# EMIPAK 2B PressFit Full Bridge Inverter Silicon Carbide MOSFET Power Modules

EMIPAK 2B
(package example)

## FEATURES

- Silicon carbide power MOSFET
- Very tight variation of on-resistance vs. temperature
- Slight variation of switching losses with temperature
- Very fast body diode
- PressFit pins technology
- Exposed $Al_2O_3$ substrate with low thermal resistance
- Low input capacitance
- Low internal inductance
- Easy to drive
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS
COMPLIANT

| PRIMARY CHARACTERISTICS | |
|---|---|
| FULL BRIDGE INVERTER - Q1 to Q6 MOSFET | |
| $V_{DSS}$ | 1200 V |
| $R_{DS(on)}$ typical at $I_D$ = 20 A | 71 mΩ |
| $I_D$ at $T_C$ = 80 °C | 26 A |
| Type | Modules - MOSFET |
| Package | EMIPAK 2B |
| Circuit configuration | Full bridge |

## DESCRIPTION

The EMIPAK 2B package is easy to use thanks to the PressFit pins. The exposed substrate provides improved thermal performance.

The optimized layout also helps to minimize stray parameters, allowing for better EMI performance.

## TYPICAL APPLICATIONS

- Solar inverter

| ABSOLUTE MAXIMUM RATINGS | | | | |
|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | MAX. | UNITS |
| Operating junction temperature | $T_J$ | | 175 | °C |
| Storage temperature range | $T_{Stg}$ | | -40 to +150 | |
| RMS isolation voltage | $V_{ISOL}$ | $T_J$ = 25 °C, all terminals shorted, f = 50 Hz, t = 1 s | 3500 | V |
| **Q1 to Q6 - MOSFET** | | | | |
| Drain to source voltage | $V_{DSS}$ | | 1200 | V |
| Gate to source voltage | $V_{GSS}$ | | -10 / +25 | |
| Pulsed drain current | $I_{DM}$ (1) | | 90 | A |
| Continuous drain current | $I_D$ | $T_C$ = 25 °C | 32 | A |
| | | $T_C$ = 80 °C | 26 | |
| | | $T_{SINK}$ = 80 °C | 22 | |
| Power dissipation | $P_D$ | $T_C$ = 25 °C | 143 | W |
| | | $T_C$ = 80 °C | 90 | |
| Pulsed source current (body diode) | $I_{SM}$ | | 90 | A |

**Note**

(1) Pulse width limited by safe operating area

| **ELECTRICAL SPECIFICATIONS** ($T_J$ = 25 °C unless otherwise noted) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| **Q1 to Q6 - MOSFET** | | | | | | |
| Drain to source on resistance | $R_{DS(on)}$ | $V_{GS}$ = 20 V, $I_D$ = 20 A | - | 71 | 105 | mΩ |
| | | $V_{GS}$ = 20 V, $I_D$ = 20 A, $T_J$ = 150 °C | - | 79 | - | |
| | | $V_{GS}$ = 20 V, $I_D$ = 20 A, $T_J$ = 175 °C | - | 81 | - | |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS} = V_{GS}$, $I_D$ = 1.0 mA | 1.6 | 3.6 | 6.5 | V |
| Temperature coefficient of threshold voltage | $\Delta V_{GS(th)}/\Delta T_J$ | $V_{DS} = V_{GS}$, $I_D$ = 1.0 mA (25 °C to 125 °C) | - | -8.3 | - | mV/°C |
| Forward transconductance | $g_{fs}$ | $V_{DS}$ = 20 V, $I_D$ = 20 A | - | 9.5 | - | S |
| Transfer characteristics | $V_{GS}$ | $V_{DS}$ = 20 V, $I_D$ = 20 A | - | 12 | - | V |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{GS}$ = 0 V, $V_{DD}$ = 1200 V | - | 25 | 230 | μA |
| | | $V_{GS}$ = 0 V, $V_{DD}$ = 1200 V, $T_J$ = 150 °C | - | 50 | - | |
| Gate to source leakage current | $I_{GSS}$ | $V_{GS}$ = +20 V / -10 V, $V_{DS}$ = 0 V | - | - | 150 | nA |
| **Q1 to Q6 - BODY DIODE** | | | | | | |
| Forward voltage drop | $V_{SD}$ | $I_{SD}$ = 10 A; $V_{GS}$ = 0 | - | 3.2 | - | V |

