

# VBE5415 Datasheet

## N- and P-Channel 40 V (D-S) MOSFET

### PRODUCT SUMMARY

|                                                   | N-CHANNEL     | P-CHANNEL |
|---------------------------------------------------|---------------|-----------|
| $V_{DS}$ (V)                                      | 40            | - 40      |
| $R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = \pm 10$ V  | 0.014         | 0.014     |
| $R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = \pm 4.5$ V | 0.016         | 0.016     |
| $I_D$ (A)                                         | 50            | - 50      |
| Configuration                                     | N- and P-Pair |           |

### FEATURES

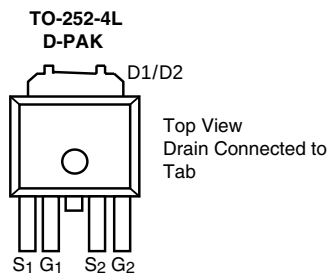
- Trench Power MOSFET
- 100 %  $R_g$  and UIS Tested

### APPLICATIONS

- CCFL Inverter



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



### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ , unless otherwise noted)

| PARAMETER                                                 |                         | SYMBOL                            | N-CHANNEL     | P-CHANNEL | UNIT |
|-----------------------------------------------------------|-------------------------|-----------------------------------|---------------|-----------|------|
| Drain-Source Voltage                                      |                         | V <sub>DS</sub>                   | 40            | - 40      | V    |
| Gate-Source Voltage                                       |                         | V <sub>GS</sub>                   | ± 20          |           |      |
| Continuous Drain Current <sup>a</sup>                     | T <sub>C</sub> = 25 °C  | I <sub>D</sub>                    | 50            | -50       | A    |
|                                                           | T <sub>C</sub> = 125 °C |                                   | 35            | -35       |      |
| Continuous Source Current (Diode Conduction) <sup>a</sup> |                         | I <sub>S</sub>                    | 50            | -50       |      |
| Pulsed Drain Current <sup>b</sup>                         |                         | I <sub>DM</sub>                   | 150           | -150      |      |
| Single Pulse Avalanche Current                            | L = 0.1 mH              | I <sub>AS</sub>                   | 30            | - 30      | mJ   |
| Single Pulse Avalanche Energy                             |                         | E <sub>AS</sub>                   | 245           | 245       |      |
| Maximum Power Dissipation <sup>b</sup>                    | T <sub>C</sub> = 25 °C  | P <sub>D</sub>                    | 108           | 108       | W    |
|                                                           | T <sub>C</sub> = 125 °C |                                   | 32            | 32        |      |
| Operating Junction and Storage Temperature Range          |                         | T <sub>J</sub> , T <sub>stg</sub> | - 55 to + 175 |           | °C   |
| Soldering Recommendations (Peak Temperature)              |                         |                                   | 260           |           |      |

### THERMAL RESISTANCE RATINGS

| PARAMETER                | SYMBOL     | N-CHANNEL | P-CHANNEL | UNIT               |
|--------------------------|------------|-----------|-----------|--------------------|
| Junction-to-Ambient      | $R_{thJA}$ | 85        | 85        | $^\circ\text{C/W}$ |
| Junction-to-Case (Drain) | $R_{thJC}$ | 3.1       | 3.1       |                    |

#### Notes

- Package limited.
- Pulse test; pulse width  $\leq 300 \mu\text{s}$ , duty cycle  $\leq 2\%$ .
- When mounted on 1" square PCB (FR4 material).
- Parametric verification ongoing.

