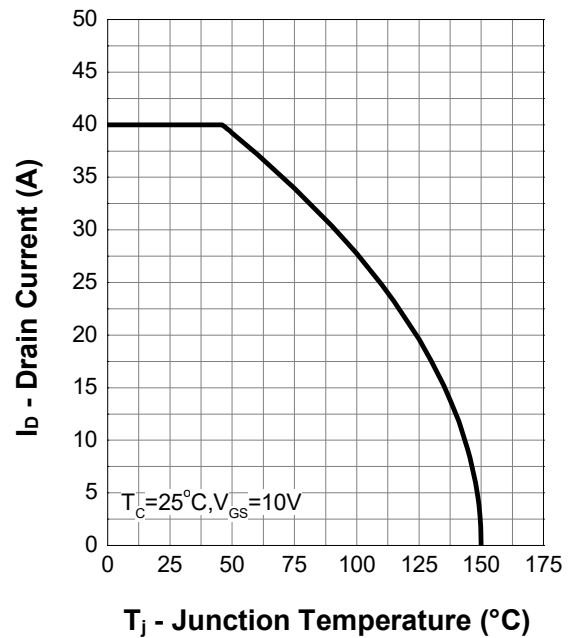
b : Guaranteed by design, not subject to production testing

## 7. Typical Characteristics (Cont.)

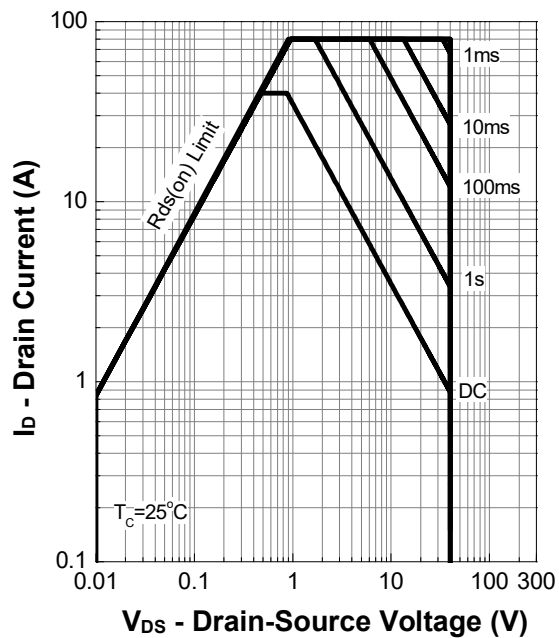
Power Capability



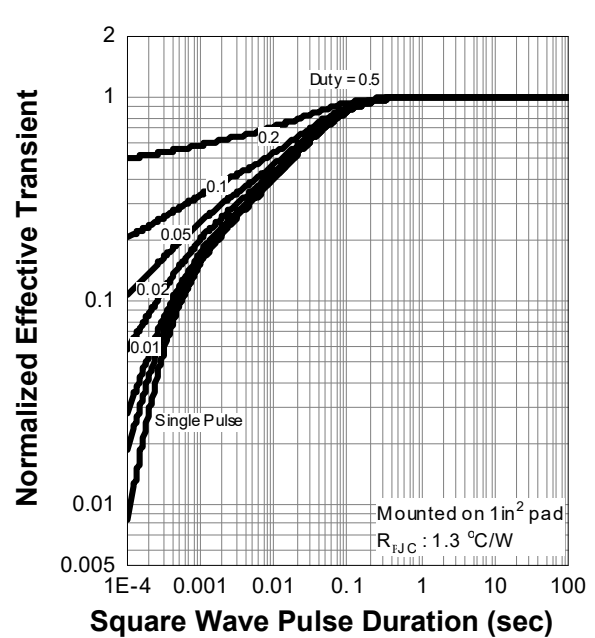
