# P-Channel 20 V (D-S) MOSFET

## PRODUCT SUMMARY

| $V_{DS}$ (V) | $R_{DS(on)}$ ($\Omega$) | $I_D$ (A) [a, e] | $Q_g$ (TYP.) |
|---|---|---|---|
| -20 | 0.100 at $V_{GS}$ = -4.5 V | -3.7 | 9.5 nC |
| | 0.118 at $V_{GS}$ = -2.5 V | -3.4 | |
| | 0.140 at $V_{GS}$ = -1.8 V | -3.1 | |
| | 0.205 at $V_{GS}$ = -1.5 V | -2 | |

### MICRO FOOT® 1 x 1



Backside View    Bump Side View
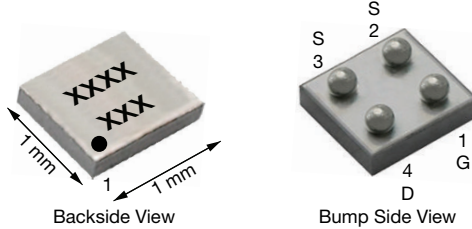
**Marking Code:** xxxx = 8461
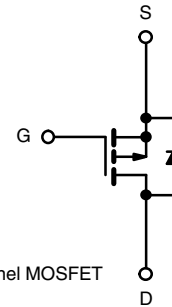xxx = Date / lot traceability code

**Ordering Information:**
Si8461DB-T2-E1 (lead (Pb)-free and halogen-free)

## FEATURES
- TrenchFET® power MOSFET
- Ultra small 1 mm x 1 mm maximum outline
- Ultra-thin 0.548 mm maximum height
- Material categorization:
  for definitions of compliance please see
  www.vishay.com/doc?99912

## APPLICATIONS
- Load switch
- Battery switch
- Charger switch



P-Channel MOSFET

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

| PARAMETER | | SYMBOL | LIMIT | UNIT |
|---|---|---|---|---|
| Drain-Source Voltage | | $V_{DS}$ | -20 | V |
| Gate-Source Voltage | | $V_{GS}$ | ± 8 | |
| Continuous Drain Current ($T_J$ = 150 °C) | $T_A$ = 25 °C | $I_D$ | -3.7 [a] | A |
| | $T_A$ = 70 °C | | -3 [a] | |
| | $T_A$ = 25 °C | | -2.5 [b] | |
| | $T_A$ = 70 °C | | -1.9 [b] | |
| Pulsed Drain Current | | $I_{DM}$ | -20 | |
| Continuous Source-Drain Diode Current | $T_C$ = 25 °C | $I_S$ | -1.5 [a] | |
| | $T_A$ = 25 °C | | -0.65 [b] | |
| Maximum Power Dissipation | $T_A$ = 25 °C | $P_D$ | 1.8 [a] | W |
| | $T_A$ = 70 °C | | 1.1 [a] | |
| | $T_A$ = 25 °C | | 0.78 [b] | |
| | $T_A$ = 70 °C | | 0.5 [b] | |
| Operating Junction and Storage Temperature Range | | $T_J$, $T_{stg}$ | -55 to +150 | °C |
| Package Reflow Conditions [c] | VPR | | 260 | |
| | IR/Convection | | 260 | |

## THERMAL RESISTANCE RATINGS

| PARAMETER | | SYMBOL | TYPICAL | MAXIMUM | UNIT |
|---|---|---|---|---|---|
| Maximum Junction-to-Ambient [f, g] | t = 10 s | $R_{thJA}$ | 55 | 70 | °C/W |
| Maximum Junction-to-Ambient [h, i] | t = 10 s | | 125 | 160 | |

**Notes**
a. Surface mounted on 1" x 1" FR4 board with full copper, t = 10 s.
b. Surface mounted on 1" x 1" FR4 board with minimum copper, t = 10 s.
c. Refer to IPC/JEDEC® (J-STD-020), no manual or hand soldering.
d. In this document, any reference to case represents the body of the MICRO FOOT device and foot is the bump.
e. Based on $T_A$ = 25 °C.
f. Surface mounted on 1" x 1" FR4 board with full copper.
g. Maximum under steady state conditions is 100 °C/W.
h. Surface mounted on 1" x 1" FR4 board with minimum copper.
i. Maximum under steady state conditions is 190 °C/W.

