

## N-Channel 650V (D-S) Super Junction Power MOSFET

### PRODUCT SUMMARY

|                                         |                 |       |
|-----------------------------------------|-----------------|-------|
| $V_{DS}$ (V) at $T_J$ max.              | 650             |       |
| $R_{DS(on)}$ typ. ( $\Omega$ ) at 25 °C | $V_{GS} = 10$ V | 0.560 |

### FEATURES

- Low figure-of-merit (FOM)  $R_{on} \times Q_g$
- Low input capacitance ( $C_{iss}$ )
- Reduced switching and conduction losses
- Ultra low gate charge ( $Q_g$ )
- Avalanche energy rated (UIS)

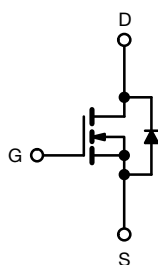


**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

TO-252



Top View



N-Channel MOSFET

### APPLICATIONS

- Server and telecom power supplies
- Switch mode power supplies (SMPS)
- Power factor correction power supplies (PFC)
- Lighting
  - High-intensity discharge (HID)
  - Fluorescent ballast lighting
- Industrial
  - Welding
  - Induction heating
  - Motor drives
  - Battery chargers
  - Renewable energy
  - Solar (PV inverters)

### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted)

| PARAMETER                                                 |                         |                         | SYMBOL                            | LIMIT       | UNIT |
|-----------------------------------------------------------|-------------------------|-------------------------|-----------------------------------|-------------|------|
| Drain-source voltage                                      |                         |                         | V <sub>DS</sub>                   | 650         | V    |
| Gate-source voltage                                       |                         |                         | V <sub>GS</sub>                   | ± 30        |      |
| Continuous drain current (T <sub>J</sub> = 150 °C)        | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub>                    | 8           | A    |
|                                                           |                         | T <sub>C</sub> = 100 °C |                                   | 5           |      |
| Pulsed drain current <sup>a</sup>                         |                         |                         | I <sub>DM</sub>                   | 24          |      |
| Linear derating factor                                    |                         |                         |                                   | 1.7         | W/°C |
| Single pulse avalanche energy <sup>b</sup>                |                         |                         | E <sub>AS</sub>                   | 330         | mJ   |
| Maximum power dissipation                                 |                         |                         | P <sub>D</sub>                    | 180         | W    |
| Operating junction and storage temperature range          |                         |                         | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150 | °C   |
| Drain-source voltage slope                                | T <sub>J</sub> = 125 °C |                         | dV/dt                             | 50          | V/ns |
| Reverse diode dV/dt <sup>d</sup>                          |                         | 5.1                     |                                   |             |      |
| Soldering recommendations (peak temperature) <sup>c</sup> | For 10 s                |                         |                                   | 260         | °C   |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature
- $V_{DD} = 100$  V, starting  $T_J = 25$  °C,  $L = 30$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 4$  A
- 1.6 mm from case
- $I_{SD} \leq I_D$ ,  $dI/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C

**THERMAL RESISTANCE RATINGS**

| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum junction-to-ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum junction-to-case (drain) | $R_{thJC}$ | -    | 0.85 |      |