| **SWITCHING CHARACTERISTICS** ($T_J$ = 25 °C unless otherwise noted) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| **Q1 to Q6 - MOSFET** | | | | | | |
| Total gate charge (turn-on) | $Q_g$ | $I_D$ = 20 A<br>$V_{DD}$ = 800 V<br>$V_{GS}$ = 20 V | - | 105 | - | nC |
| Gate to source charge (turn-on) | $Q_{gs}$ | | - | 16 | - | |
| Gate to drain charge (turn-on) | $Q_{gd}$ | | - | 40 | - | |
| Turn-on delay time | $t_{d(on)}$ | $I_D$ = 20 A<br>$V_{DD}$ = 600 V<br>$V_{GS}$ = +20 V/-2 V<br>$R_g$ = 4.7 Ω, L = 500 μH | - | 41 | - | ns |
| Rise time | $t_r$ | | - | 29 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 79 | - | |
| Fall time | $t_f$ | | - | 62 | - | |
| Turn-on delay time | $t_{d(on)}$ | $I_D$ = 20 A<br>$V_{DD}$ = 600 V<br>$V_{GS}$ = +20 V/-2 V<br>$R_g$ = 4.7 Ω, L = 500 μH, $T_J$ = 150 °C | - | 41 | - | ns |
| Rise time | $t_r$ | | - | 30 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 91 | - | |
| Fall time | $t_f$ | | - | 75 | - | |
| Input capacitance | $C_{iss}$ | $V_{GS}$ = 0 V<br>$V_{DS}$ = 400 V<br>f = 1 MHz | - | 1700 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 130 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 25 | - | |
| **Q1 to Q6 - BODY DIODE** | | | | | | |
| Diode reverse recovery time | $t_{rr}$ | $V_R$ = 400 V, $T_J$ = 25 °C<br>$I_S$ = 20 A<br>dI/dt = 100 A/μs | - | 140 | - | ns |
| Diode reverse recovery current | $I_{rr}$ | | - | 3.1 | - | A |
| Diode reverse recovery charge | $Q_{rr}$ | | - | 220 | - | nC |

| INTERNAL NTC - THERMISTOR SPECIFICATIONS | | | | |
|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | VALUE | UNITS |
| Resistance | $R_{25}$ | $T_J$ = 25 °C | 22 000 ± 5 % | Ω |
| | $R_{150}$ | $T_J$ = 150 °C | 483.86 ± 5 % | |
| B constant | $B_{25/85}$ | | 3800 ± 1 % | K |
| Operating temperature range at zero power | | | -40 to +150 | °C |
| Maximum dissipation at 25 °C | | | 210 | mW |
| Dissipation factor | D | | 3.5 | mW/K |
| Thermal time constant | τ | | ≈ 10 | s |

| INTERNAL C1 / C3 DC LINK CAPACITOR - ELECTRICAL SPECIFICATIONS | | | | |
|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | VALUE | UNITS |
| Capacitance | C | | 0.047 ± 10 % | μF |
| Voltage | | | 1000 | V |

| THERMAL AND MECHANICAL SPECIFICATIONS | | | | | |
|---|---|---|---|---|---|
| PARAMETER | SYMBOL | MIN. | TYP. | MAX. | UNITS |
| Q1 to Q6 - MOSFET - Junction to case thermal resistance (per switch) | $R_{thJC}$ | - | - | 1.05 | °C/W |
| Q1 to Q6 - MOSFET - Case to sink thermal resistance (per switch) | $R_{thCS}$ | - | 0.55 | - | |
| Mounting torque (M4) [(1)] | | 2 | - | 3 | Nm |
| Weight | | - | 45 | - | g |

**Note**

[(1)] See application note for further suggestion on mounting operation: www.vishay.com/doc?95580.