Current Capability



Safe Operation Area

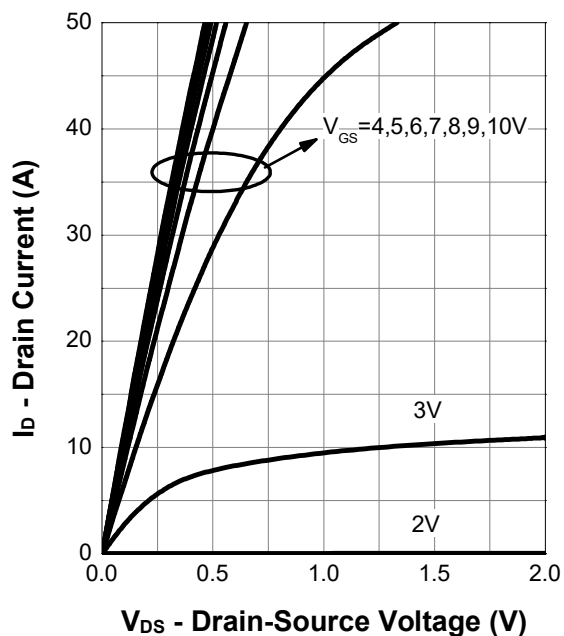


Transient Thermal Impedance

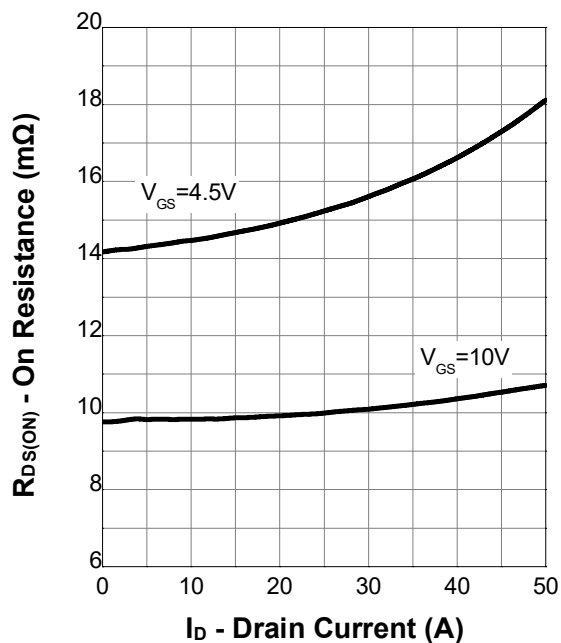


## 7. Typical Characteristics (Cont.)

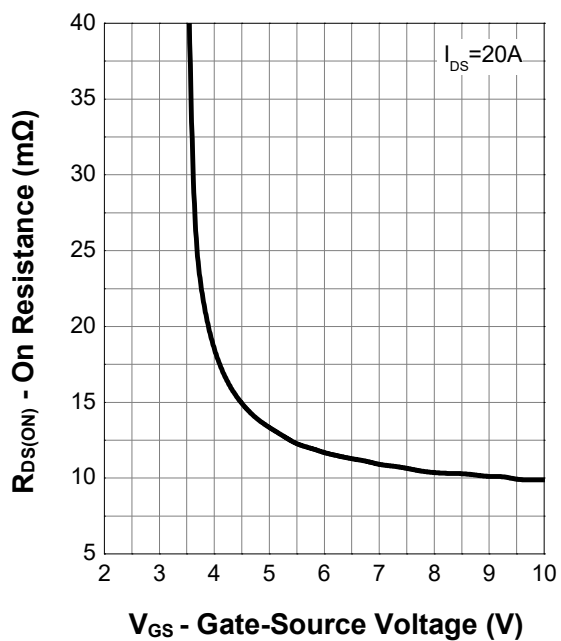
Output Characteristics