For technical questions, contact: pmostechsupport@vishay.com

## SPECIFICATIONS ($T_J$ = 25 °C, unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Static** | | | | | | |
| Drain-Source Breakdown Voltage | $V_{DS}$ | $V_{GS}$ = 0 V, $I_D$ = -250 µA | -20 | - | - | V |
| $V_{DS}$ Temperature Coefficient | $\Delta V_{DS}/T_J$ | $I_D$ = -250 µA | - | -12 | - | mV/°C |
| $V_{GS(th)}$ Temperature Coefficient | $\Delta V_{GS(th)}/T_J$ | | - | 2.5 | - | |
| Gate-Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = -250 µA | -0.4 | - | -1 | V |
| Gate-Source Leakage | $I_{GSS}$ | $V_{DS}$ = 0 V, $V_{GS}$ = ± 8 V | - | - | ± 100 | nA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = -20 V, $V_{GS}$ = 0 V | - | - | -1 | µA |
| | | $V_{DS}$ = -20 V, $V_{GS}$ = 0 V, $T_J$ = 70 °C | - | - | -10 | |
| On-State Drain Current [a] | $I_{D(on)}$ | $V_{DS} \leq$ -5 V, $V_{GS}$ = -4.5 V | -10 | - | - | A |
| Drain-Source On-State Resistance [a] | $R_{DS(on)}$ | $V_{GS}$ = -4.5 V, $I_D$ = -1.5 A | - | 0.083 | 0.100 | Ω |
| | | $V_{GS}$ = -2.5 V, $I_D$ = -1.5 A | - | 0.098 | 0.118 | |
| | | $V_{GS}$ = -1.8 V, $I_D$ = -1 A | - | 0.115 | 0.140 | |
| | | $V_{GS}$ = -1.5 V, $I_D$ = -0.5 A | - | 0.136 | 0.205 | |
| Forward Transconductance [a] | $g_{fs}$ | $V_{DS}$ = -10 V, $I_D$ = -1 A | - | 7 | - | S |
| **Dynamic [b]** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{DS}$ = -10 V, $V_{GS}$ = 0 V, f = 1 MHz | - | 610 | - | pF |
| Output Capacitance | $C_{oss}$ | | - | 120 | - | |
| Reverse Transfer Capacitance | $C_{rss}$ | | - | 95 | - | |
| Total Gate Charge | $Q_g$ | $V_{DS}$ = -10 V, $V_{GS}$ = -8 V, $I_D$ = 1 A | - | 16 | 24 | nC |
| | | $V_{DS}$ = -10 V, $V_{GS}$ = -4.5 V, $I_D$ = 1 A | - | 9.5 | 15 | |
| Gate-Source Charge | $Q_{gs}$ | | - | 0.9 | - | |
| Gate-Drain Charge | $Q_{gd}$ | | - | 2.6 | - | |
| Gate Resistance | $R_g$ | $V_{GS}$ = -0.1 V, f = 1 MHz | - | 6.5 | - | Ω |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD}$ = -10 V, $R_L$ = 10 Ω $I_D \cong$ -1 A, $V_{GEN}$ = -4.5 V, $R_g$ = 1 Ω | - | 15 | 25 | ns |
| Rise Time | $t_r$ | | - | 25 | 40 | |
| Turn-Off Delay Time | $t_{d(off)}$ | | - | 35 | 55 | |
| Fall Time | $t_f$ | | - | 10 | 15 | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD}$ = -10 V, $R_L$ = 10 Ω $I_D \cong$ -1 A, $V_{GEN}$ = -8 V, $R_g$ = 1 Ω | - | 7 | 15 | |
| Rise Time | $t_r$ | | - | 12 | 20 | |
| Turn-Off Delay Time | $t_{d(off)}$ | | - | 32 | 50 | |
| Fall Time | $t_f$ | | - | 12 | 20 | |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Continuous Source-Drain Diode Current | $I_S$ | $T_A$ = 25 °C | - | - | -1.5 | A |
| Pulse Diode Forward Current | $I_{SM}$ | | - | - | -20 | |
| Body Diode Voltage | $V_{SD}$ | $I_S$ = -1 A, $V_{GS}$ = 0 V | - | -0.8 | -1.2 | V |
| Body Diode Reverse Recovery Time | $t_{rr}$ | $I_F$ = -1 A, dI/dt = 100 A/µs, $T_J$ = 25 °C | - | 15 | 30 | ns |
| Body Diode Reverse Recovery Charge | $Q_{rr}$ | | - | 10 | 20 | nC |
| Reverse Recovery Fall Time | $t_a$ | | - | 9 | - | ns |
| Reverse Recovery Rise Time | $t_b$ | | - | 6 | - | |