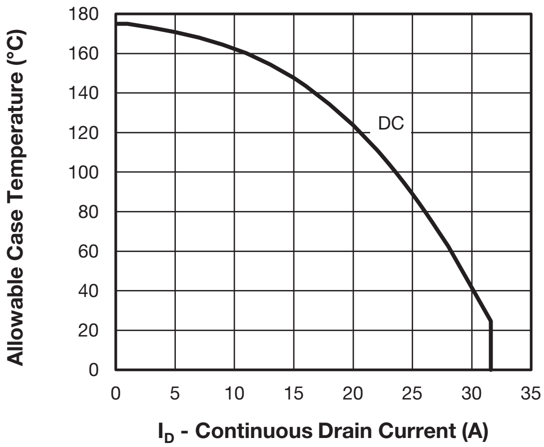



Fig. 1 - Maximum Continuous Drain Current vs. Case Temperature

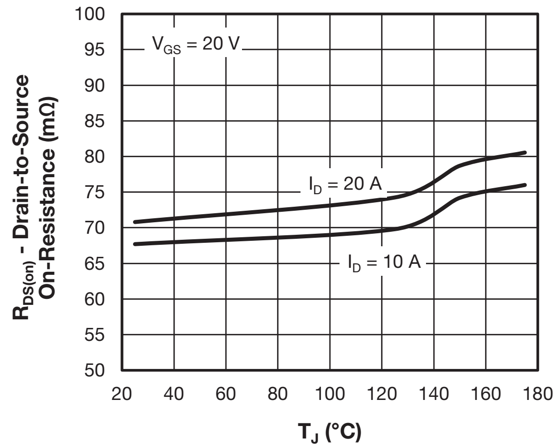



Fig. 4 - Typical Drain-to-Source On-Resistance vs. Temperature

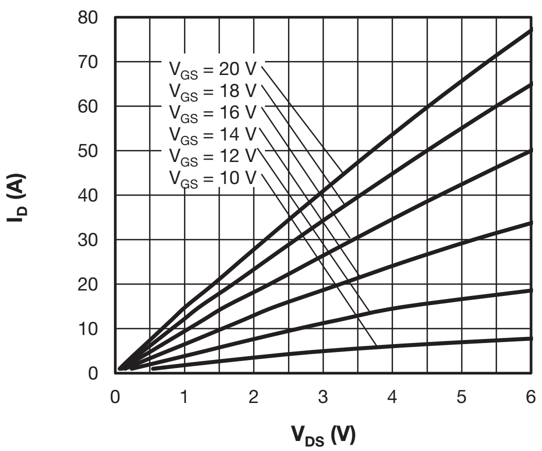



Fig. 2 - Typical Drain-to-Source Current Output Characteristics at $T_J$ = 25 °C

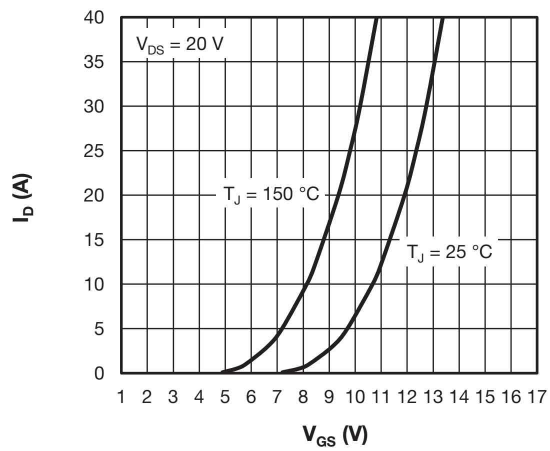



Fig. 5 - Typical Transfer Characteristics

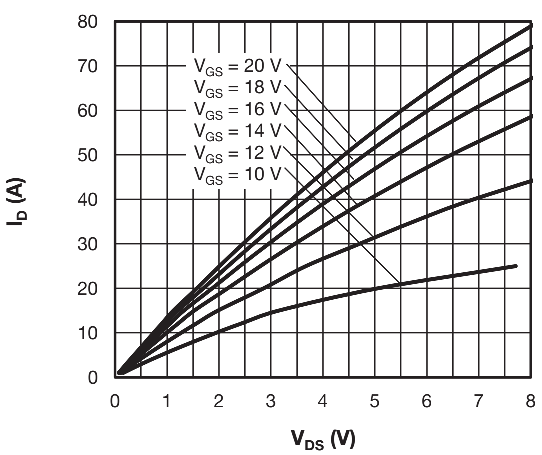



Fig. 3 - Typical Drain-to-Source Current Output Characteristics at $T_J$ = 150 °C