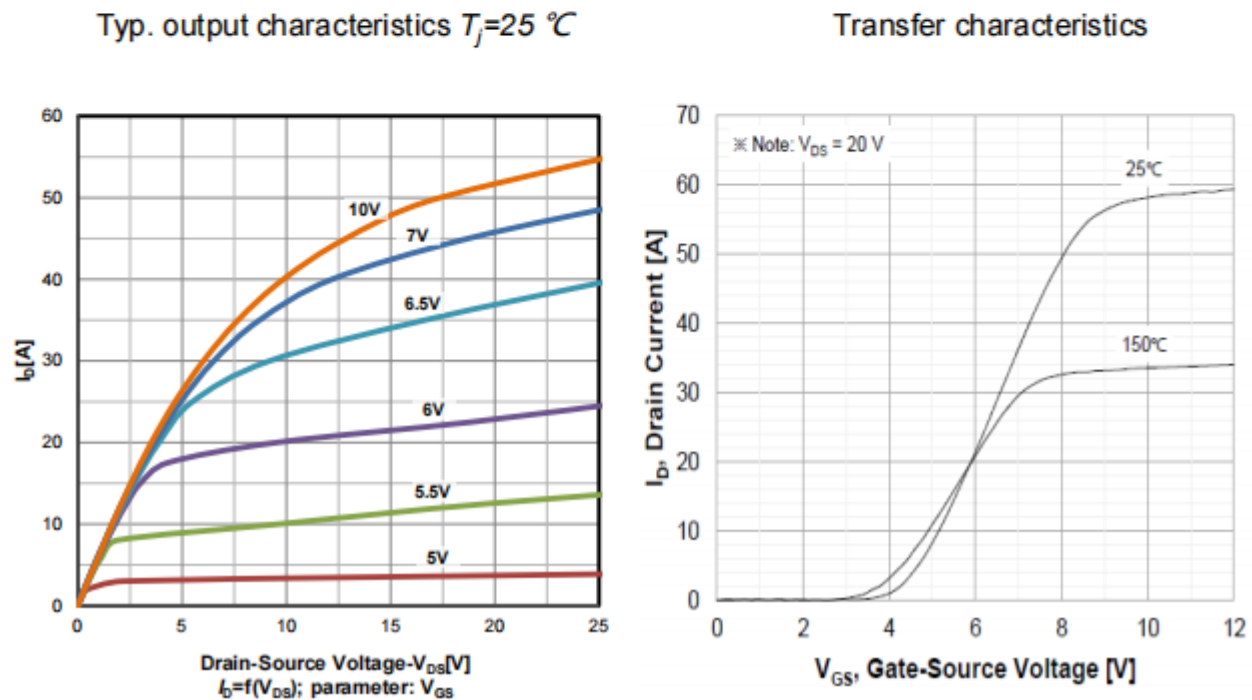
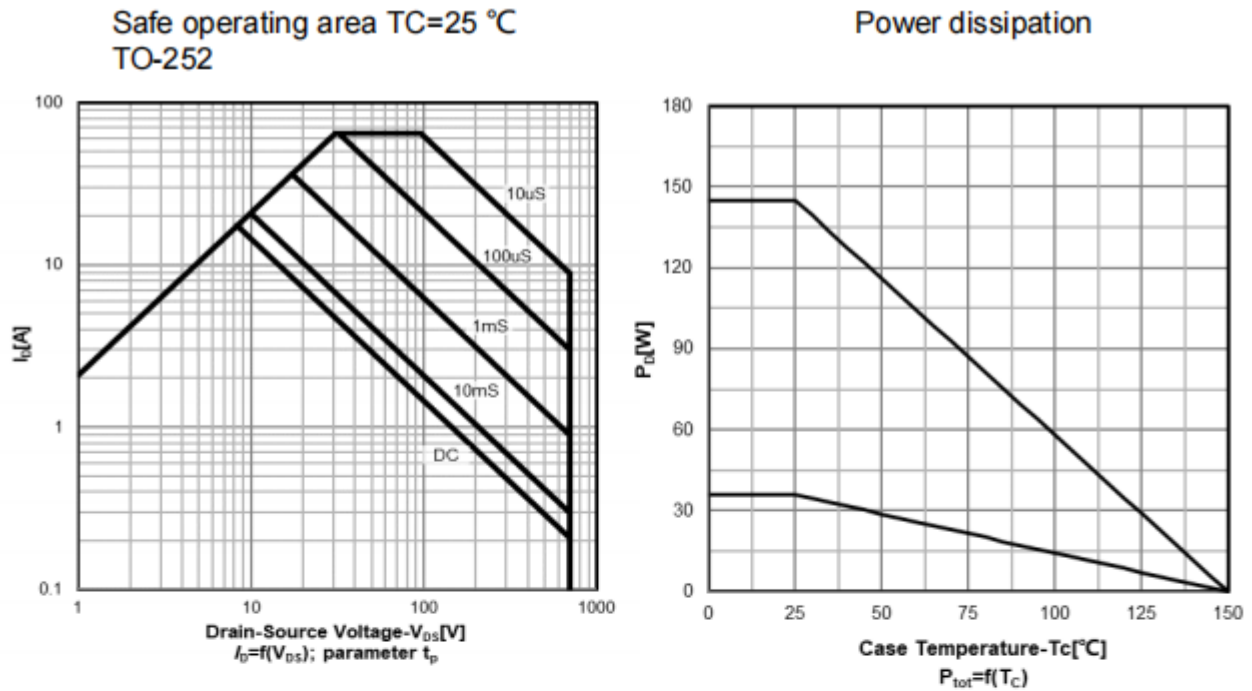
**SPECIFICATIONS** ( $T_J = 25\text{ °C}$ , unless otherwise noted)