**Notes**

a. Pulse test; pulse width ≤ 300 µs, duty cycle ≤ 2 %.
b. Guaranteed by design, not subject to production testing.

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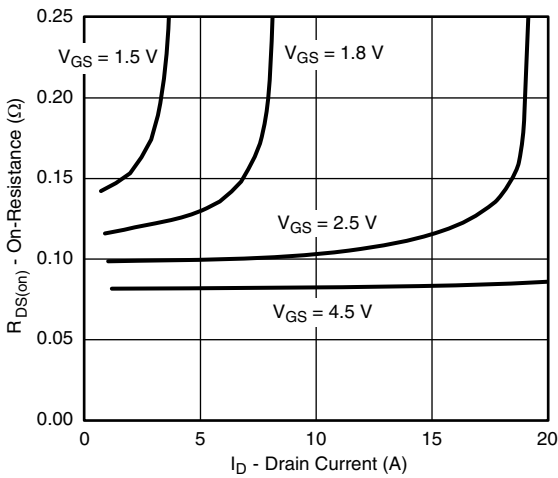
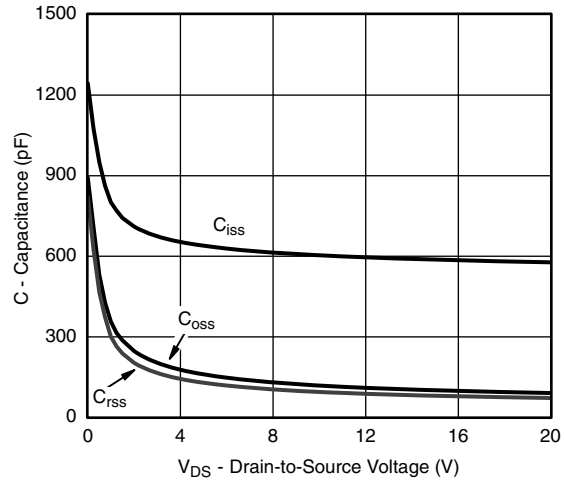**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)
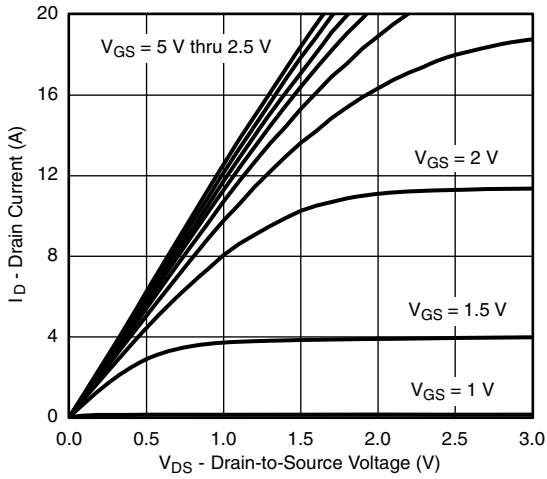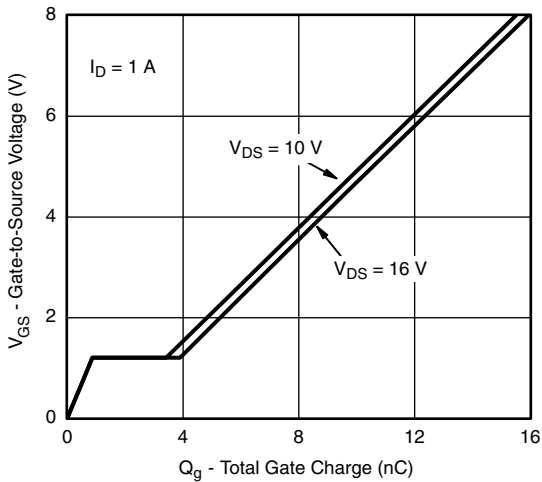