| SPECIFICATIONS (T <sub>C</sub> = 25 °C, unless otherwise noted) |                     |                                                               |                                                   |      |       |       |       |      |
|-----------------------------------------------------------------|---------------------|---------------------------------------------------------------|---------------------------------------------------|------|-------|-------|-------|------|
| PARAMETER                                                       | SYMBOL              | TEST CONDITIONS                                               |                                                   |      | MIN.  | TYP.  | MAX.  | UNIT |
| Static                                                          |                     |                                                               |                                                   |      |       |       |       |      |
| Drain-Source Breakdown Voltage                                  | V <sub>DS</sub>     | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                |                                                   | N-Ch | 40    | -     | -     | V    |
|                                                                 |                     | V <sub>GS</sub> = 0 V, I <sub>D</sub> = - 250 μA              |                                                   | P-Ch | - 40  | -     | -     |      |
| Gate-Source Threshold Voltage                                   | V <sub>GS(th)</sub> | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA   |                                                   | N-Ch | 1.0   | -     | 3.0   |      |
|                                                                 |                     | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = - 250 μA |                                                   | P-Ch | - 1.0 | -     | -3.0  |      |
| Gate-Source Leakage                                             | I <sub>GSS</sub>    | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 20 V               |                                                   | N-Ch | -     | -     | ± 100 | nA   |
|                                                                 |                     |                                                               |                                                   | P-Ch | -     | -     | ± 100 |      |
| Zero Gate Voltage Drain Current                                 | I <sub>DSS</sub>    | V <sub>GS</sub> = 0 V                                         | V <sub>DS</sub> = 40 V                            | N-Ch | -     | -     | 1     | μA   |
|                                                                 |                     | V <sub>GS</sub> = 0 V                                         | V <sub>DS</sub> = - 40 V                          | P-Ch | -     | -     | - 1   |      |
|                                                                 |                     | V <sub>GS</sub> = 0 V                                         | V <sub>DS</sub> = 40 V, T <sub>J</sub> = 125 °C   | N-Ch | -     | -     | 50    |      |
|                                                                 |                     | V <sub>GS</sub> = 0 V                                         | V <sub>DS</sub> = - 40 V, T <sub>J</sub> = 125 °C | P-Ch | -     | -     | - 50  |      |
|                                                                 |                     | V <sub>GS</sub> = 0 V                                         | V <sub>DS</sub> = 40 V, T <sub>J</sub> = 175 °C   | N-Ch | -     | -     | 150   |      |
|                                                                 |                     | V <sub>GS</sub> = 0 V                                         | V <sub>DS</sub> = - 40 V, T <sub>J</sub> = 175 °C | P-Ch | -     | -     | - 150 |      |
| On-State Drain Current <sup>a</sup>                             | I <sub>D(on)</sub>  | V <sub>GS</sub> = 10 V                                        | V <sub>DS</sub> ≥ 5 V                             | N-Ch | 25    | -     | -     | A    |
|                                                                 |                     | V <sub>GS</sub> = - 10 V                                      | V <sub>DS</sub> ≤ 5 V                             | P-Ch | - 25  | -     | -     |      |
| Drain-Source On-State Resistance <sup>a</sup>                   | R <sub>DS(on)</sub> | V <sub>GS</sub> = 10 V                                        | I <sub>D</sub> = 38 A                             | N-Ch | -     | 0.014 | -     | Ω    |
|                                                                 |                     | V <sub>GS</sub> = - 10 V                                      | I <sub>D</sub> = - 38 A                           | P-Ch | -     | 0.014 | -     |      |
|                                                                 |                     | V <sub>GS</sub> = 10 V                                        | I <sub>D</sub> = 38 A, T <sub>J</sub> = 125 °C    | N-Ch | -     | 0.017 | -     |      |
|                                                                 |                     | V <sub>GS</sub> = - 10 V                                      | I <sub>D</sub> = - 38 A, T <sub>J</sub> = 125 °C  | P-Ch | -     | 0.017 | -     |      |
|                                                                 |                     | V <sub>GS</sub> = 10 V                                        | I <sub>D</sub> = 38 A, T <sub>J</sub> = 175 °C    | N-Ch | -     | 0.025 | -     |      |
|                                                                 |                     | V <sub>GS</sub> = - 10 V                                      | I <sub>D</sub> = - 38 A, T <sub>J</sub> = 175 °C  | P-Ch | -     | 0.025 | -     |      |
|                                                                 |                     | V <sub>GS</sub> = 4.5 V                                       | I <sub>D</sub> = 30 A                             | N-Ch | -     | 0.016 | -     |      |
|                                                                 |                     | V <sub>GS</sub> = - 4.5 V                                     | I <sub>D</sub> = - 30A                            | P-Ch | -     | 0.016 | -     |      |
| Forward Transconductance <sup>b</sup>                           | g <sub>fs</sub>     | V <sub>DS</sub> = 15 V, I <sub>D</sub> = 38 A                 |                                                   | N-Ch | -     | 40    | -     | S    |
|                                                                 |                     | V <sub>DS</sub> = - 15 V, I <sub>D</sub> = - 38 A             |                                                   | P-Ch | -     | 18    | -     |      |
| Dynamic <sup>b</sup>                                            |                     |                                                               |                                                   |      |       |       |       |      |
| Input Capacitance                                               | C <sub>iss</sub>    | V <sub>GS</sub> = 0 V                                         | V <sub>DS</sub> = 20 V, f = 1 MHz                 | N-Ch | -     | 1799  | 2248  | pF   |
|                                                                 |                     | V <sub>GS</sub> = 0 V                                         | V <sub>DS</sub> = - 20 V, f = 1 MHz               | P-Ch | -     | 2000  | 3500  |      |
| Output Capacitance                                              | C <sub>oss</sub>    | V <sub>GS</sub> = 0 V                                         | V <sub>DS</sub> = 20 V, f = 1 MHz                 | N-Ch | -     | 282   | 352   |      |
|                                                                 |                     | V <sub>GS</sub> = 0 V                                         | V <sub>DS</sub> = - 20 V, f = 1 MHz               | P-Ch | -     | 320   | 550   |      |
| Reverse Transfer Capacitance                                    | C <sub>rss</sub>    | V <sub>GS</sub> = 0 V                                         | V <sub>DS</sub> = 20 V, f = 1 MHz                 | N-Ch | -     | 109   | 136   |      |
|                                                                 |                     | V <sub>GS</sub> = 0 V                                         | V <sub>DS</sub> = - 20 V, f = 1 MHz               | P-Ch | -     | 220   | 360   |      |
| Total Gate Charge <sup>c</sup>                                  | Q <sub>g</sub>      | V <sub>GS</sub> = 10 V                                        | V <sub>DS</sub> = 20 V, I <sub>D</sub> = 10 A     | N-Ch | -     | 310   | -     | nC   |
|                                                                 |                     | V <sub>GS</sub> = - 10 V                                      | V <sub>DS</sub> = - 20 V, I <sub>D</sub> = - 10 A | P-Ch | -     | 420   | -     |      |
| Gate-Source Charge <sup>c</sup>                                 | Q <sub>gs</sub>     | V <sub>GS</sub> = 10 V                                        | V <sub>DS</sub> = 20 V, I <sub>D</sub> = 10 A     | N-Ch | -     | 5.7   | -     |      |
|                                                                 |                     | V <sub>GS</sub> = - 10 V                                      | V <sub>DS</sub> = - 20 V, I <sub>D</sub> = - 10 A | P-Ch | -     | 5.5   | -     |      |
| Gate-Drain Charge <sup>c</sup>                                  | Q <sub>gd</sub>     | V <sub>GS</sub> = 10 V                                        | V <sub>DS</sub> = 20 V, I <sub>D</sub> = 10 A     | N-Ch | -     | 4.8   | -     |      |
|                                                                 |                     | V <sub>GS</sub> = - 10 V                                      | V <sub>DS</sub> = - 20 V, I <sub>D</sub> = - 10 A | P-Ch | -     | 10.5  | -     |      |
| Gate Resistance                                                 | R <sub>g</sub>      | f = 1 MHz                                                     |                                                   | N-Ch | 2     | 4.11  | 6.2   | Ω    |
|                                                                 |                     |                                                               |                                                   | P-Ch | 3.1   | 6.3   | 9.5   |      |

**Notes**

- a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .  
 b. Guaranteed by design, not subject to production testing.  
 c. Independent of operating temperature.