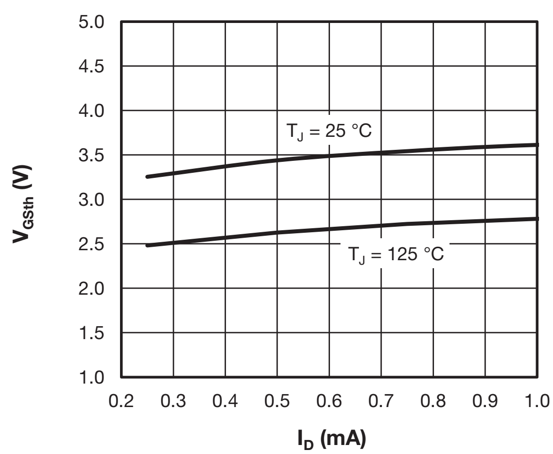



Fig. 6 - Typical Gate Threshold Voltage Characteristics

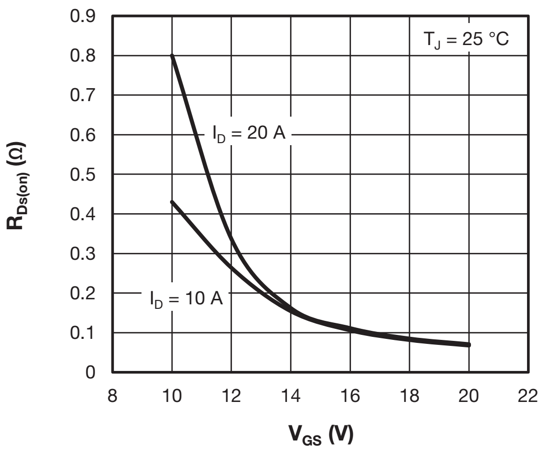



Fig. 7 - Typical Drain-State Resistance vs. Gate-to-Source Voltage

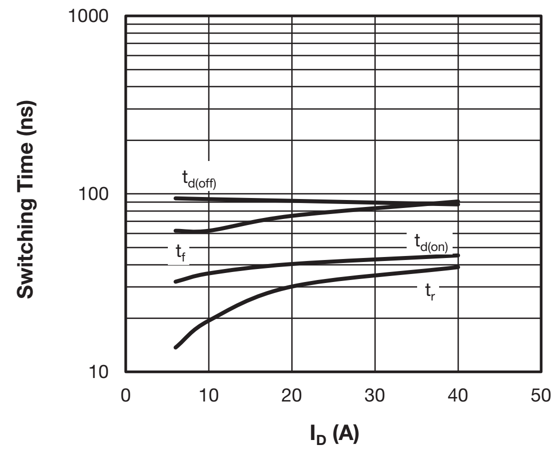



Fig. 10 - Typical Switching Time vs. $I_D$
$T_J$ = 150 °C, $V_{DD}$ = 600 V, $R_g$ = 4.7 Ω, $V_{GS}$ = +20 V/-2 V, L = 500 μH

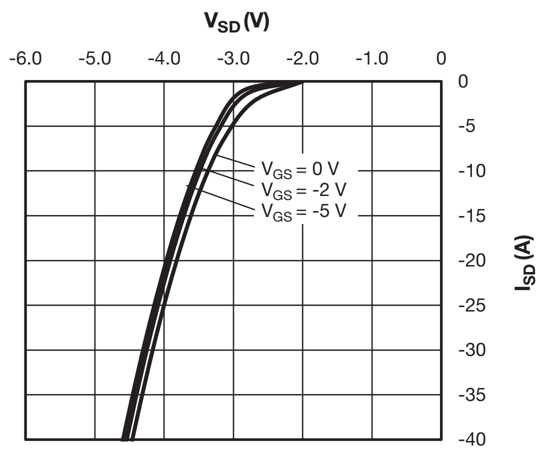



Fig. 8 - Typical Body Diode Source-to-Drain Current Characteristics at $T_J$ = 25 °C