Output Characteristics
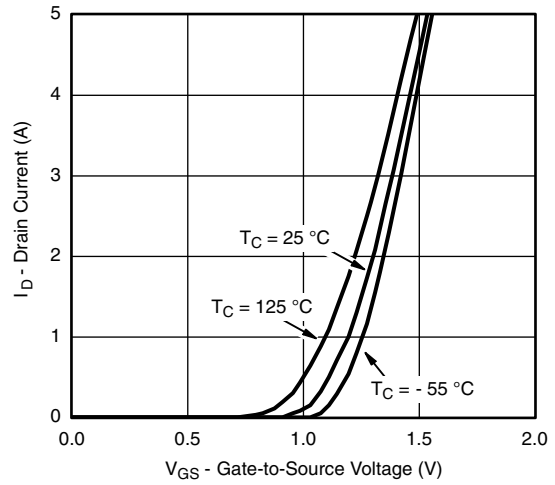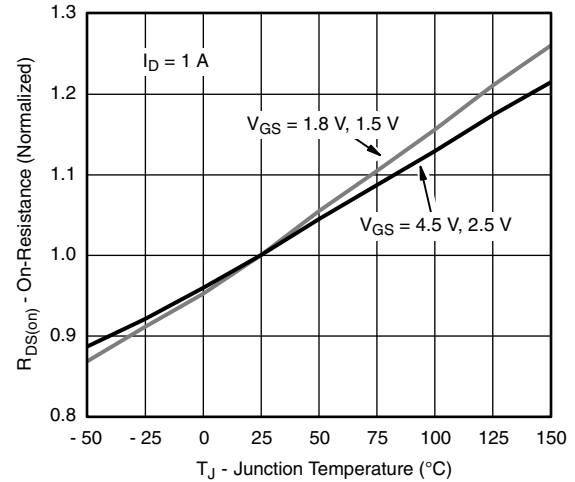