| PARAMETER                                                 | SYMBOL              | TEST CONDITIONS                                                                                                                                          |                                              | MIN. | TYP.  | MAX.      | UNIT                |
|-----------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|------|-------|-----------|---------------------|
| Static                                                    |                     |                                                                                                                                                          |                                              |      |       |           |                     |
| Drain-source breakdown voltage                            | $V_{DS}$            | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                   |                                              | 650  | -     | -         | V                   |
| $V_{DS}$ temperature coefficient                          | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$                                                                                            |                                              | -    | 1.08  | -         | V/ $^\circ\text{C}$ |
| Gate-source threshold Voltage (N)                         | $V_{GS(th)}$        | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                       |                                              | 2.0  | -     | 4.0       | V                   |
| Gate-source leakage                                       | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$                                                                                                                               |                                              | -    | -     | $\pm 100$ | nA                  |
|                                                           |                     | $V_{GS} = \pm 30\text{ V}$                                                                                                                               |                                              | -    | -     | $\pm 1$   | $\mu\text{A}$       |
| Zero gate voltage drain current                           | $I_{DSS}$           | $V_{DS} = 650\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                          |                                              | -    | -     | 1         | $\mu\text{A}$       |
|                                                           |                     | $V_{DS} = 520\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$                                                                      |                                              | -    | -     | 10        |                     |
| Drain-source on-state resistance                          | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$                                                                                                                                   | $I_D = 2.5\text{ A}$                         | -    | 0.560 | -         | $\Omega$            |
| Forward transconductance                                  | $g_{fs}$            | $V_{DS} = 30\text{ V}$ , $I_D = 8\text{ A}$                                                                                                              |                                              | -    | 8.7   | -         | S                   |
| Dynamic                                                   |                     |                                                                                                                                                          |                                              |      |       |           |                     |
| Input capacitance                                         | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 100\text{ V}$ ,<br>$f = 1\text{ MHz}$                                                                               |                                              | -    | 2300  | -         | pF                  |
| Output capacitance                                        | $C_{oss}$           |                                                                                                                                                          |                                              | -    | 51    | -         |                     |
| Reverse transfer capacitance                              | $C_{rss}$           |                                                                                                                                                          |                                              | -    | 12    | -         |                     |
| Effective output capacitance, energy related <sup>a</sup> | $C_{o(er)}$         | $V_{DS} = 0\text{ V to } 480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                           |                                              | -    | 52    | -         |                     |
| Effective output capacitance, time related <sup>b</sup>   | $C_{o(tr)}$         |                                                                                                                                                          |                                              | -    | 205   | -         |                     |
| Total gate charge                                         | $Q_g$               | $V_{GS} = 10\text{ V}$                                                                                                                                   | $I_D = 8\text{ A}$ , $V_{DS} = 480\text{ V}$ | -    | 25    | -         | nC                  |
| Gate-source charge                                        | $Q_{gs}$            |                                                                                                                                                          |                                              | -    | 8     | -         |                     |
| Gate-drain charge                                         | $Q_{gd}$            |                                                                                                                                                          |                                              | -    | 10    | -         |                     |
| Turn-on delay time                                        | $t_{d(on)}$         | $V_{DD} = 480\text{ V}$ , $I_D = 8\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ , $R_g = 9.1\text{ }\Omega$                                                     |                                              | -    | 12    | 24        | ns                  |
| Rise time                                                 | $t_r$               |                                                                                                                                                          |                                              | -    | 14    | 23        |                     |
| Turn-off delay time                                       | $t_{d(off)}$        |                                                                                                                                                          |                                              | -    | 61    | 110       |                     |
| Fall time                                                 | $t_f$               |                                                                                                                                                          |                                              | -    | 16    | -         |                     |
| Gate input resistance                                     | $R_g$               | $f = 1\text{ MHz}$ , open drain                                                                                                                          |                                              | 0.3  | 0.7   | 1.4       | $\Omega$            |
| Drain-Source Body Diode Characteristics                   |                     |                                                                                                                                                          |                                              |      |       |           |                     |
| Continuous source-drain diode current                     | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                              | -    | -     | 8         | A                   |
| Pulsed diode forward current                              | $I_{SM}$            |                                                                                                                                                          |                                              | -    | -     | 24        |                     |
| Diode forward voltage                                     | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_S = 8\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                            |                                              | -    | -     | 1.2       | V                   |
| Reverse recovery time                                     | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_F = I_S = 8\text{ A}$ ,<br>$dI/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 25\text{ V}$                                |                                              | -    | 416   | 832       | ns                  |
| Reverse recovery charge                                   | $Q_{rr}$            |                                                                                                                                                          |                                              | -    | 6.4   | 12.8      | $\mu\text{C}$       |
| Reverse recovery current                                  | $I_{RRM}$           |                                                                                                                                                          |                                              | -    | 27    | -         | A                   |