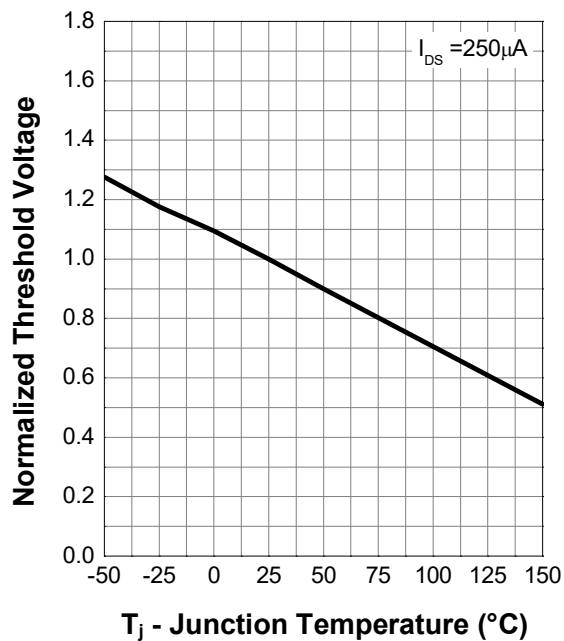
On Resistance



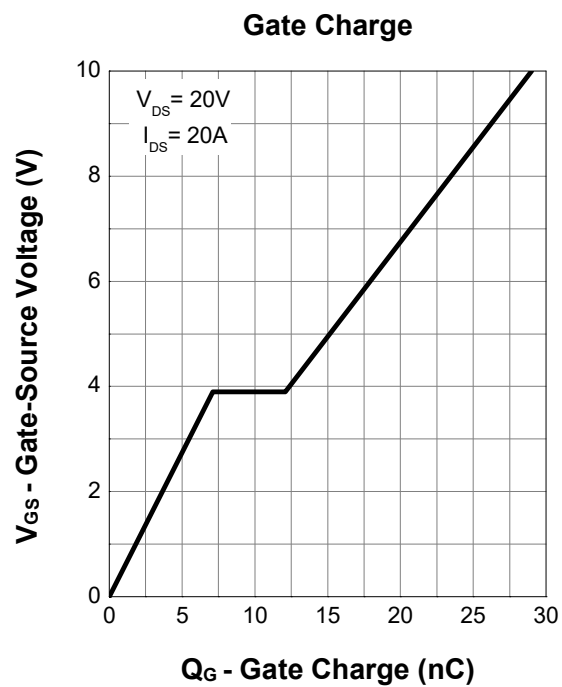
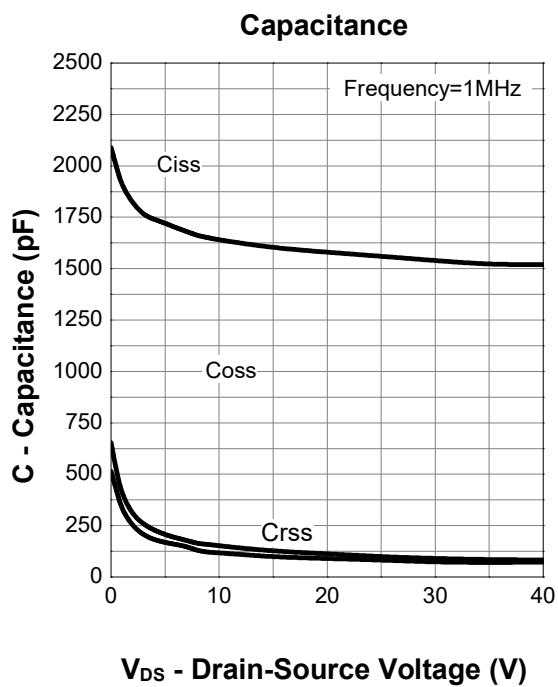
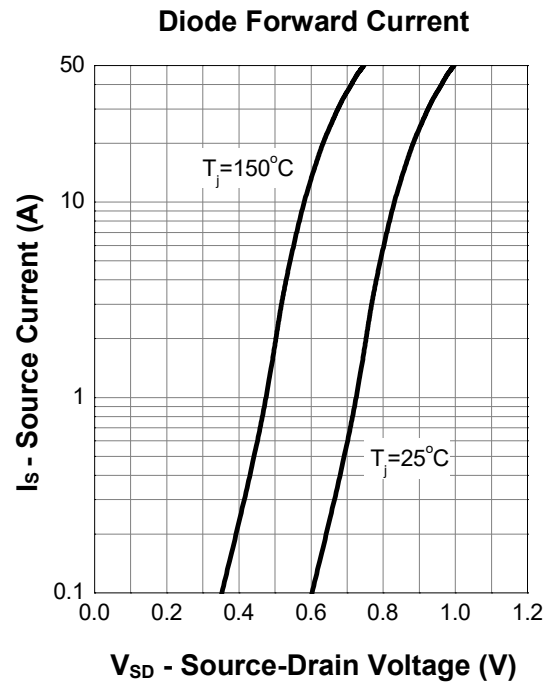
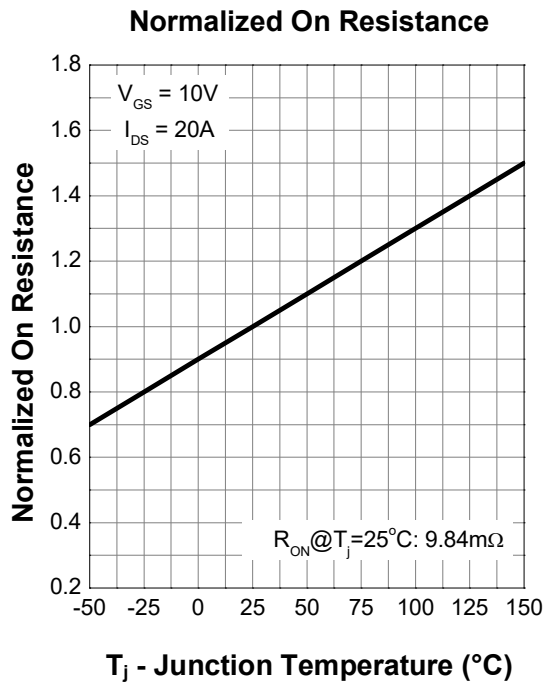
Transfer Characteristics