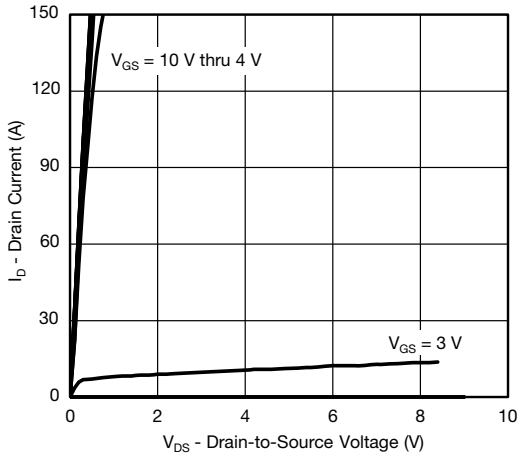
| SPECIFICATIONS (T <sub>C</sub> = 25 °C, unless otherwise noted) |                     |                                                                                                                            |      |      |        |       |      |
|-----------------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------|------|------|--------|-------|------|
| PARAMETER                                                       | SYMBOL              | TEST CONDITIONS                                                                                                            |      | MIN. | TYP.   | MAX.  | UNIT |
| Turn-On Delay Time <sup>c</sup>                                 | t <sub>d(on)</sub>  | V <sub>DD</sub> = 20 V, R <sub>L</sub> = 2 Ω<br>I <sub>D</sub> ≅ 10 A, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 1 Ω       | N-Ch | -    | 7      | 11    | ns   |
|                                                                 |                     | V <sub>DD</sub> = - 20 V, R <sub>L</sub> = 2 Ω<br>I <sub>D</sub> ≅ - 10 A, V <sub>GEN</sub> = - 10 V, R <sub>g</sub> = 1 Ω | P-Ch | -    | 11     | 17    |      |
| Rise Time <sup>c</sup>                                          | t <sub>r</sub>      | V <sub>DD</sub> = 20 V, R <sub>L</sub> = 2 Ω<br>I <sub>D</sub> ≅ 10 A, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 1 Ω       | N-Ch | -    | 21     | 32    |      |
|                                                                 |                     | V <sub>DD</sub> = - 20 V, R <sub>L</sub> = 2 Ω<br>I <sub>D</sub> ≅ - 10 A, V <sub>GEN</sub> = - 10 V, R <sub>g</sub> = 1 Ω | P-Ch | -    | 9      | 14    |      |
| Turn-Off Delay Time <sup>c</sup>                                | t <sub>d(off)</sub> | V <sub>DD</sub> = 20 V, R <sub>L</sub> = 2 Ω<br>I <sub>D</sub> ≅ 10 A, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 1 Ω       | N-Ch | -    | 33     | 50    |      |
|                                                                 |                     | V <sub>DD</sub> = - 20 V, R <sub>L</sub> = 2 Ω<br>I <sub>D</sub> ≅ - 10 A, V <sub>GEN</sub> = - 10 V, R <sub>g</sub> = 1 Ω | P-Ch | -    | 55     | 83    |      |
| Fall Time <sup>c</sup>                                          | t <sub>f</sub>      | V <sub>DD</sub> = 20 V, R <sub>L</sub> = 2 Ω<br>I <sub>D</sub> ≅ 10 A, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 1 Ω       | N-Ch | -    | 19     | 29    |      |
|                                                                 |                     | V <sub>DD</sub> = - 20 V, R <sub>L</sub> = 2 Ω<br>I <sub>D</sub> ≅ - 10 A, V <sub>GEN</sub> = - 10 V, R <sub>g</sub> = 1 Ω | P-Ch | -    | 91     | 137   |      |
| Source-Drain Diode Ratings and Characteristics <sup>b</sup>     |                     |                                                                                                                            |      |      |        |       |      |
| Pulsed Current <sup>a</sup>                                     | I <sub>SM</sub>     |                                                                                                                            | N-Ch | -    | -      | 32    | A    |
|                                                                 |                     |                                                                                                                            | P-Ch | -    | -      | - 32  |      |
| Forward Voltage                                                 | V <sub>SD</sub>     | I <sub>S</sub> = 4 A                                                                                                       | N-Ch | -    | 0.79   | 1.2   | V    |
|                                                                 |                     | I <sub>S</sub> = - 4 A                                                                                                     | P-Ch | -    | - 0.82 | - 1.2 |      |

**Notes**

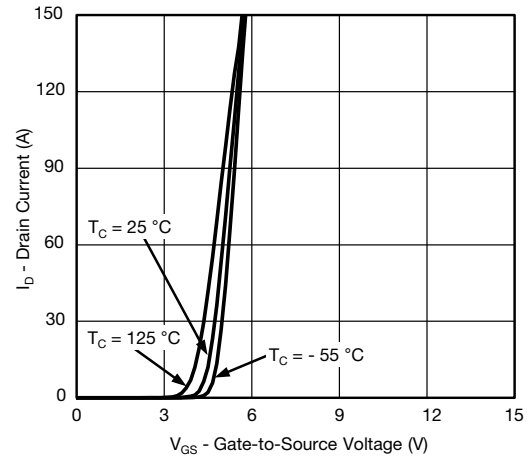
- a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .  
 b. Guaranteed by design, not subject to production testing.  
 c. Independent of operating temperature.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

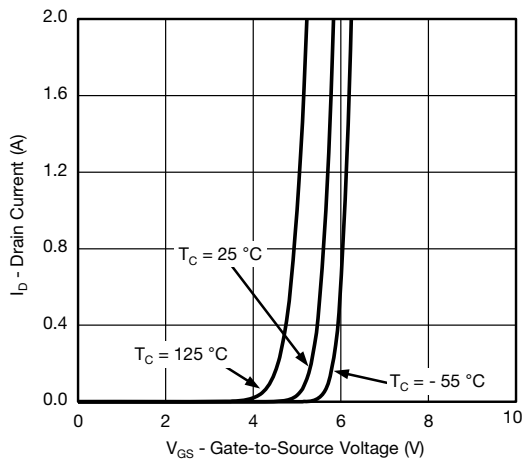
**N-CHANNEL TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)