Transfer Characteristics



On-Resistance vs. Drain Current and Gate Voltage



Capacitance



Gate Charge



On-Resistance vs. Junction Temperature

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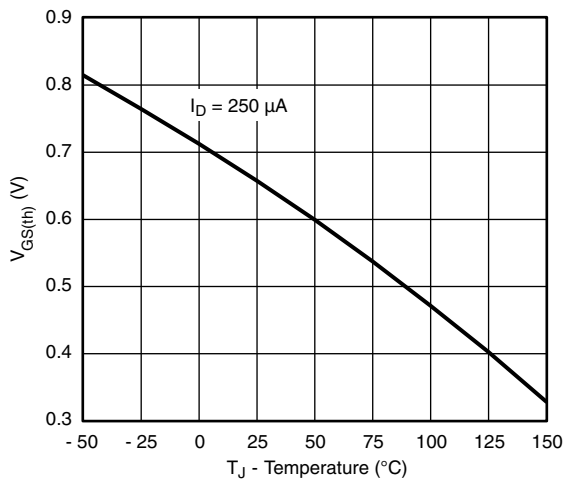
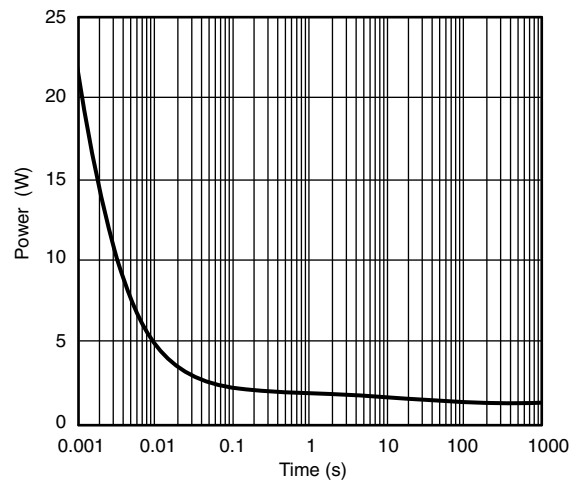**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)
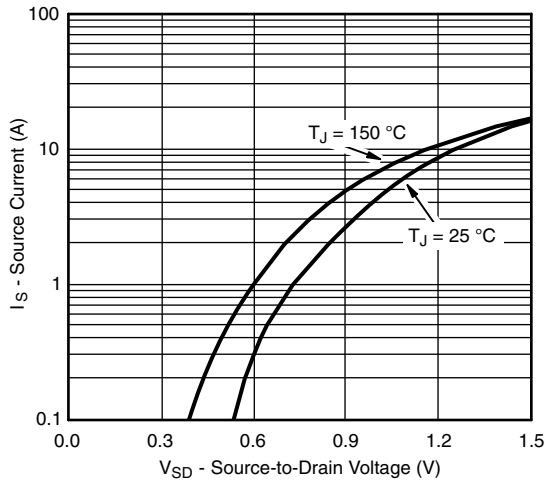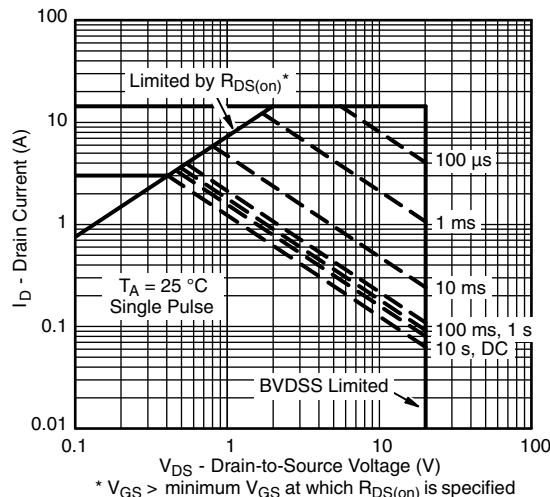
Source-Drain Diode Forward Voltage
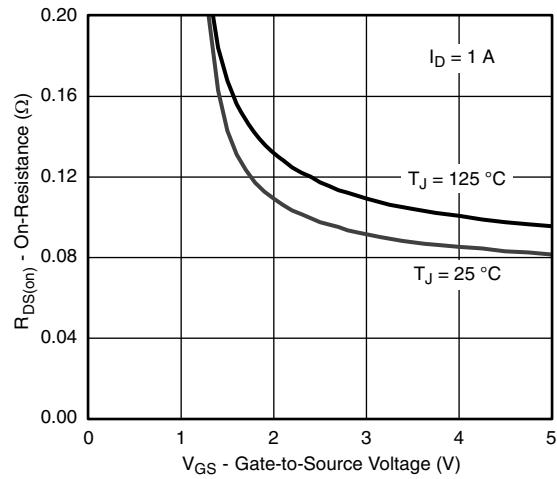
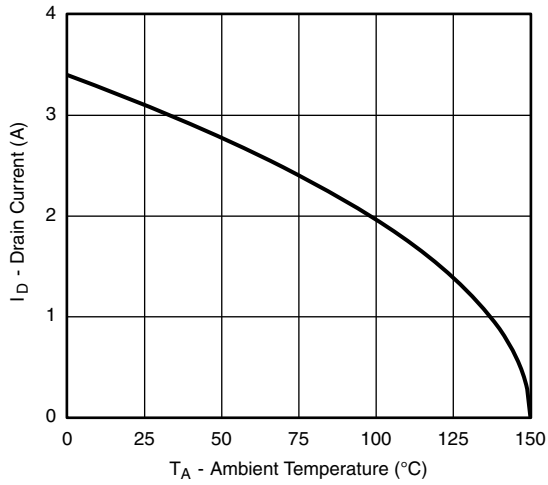On-Resistance vs. Gate-to-Source Voltage