Normalized Threshold Voltage

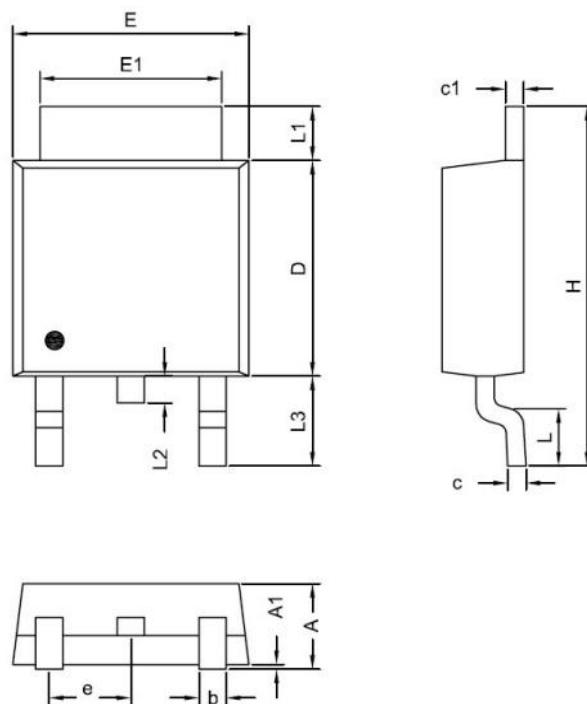


## 7. Typical Characteristics (Cont.)



## 8.Package Dimensions

TO252-3L



| Symbol | Dimensions In Millimeters |       |
|--------|---------------------------|-------|
|        | MIN.                      | MAX.  |
| A      | 2.19                      | 2.38  |
| A1     | 0.02                      | 0.13  |
| D      | 5.30                      | 6.40  |
| E      | 6.35                      | 6.80  |
| E1     | 5.20                      | 5.50  |
| c      | 0.40                      | 0.60  |
| c1     | 0.40                      | 0.60  |
| b      | 0.55                      | 0.85  |
| e      | 2.30 BCS                  |       |
| L      | 1.00                      | 1.80  |
| L1     | 0.70                      | 1.80  |
| L2     | 0.70 BCS                  |       |
| L3     | 2.40                      | 2.80  |
| H      | 9.20                      | 10.40 |