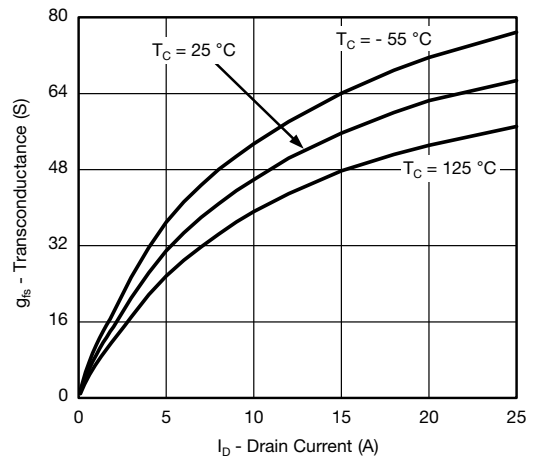
**Output Characteristics**



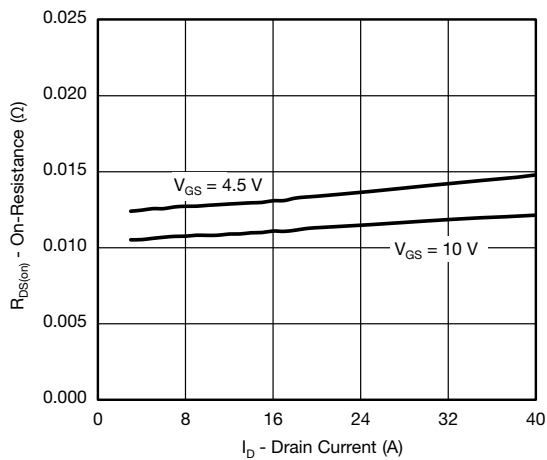
**Transfer Characteristics**



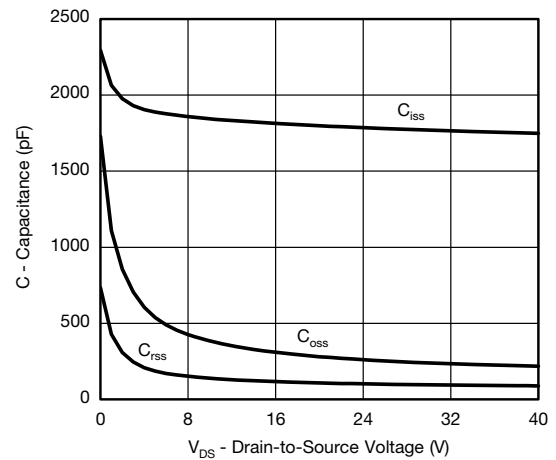
**Transfer Characteristics**



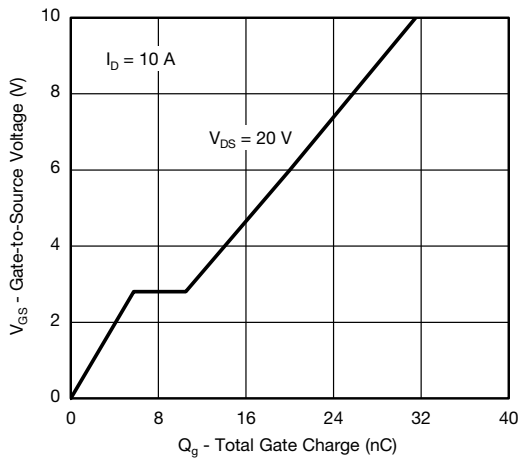
**Transconductance**



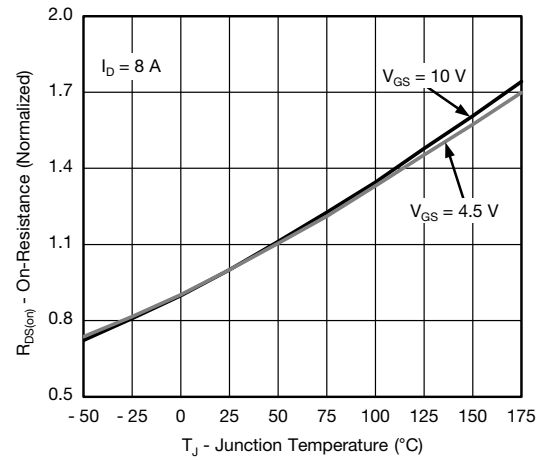
**On-Resistance vs. Drain Current**



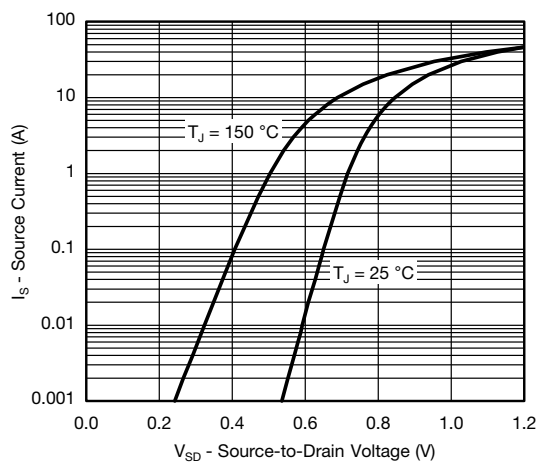
**Capacitance**

**N-CHANNEL TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)


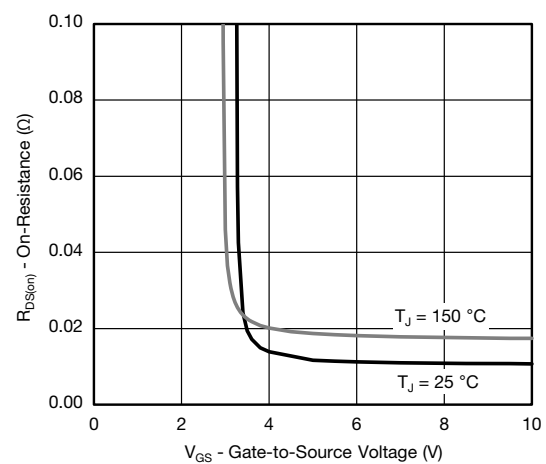
Gate Charge



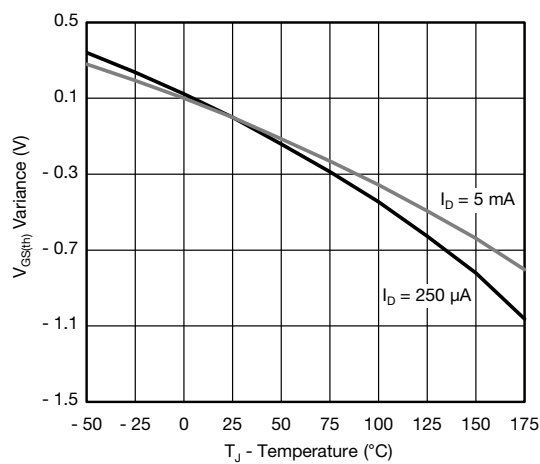
On-Resistance vs. Junction Temperature