Threshold Voltage

Single Pulse Power, Junction-to-Ambient

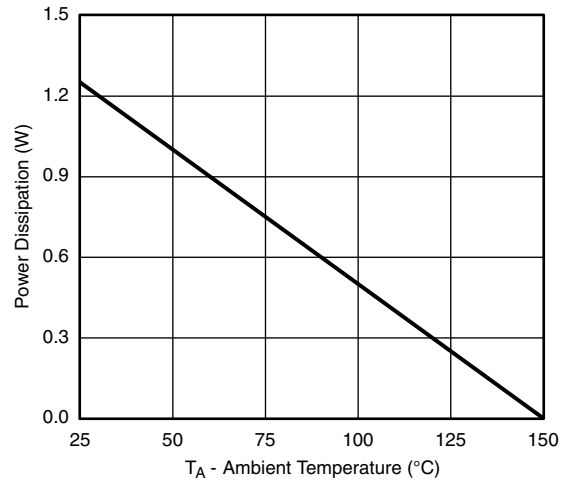Safe Operating Area, Junction-to-Ambient

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



**Current Derating** [a]



**Power Derating**

**Note**
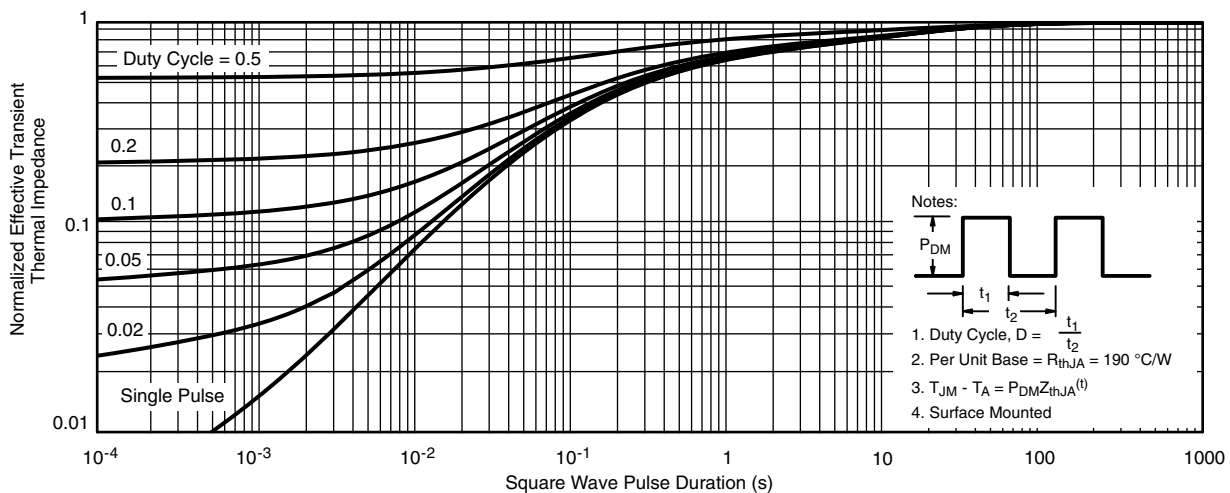- When mounted on 1" x 1" FR4 with full copper.

**Note**

a. The power dissipation $P_D$ is based on $T_J$ (max.) = 150 °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit.