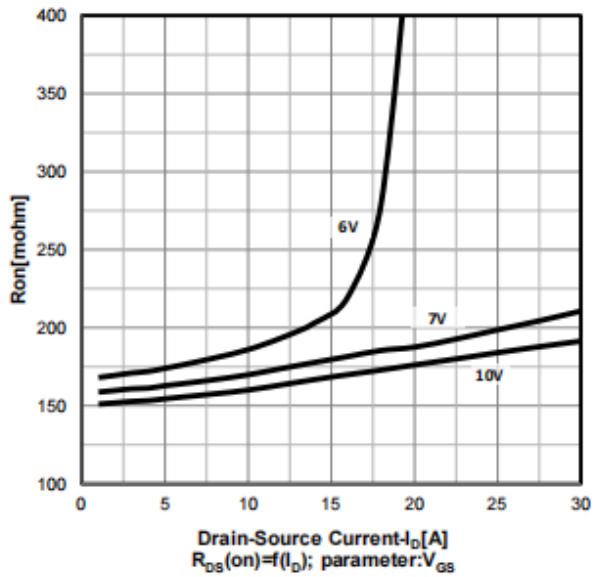
**Notes**

- a.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$   
 b.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$

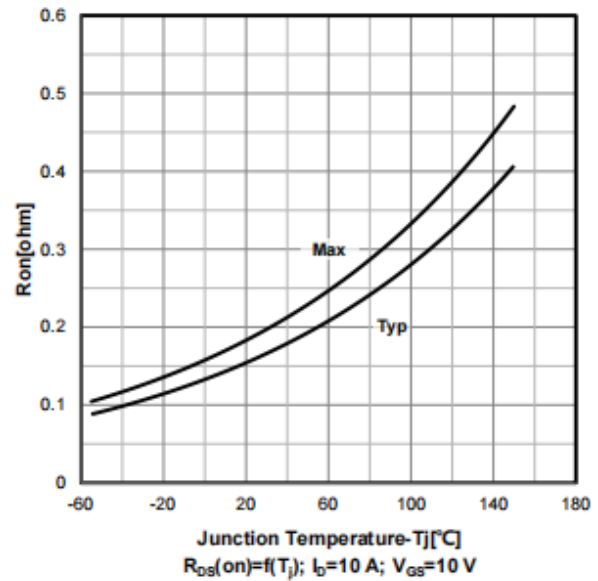
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