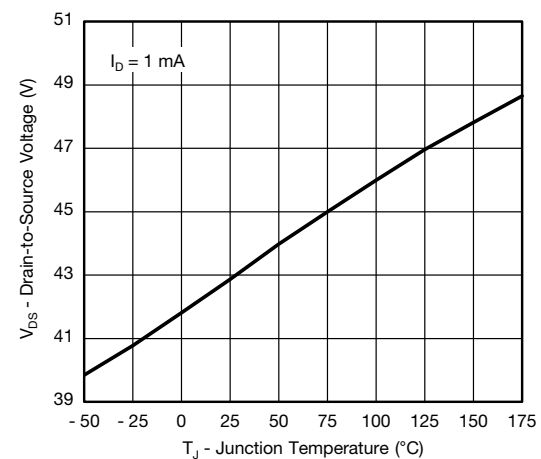
Source Drain Diode Forward Voltage



On-Resistance vs. Gate-to-Source Voltage

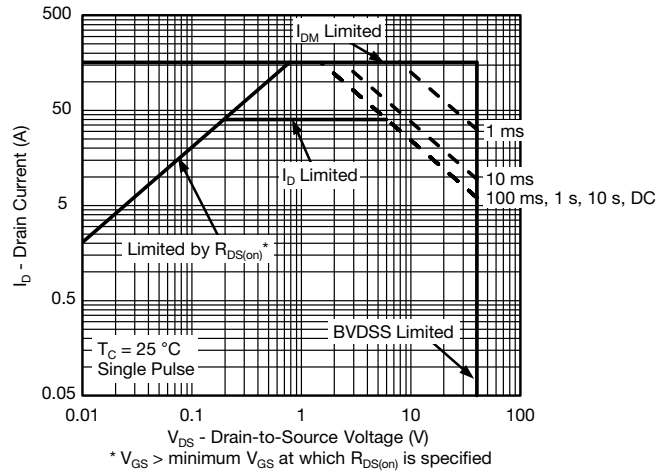


Threshold Voltage

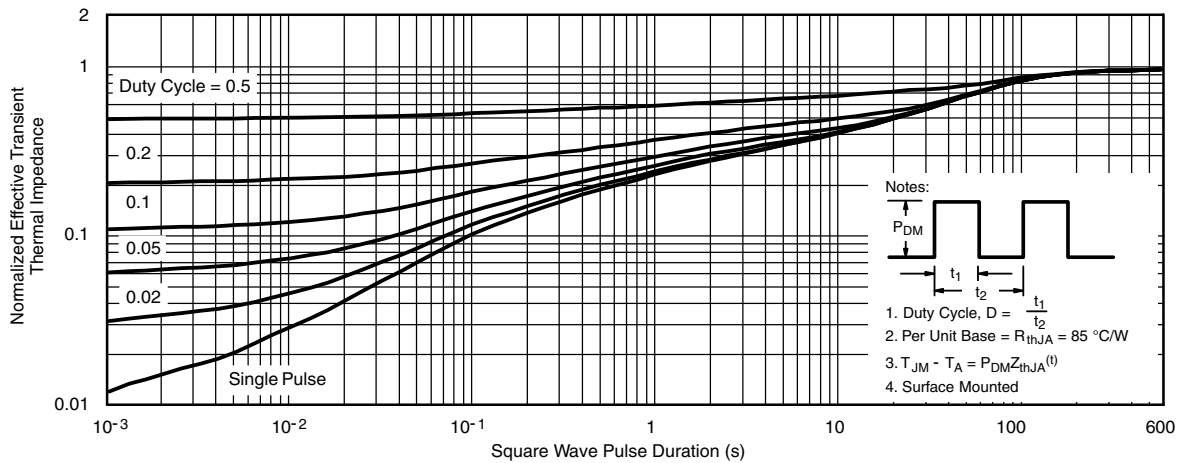


Drain Source Breakdown vs. Junction Temperature

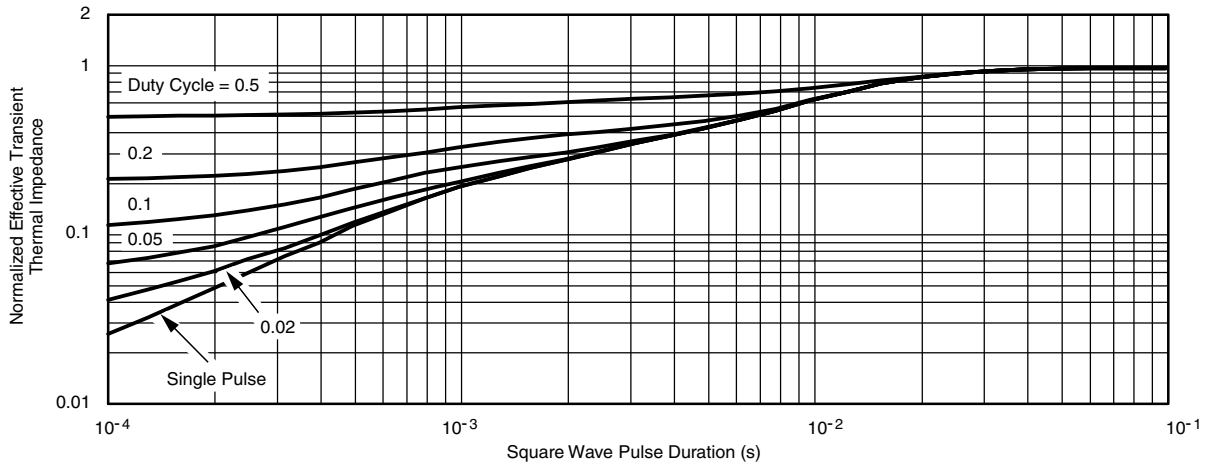
**N-CHANNEL TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)



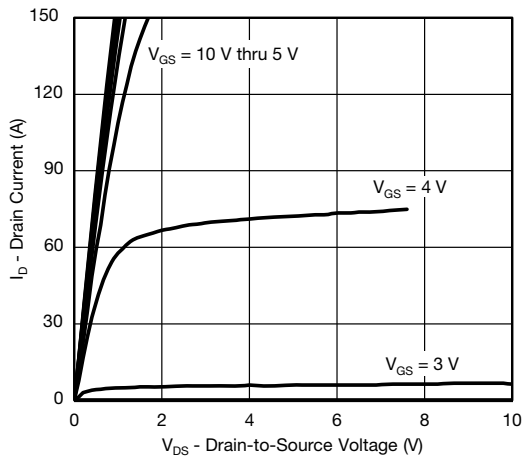
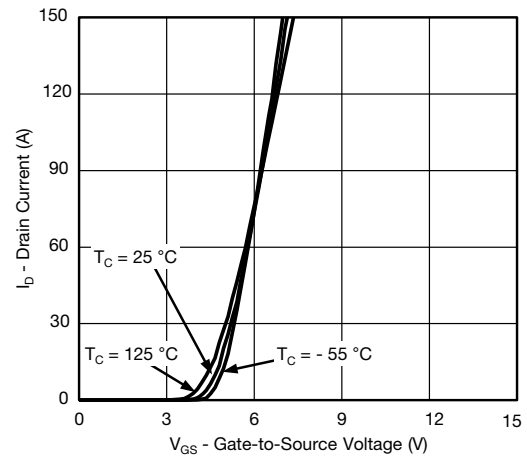
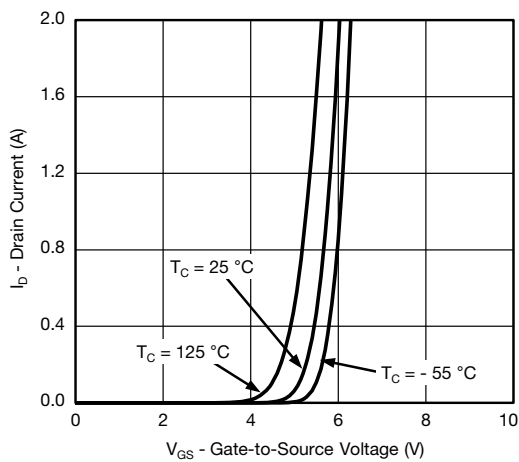
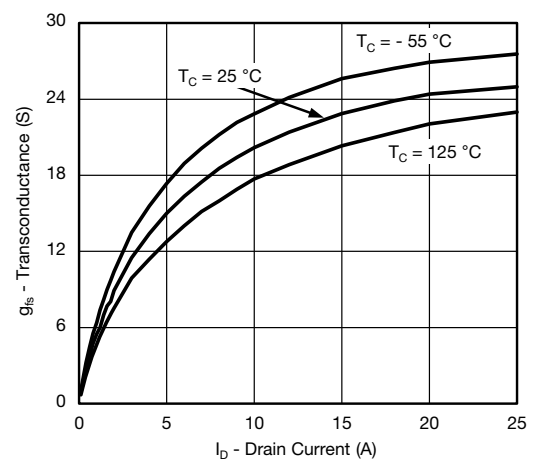
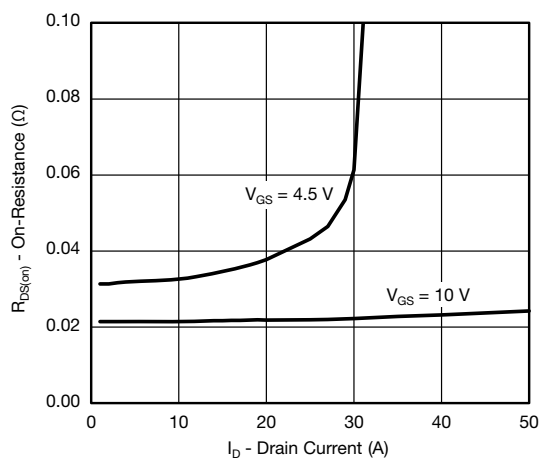
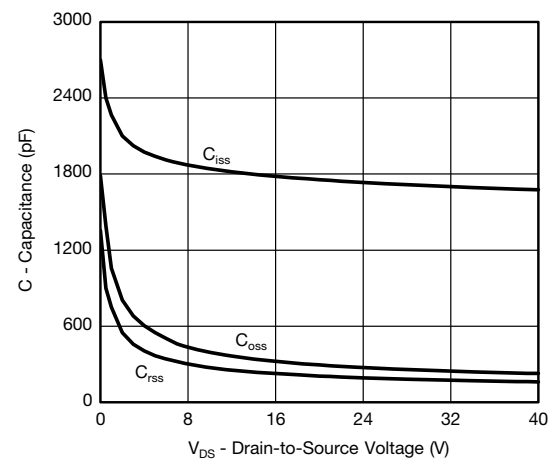
**Safe Operating Area**