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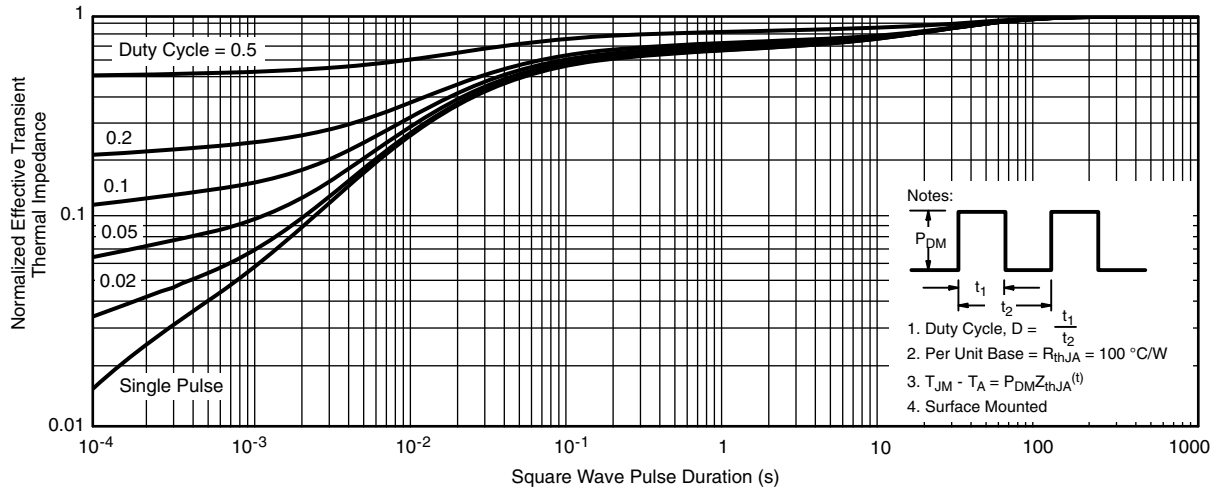


**Normalized Thermal Transient Impedance, Junction-to-Ambient (1" x 1" FR4 Board with Full Copper)**



**Normalized Thermal Transient Impedance, Junction-to-Ambient (1" x 1" FR4 Board with Minimum Copper)**

For technical questions, contact: pmostechsupport@vishay.com

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# MICRO FOOT®: 4-Bumps
# (1 mm x 1 mm, 0.5 mm Pitch, 0.286 mm Bump Height)

Mark on backside of die

XXXX
. XXX

Note 5

4x Ø b1

4x 0.30 to 0.31
(Note 3)
Solder mask-0.4

Recommended land pattern

Bump (Note 1)

## Notes
1. Bumps are 95.5/3.8/0.7 Sn/Ag/Cu.
2. Backside surface is coated with a Ti/Ni/Ag layer.
3. Non-solder mask defined copper landing pad.
4. Laser mark on the backside surface of die.
5. "b1" is the diameter of the solderable substrate surface, defined by an opening in the solder resist layer solder mask defined.
6. • is the location of pin 1

| DIM. | MILLIMETERS | | | INCHES | | |
|------|------|------|------|------|------|------|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 0.458 | 0.504 | 0.550 | 0.0180 | 0.0198 | 0.0217 |
| A1 | 0.214 | 0.250 | 0.286 | 0.0084 | 0.0098 | 0.0113 |
| A2 | 0.244 | 0.254 | 0.264 | 0.0096 | 0.0100 | 0.0104 |
| b | 0.297 | 0.330 | 0.363 | 0.0117 | 0.0130 | 0.0143 |
| b1 | | 0.250 | | | 0.0098 | |
| e | | 0.500 | | | 0.0197 | |
| s | 0.210 | 0.230 | 0.250 | 0.0083 | 0.0091 | 0.0096 |
| D | 0.920 | 0.960 | 1.000 | 0.0362 | 0.0378 | 0.0394 |
| K | 0.029 | 0.065 | 0.102 | 0.0011 | 0.0026 | 0.0040 |

## Note
• Use millimeters as the primary measurement.

ECN: T15-0176-Rev. A, 27-Apr-15
DWG: 6039

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MIC4420CM-TR  VN1206L  SBVS138LT1G  614234A  715780A  NTNS3166NZT5G  SSM6J414TU,LF(T  751625C  BUK954R8-60E
DMN3404LQ-7  NTE6400  SQJ402EP-T1-GE3  2SK2614(TE16L1,Q)  2N7002KW-FAI  DMN1017UCP3-7  EFC2J004NUZTDG  ECH8691-
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NTE2967  NTE2969  NTE2976  NTE455  NTE6400A  NTE2910  NTE2916  NTE2956  NTE2911  DMN2080UCB4-7  TK10A80W,S4X(S
SSM6P69NU,LF  DMP22D4UFO-7B