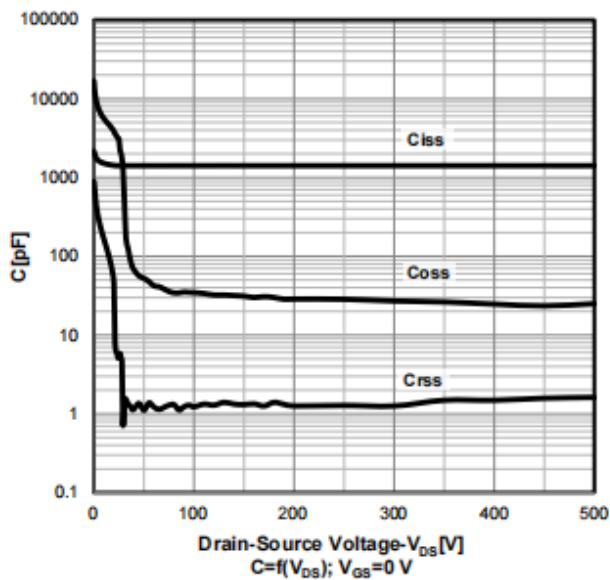
Typ. drain-source on-state resistance



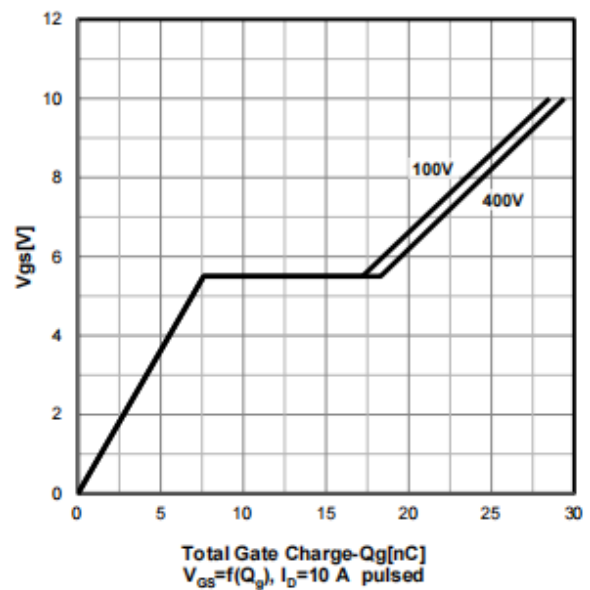
On-resistance vs temperature



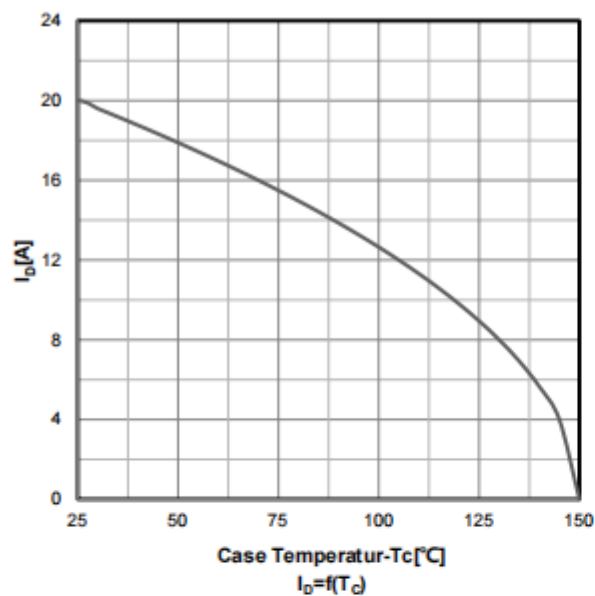
Typ. capacitances



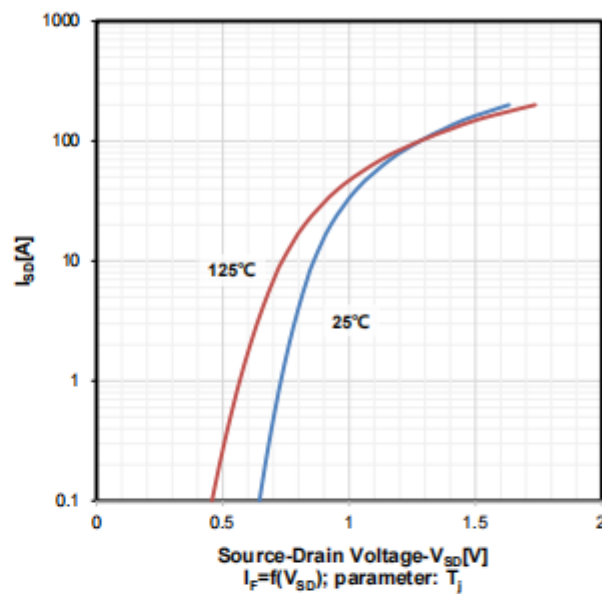
Typ. gate charge characteristics



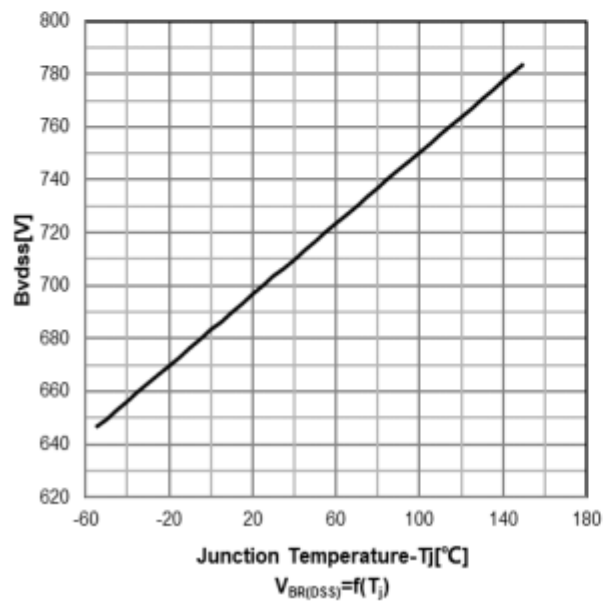
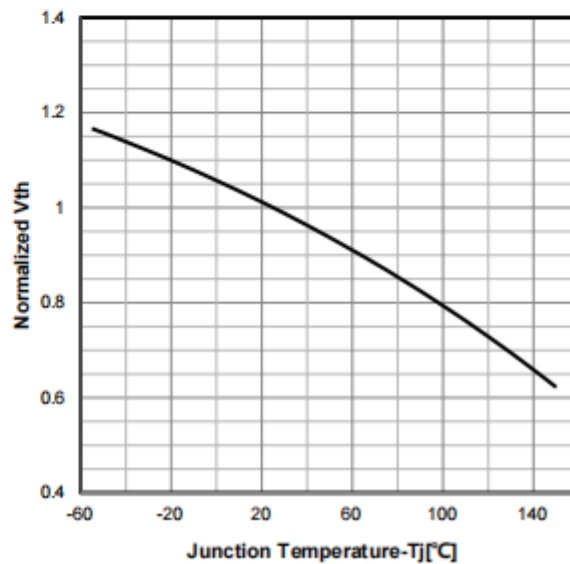
Drain current vs temperature



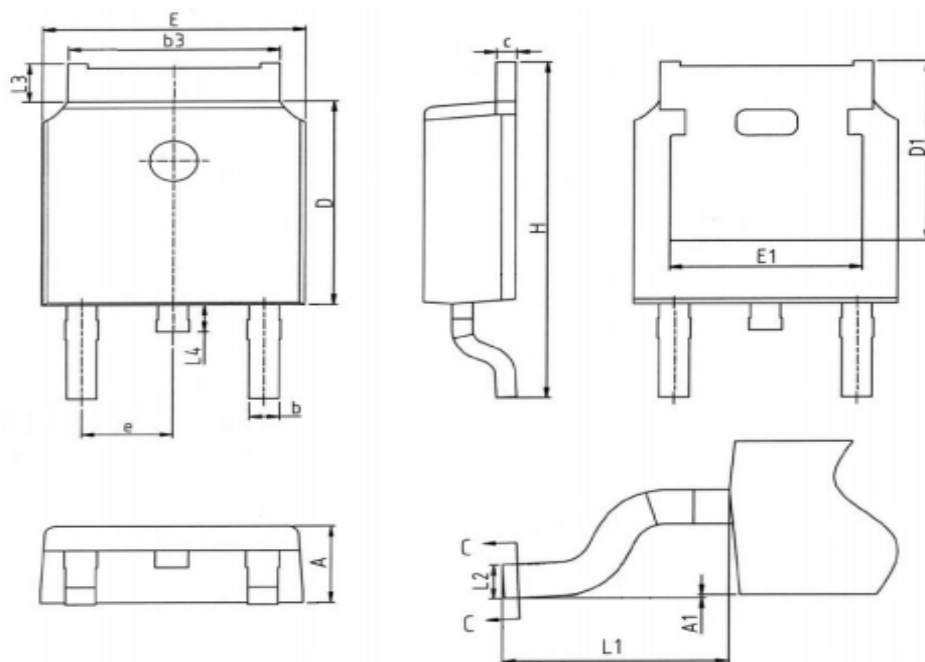
Forward characteristics of reverse diode



Drain-source breakdown voltage

Normalized  $V_{GS(th)}$  characteristics

Package Outline : TO 252



COMMON DIMENSIONS

| SYMBOL | UNIT(mm) |       |       |
|--------|----------|-------|-------|
|        | MIN      | NOM   | MAX   |
| A      | 2.20     | 2.30  | 2.40  |
| A1     | 0.00     | -     | 0.127 |
| b      | 0.66     | 0.78  | 0.90  |
| b3     | 5.16     | 5.31  | 5.46  |
| c      | 0.43     | 0.53  | 0.63  |
| D      | 5.98     | 6.10  | 6.22  |
| D1     | 5.30REF  |       |       |
| E      | 6.40     | 6.60  | 6.75  |
| E1     | 4.63     | -     | -     |
| e      | 2.286BSC |       |       |
| H      | 9.40     | 10.10 | 10.50 |
| L1     | 2.90REF  |       |       |
| L2     | 0.51BSC  |       |       |
| L3     | 0.88     | 1.08  | 1.28  |
| L4     | 0.50     | 0.80  | 1.00  |

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