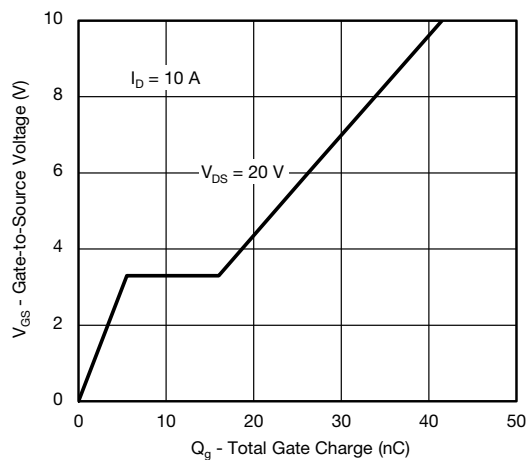


**Normalized Thermal Transient Impedance, Junction-to-Ambient**

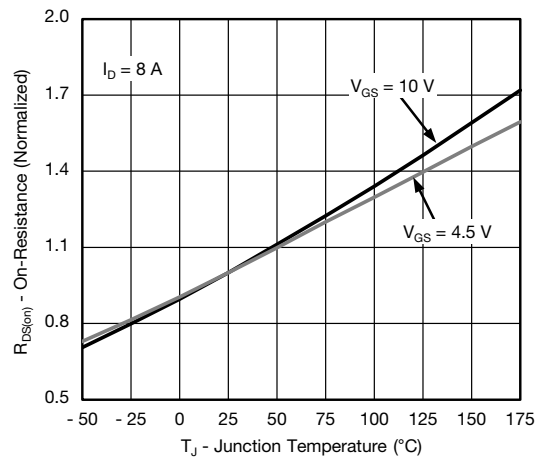
**N-CHANNEL TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

**Normalized Thermal Transient Impedance, Junction-to-Case**
**Note**

- The characteristics shown in the two graphs
  - Normalized Transient Thermal Impedance Junction-to-Ambient ( $25\text{ }^{\circ}\text{C}$ )
  - Normalized Transient Thermal Impedance Junction-to-Case ( $25\text{ }^{\circ}\text{C}$ )
 are given for general guidelines only to enable the user to get a "ball park" indication of part capabilities. The data are extracted from single pulse transient thermal impedance characteristics which are developed from empirical measurements. The latter is valid for the part mounted on printed circuit board - FR4, size 1" x 1" x 0.062", double sided with 2 oz. copper, 100 % on both sides. The part capabilities can widely vary depending on actual application parameters and operating conditions.

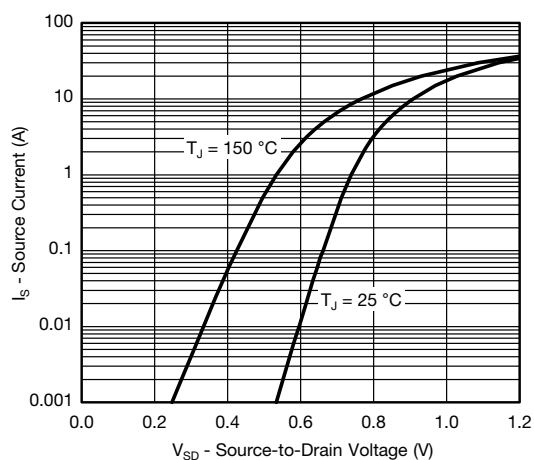
**P-CHANNEL TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