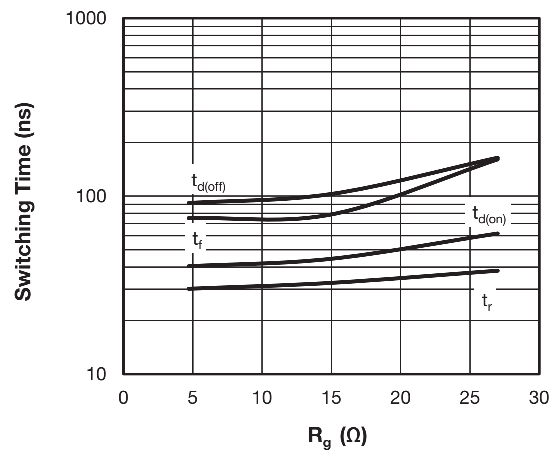



Fig. 11 - Typical Switching Time vs. $R_g$
$T_J$ = 150 °C, $V_{DD}$ = 600 V, $I_D$ = 20 A, $V_{GS}$ = +20 V / -2 V, L = 500 μH

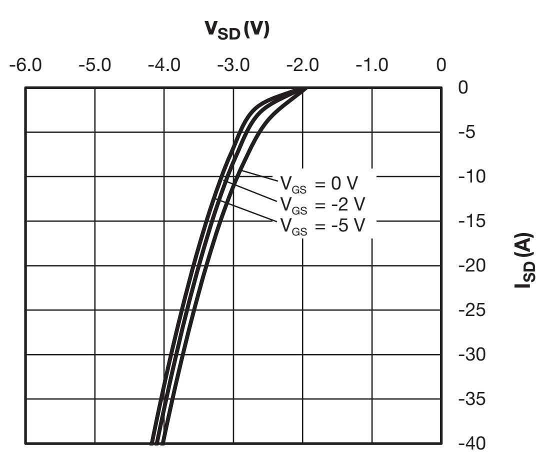



Fig. 9 - Typical Body Diode Source-to-Drain Current Characteristics at $T_J$ = 150 °C