**Output Characteristics**

**Transfer Characteristics**

**Transfer Characteristics**

**Transconductance**

**On-Resistance vs. Drain Current**

**Capacitance**

**P-CHANNEL TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)


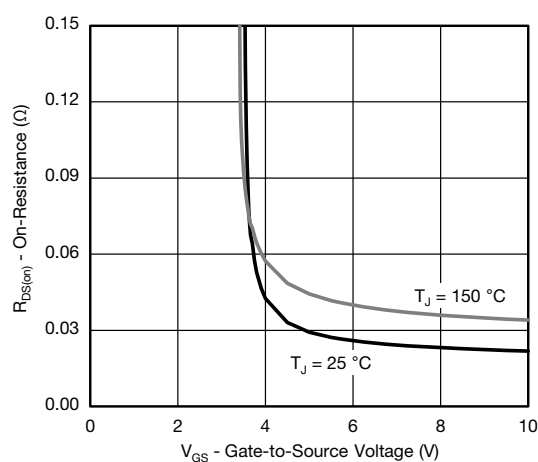
Gate Charge



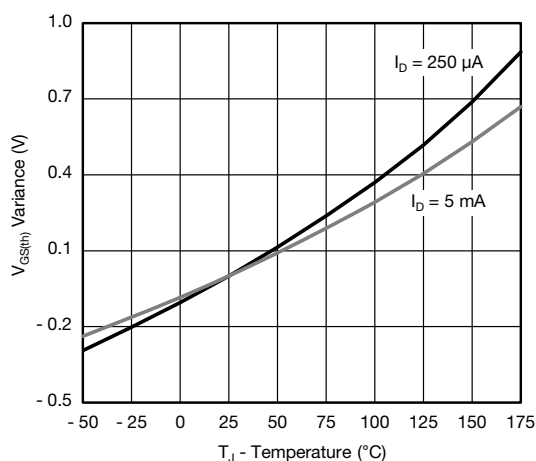
On-Resistance vs. Junction Temperature



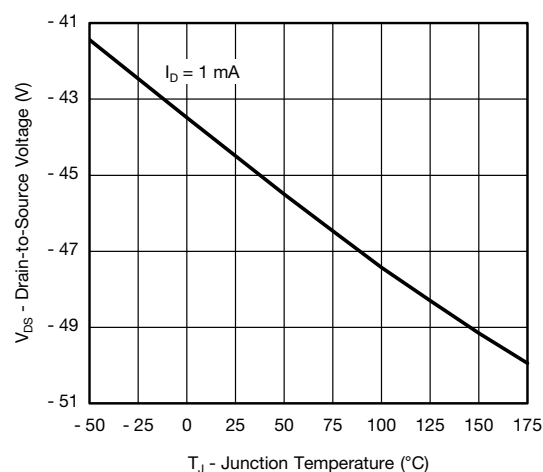
Source Drain Diode Forward Voltage



On-Resistance vs. Gate-to-Source Voltage

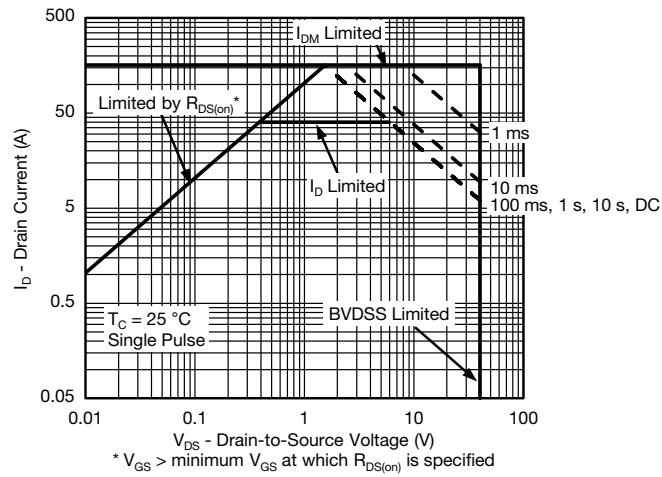


Threshold Voltage

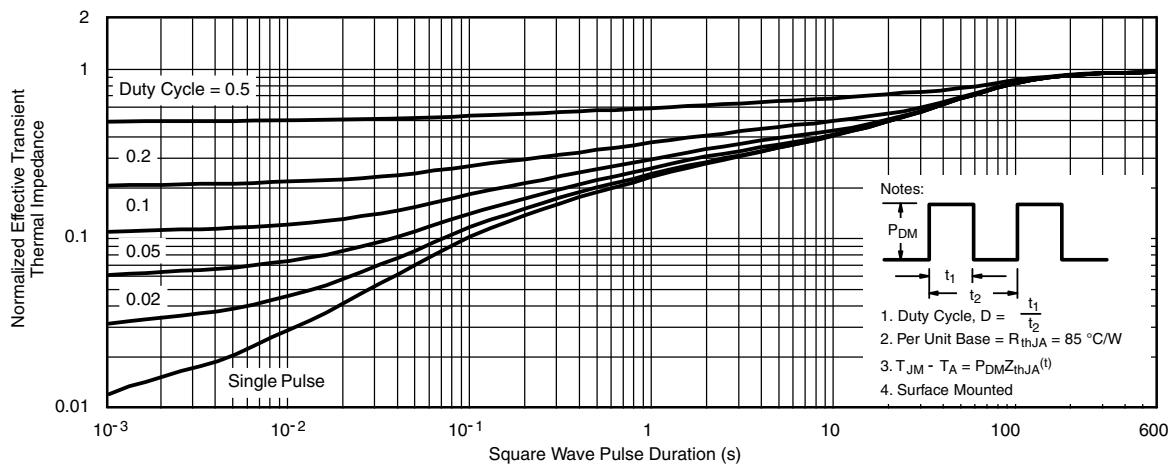


Drain Source Breakdown vs. Junction Temperature

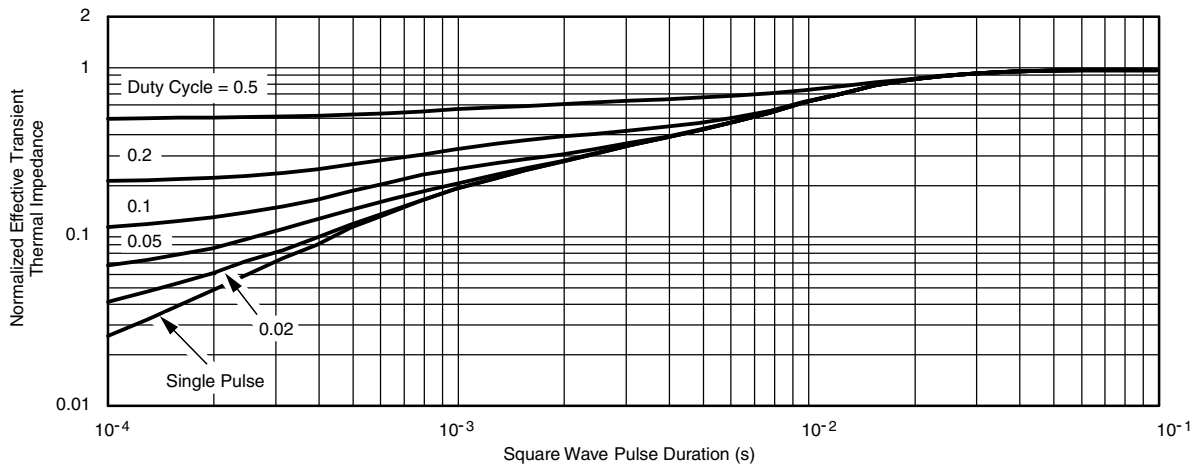
**P-CHANNEL TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)