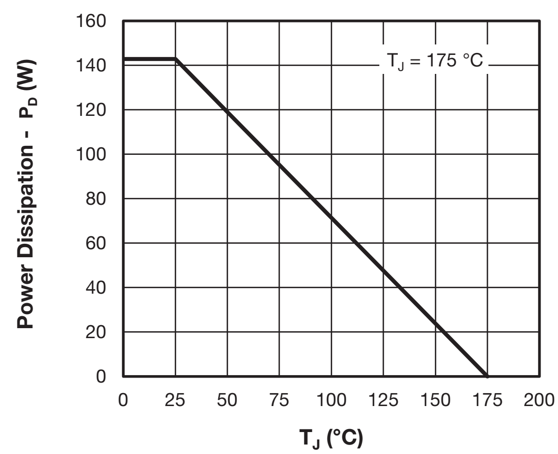



Fig. 12 - Power Dissipation Curve

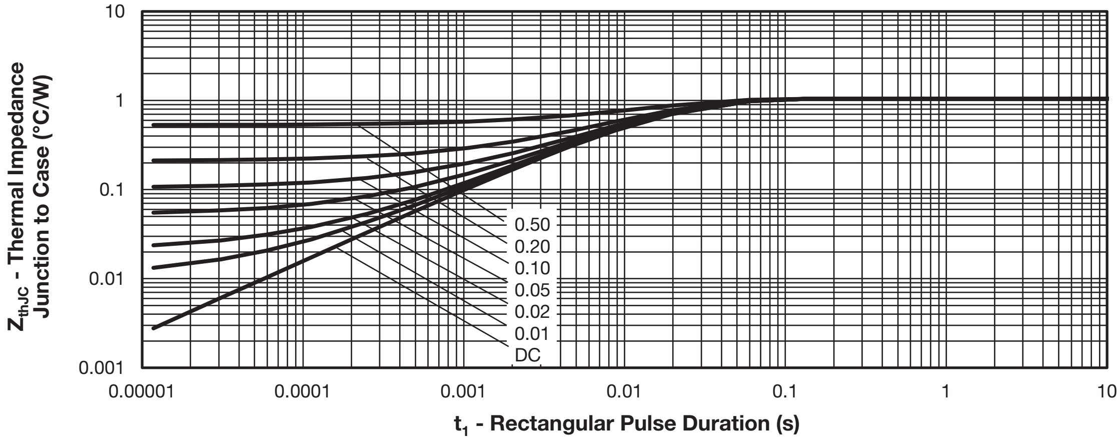



Fig. 13 - Maximum Thermal Impedance Junction-to-Case Characteristics

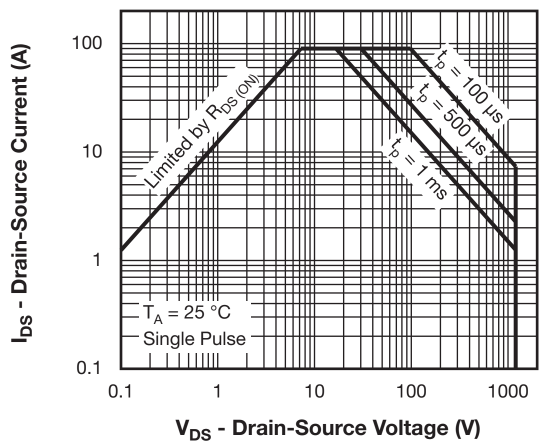
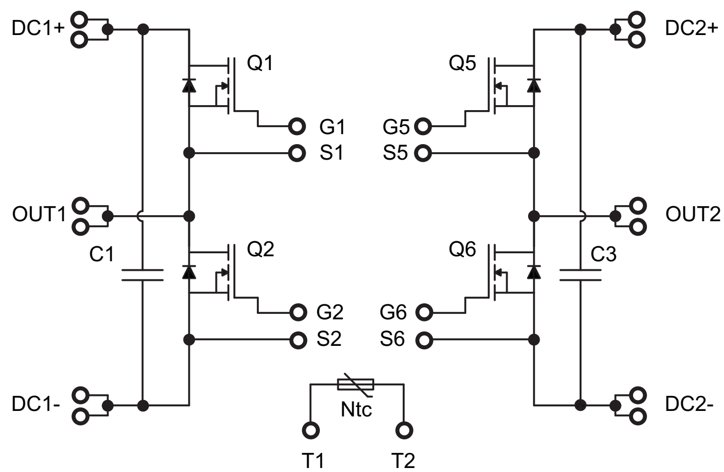



Fig. 14 - Safe Operating Area

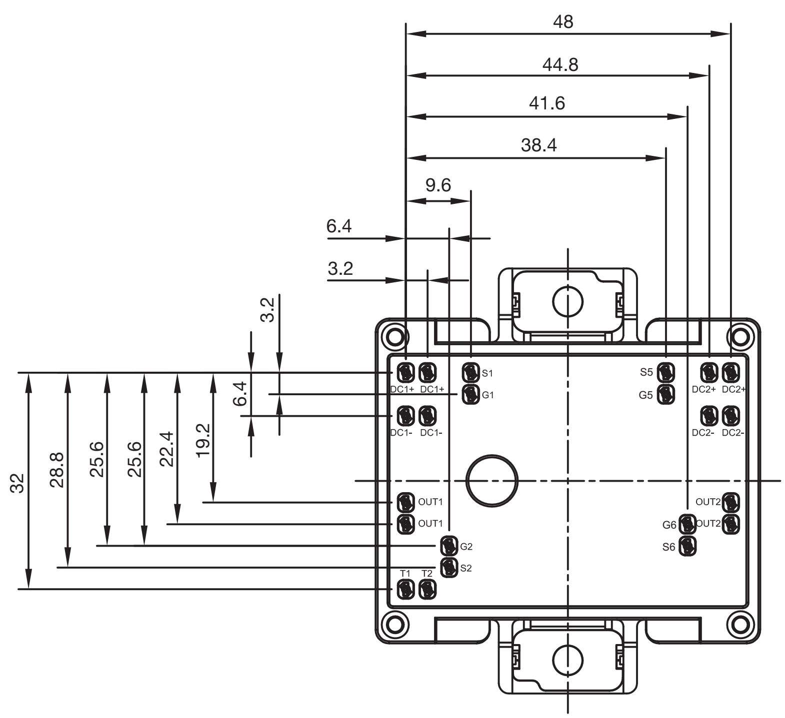
## ORDERING INFORMATION TABLE

| Device code | VS- | ET | Y | 020 | P | 120 | F |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

| | | |
|---|---|---|
| 1 | - | Vishay Semiconductors product |
| 2 | - | Package indicator (ET = EMIPAK 2B) |
| 3 | - | Circuit configuration (Y = full bridge inverter) |
| 4 | - | Current rating (020 = 20 A) |
| 5 | - | Switch die technology |
| 6 | - | Voltage rating (120 = 1200 V) |
| 7 | - | Diode die technology |

| CIRCUIT CONFIGURATION | | |
|---|---|---|
| CIRCUIT | CIRCUIT CONFIGURATION CODE | CIRCUIT DRAWING |
| Full bridge inverter | Y |   |

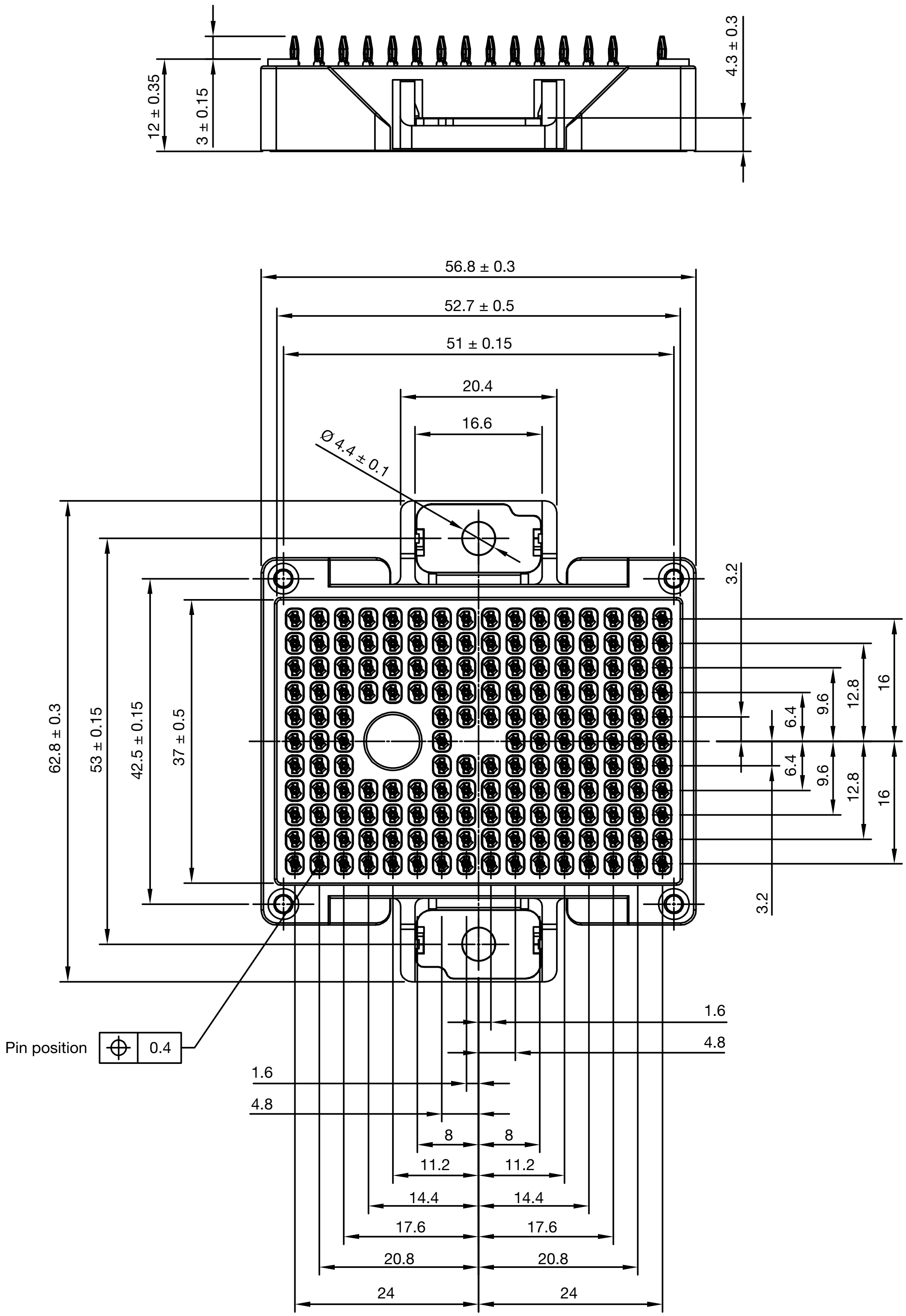
## PACKAGE




| LINKS TO RELATED DOCUMENTS | |
|---|---|
| Dimensions | www.vishay.com/doc?95559 |

# EMIPAK-2B PressFit

**DIMENSIONS** in millimeters



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