**Safe Operating Area**

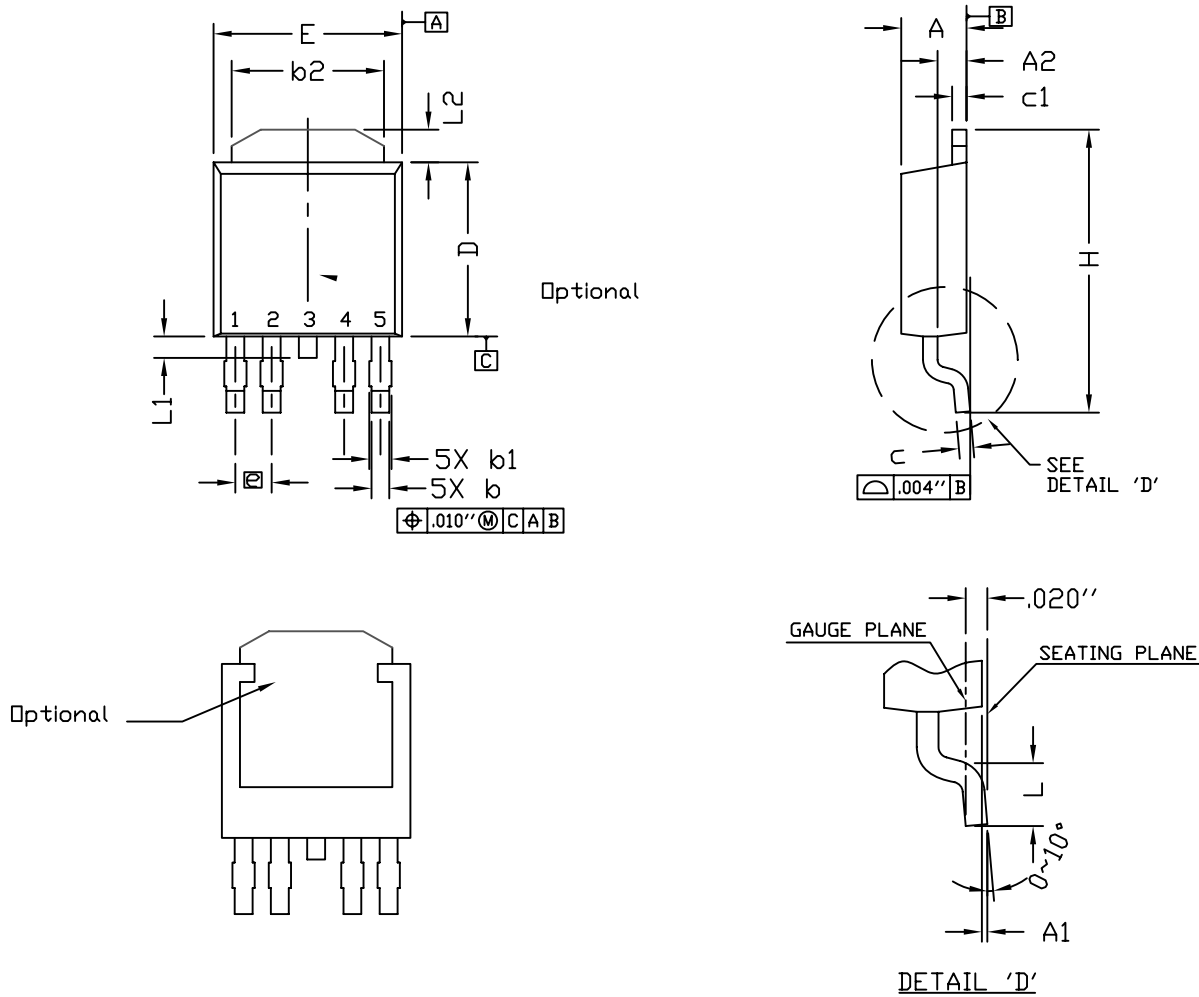


**Normalized Thermal Transient Impedance, Junction-to-Ambient**

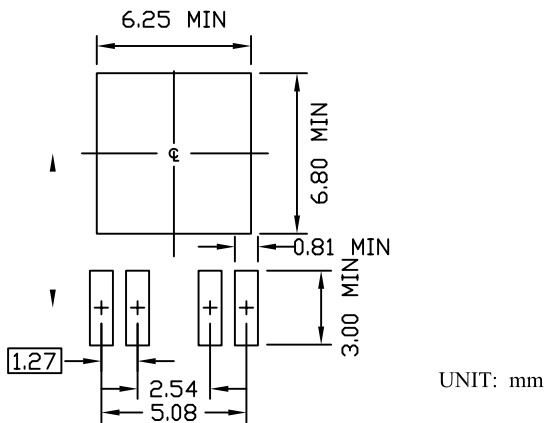
**P-CHANNEL TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

**Normalized Thermal Transient Impedance, Junction-to-Case**
**Note**

- The characteristics shown in the two graphs
  - Normalized Transient Thermal Impedance Junction-to-Ambient ( $25\text{ }^{\circ}\text{C}$ )
  - Normalized Transient Thermal Impedance Junction-to-Case ( $25\text{ }^{\circ}\text{C}$ )
 are given for general guidelines only to enable the user to get a "ball park" indication of part capabilities. The data are extracted from single pulse transient thermal impedance characteristics which are developed from empirical measurements. The latter is valid for the part mounted on printed circuit board - FR4, size 1" x 1" x 0.062", double sided with 2 oz. copper, 100 % on both sides. The part capabilities can widely vary depending on actual application parameters and operating conditions.

# TO-252\_4L Package Outline



## RECOMMENDED LAND PATTERN



### NOTE

1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS. MOLD FLASH SHOULD BE LESS THAN 6 MIL.
2. DIMENSION L IS MEASURED IN GAUGE PLANE.
3. TOLERANCE 0.10 mm UNLESS OTHERWISE SPECIFIED.
4. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.
5. REFER TO JEDEC TO-252 (AD).

| SYMBOL | DIMENSION IN MILLIMETERS |       |        | DIMENSIONS IN INCHES |       |       |
|--------|--------------------------|-------|--------|----------------------|-------|-------|
|        | MIN.                     | NOM.  | MAX.   | MIN.                 | NOM.  | MAX.  |
| A      | 2.184                    | 2.286 | 2.388  | 0.086                | 0.090 | 0.094 |
| A1     | 0.000                    | ----  | 0.127  | 0.000                | ----  | 0.005 |
| A2     | 0.889                    | ----  | 1.143  | 0.035                | ----  | 0.045 |
| b      | 0.508                    | ----  | 0.711  | 0.020                | ----  | 0.028 |
| b1     | 0.584                    | ----  | 0.787  | 0.023                | ----  | 0.031 |
| b2     | 4.953                    | ----  | 5.461  | 0.195                | ----  | 0.215 |
| c      | 0.457                    | 0.508 | 0.610  | 0.018                | 0.020 | 0.024 |
| c1     | 0.457                    | ----  | 0.610  | 0.018                | ----  | 0.024 |
| D      | 5.969                    | 6.096 | 6.223  | 0.235                | 0.240 | 0.245 |
| E      | 6.350                    | 6.604 | 6.731  | 0.250                | 0.260 | 0.265 |
| e      | 1.270 BSC.               |       |        | 0.050 BSC.           |       |       |
| H      | 9.398                    | ----  | 10.414 | 0.370                | ----  | 0.410 |
| L      | 1.270                    | ----  | 2.032  | 0.050                | ----  | 0.080 |
| L1     | ----                     | ----  | 1.016  | ----                 | ----  | 0.040 |
| L2     | 0.889                    | ----  | 1.270  | 0.035                | ----  | 0.050 |

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